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Schistosomiasis and Soil-Transmitted Helminth Burden Among School Children in Misrata, Libya: A Cross-Sectional Study

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داء البلهارسيات والديدان الطفيلية المنقولة بالتربة بين أطفال المدارس في مصراتة: دراسة مقطعية

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Abstract:
Schistosomiasis and soil-transmitted helminthiases pose significant public health challenges, particularly affecting pediatric populations in endemic regions. This cross-sectional study investigated the prevalence of Schistosoma haematobium and intestinal helminth infections among school-aged children in Misrata, Libya. A total of 200 children aged 5-15 years were enrolled from local schools. Urine and stool samples were collected and examined for Schistosoma haematobium and soil-transmitted helminths (STHs), respectively. Packed cell volume (PCV) measurements were taken to assess anemia status. The overall prevalence of S. haematobium infection was 16.2%, with the highest rate observed in the 6–10-year age group. Intestinal helminth infections were also prevalent, with Strongyloides stercoralis, Schistosoma mansoni, and Trichuris trichiura being the most common (12.5% each) among children ≤5 years old. Ascaris lumbricoides infection was detected in 2.9% of the 6–10-year-olds. Negative correlations were found between PCV values and the prevalence of S. haematobium (r=-0.582, p<0.001), S. mansoni (r=-0.328, p<0.001), T. trichiura (r=-0.427, p<0.001), A. lumbricoides (r=-0.223, p=0.001), and S. stercoralis (r=-0.231, p=0.001).The findings highlight the significant burden of schistosomiasis and STH infections among school-aged children in Misrata, Libya, and the potential impact on anemia status. Targeted control strategies and continuous monitoring are warranted to mitigate the adverse effects of these neglected tropical diseases.

Keywords: Schistosomiasis, Soil-Transmitted Helminths, Anemia, Neglected Tropical Diseases, School Children, Libya.

الملخص
تشكل داء البلهارسيات والديدان المعوية المنقولة بالتربة تحديات صحية عامة كبيرة، خاصةً في أوساط populations الأطفال في المناطق الموبوءة. تهدف هذه الدراسة المقطعية إلى التحقيق في انتشار داء البلهارسيات (Schistosoma haematobium) والعدوى بالديدان المعوية بين الأطفال في سن المدرسة في مصراتة، ليبيا. تم تسجيل 200 طفل تتراوح أعمارهم بين 5-15 سنة من المدارس المحلية. تم جمع عينات البول والبراز وفحصها للكشف عن وجود داء البلهارسيات (Schistosoma haematobium) والديدان المعوية (STHs) على التوالي. كما تم قياس حجم الخلايا المعبأة (PCV) لتقييم حالة فقر الدم. كان الانتشار العام للإصابة بداء البلهارسيات (S. haematobium) 16.2%، مع أعلى معدل لوحظ في فئة العمر من 6 إلى 10 سنوات. كما كانت العدوى بالديدان المعوية شائعة، حيث كانت ديدان (Strongyloides stercoralis)و (Schistosoma mansoni)و (Trichuris trichiura)الأكثر شيوعًا (12.5% لكل منها) بين الأطفال دون سن 5 سنوات. تم الكشف عن إصابة (Ascaris lumbricoides) بنسبة 2.9% من الأطفال في الفئة العمرية 6-10 سنوات. وُجدت علاقات سلبية بين قيم PCV وانتشار (S. haematobium) (r=-0.582و، p<0.001) ، (S. mansoni) (r=-0.328و، p<0.001)، (T. trichiura) (r=-0.427و، p<0.001)، (A. lumbricoides) (r=-0.223و، p=0.001)، و (S. stercoralis) (r=-0.231، p=0.001).). تسلط النتائج الضوء على عبء داء البلهارسيات والعدوى بالديدان المعوية الكبيرة بين الأطفال في سن المدرسة

في مصـراتة، ليبيا، والأثر المحتمل على حالة فقر الدم. تتطلب اسـتراتيجيات السـيطرة المسـتهدفة والمراقبة المسـتمرة للحد من الآثار السـلبية لهذه الأمراض الاستوائية المهملة.

1. Introduction

Schistosomiasis, a debilitating neglected tropical disease (NTD) caused by trematode infections with Schistosoma spp., remains a significant public health challenge in many parts of the world. This parasitic disease primarily afflicts impoverished rural communities, but its reach has extended to urban areas and travelers to endemic regions [1]. The disease manifests in two distinct forms: (i) intestinal schistosomiasis, caused by S. mansoni, S. japonicum, S. mekongi, and S. guineensis; and (ii) urogenital schistosomiasis, solely transmitted by S. haematobium [2]. Schistosomiasis transmission is facilitated by poor hygiene and sanitation conditions, as well as direct contact with freshwater sources harboring the infective cercariae larvae. The life cycle of Schistosoma involves freshwater snails as intermediate hosts, where the larvae undergo asexual reproduction before emerging as cercariae capable of penetrating human skin upon water exposure [3],[4]. This mode of transmission underscores the disease's strong association with water-related activities such as swimming, bathing, and washing clothes in contaminated water bodies.

As of January 2020, schistosomiasis remains endemic in 78 tropical and subtropical countries, with 51 of these nations classified as having moderate to severe infection levels, necessitating preventive treatment with praziquantel [5]. Globally, over 236 million individuals are infected, with over 90% residing in Africa. In 2016 alone, schistosomiasis claimed approximately 24,000 lives and accounted for 2.5 million disability-adjusted life years (DALYs), although these figures are likely underestimated due to data limitations, measurement challenges, and other factors [5],[6].
Alongside schistosomiasis, soil-transmitted helminthiases (STHs) pose another significant NTD burden, particularly among vulnerable populations. STHs are caused by intestinal parasites such as roundworms (Ascaris lumbricoides), whipworms (Trichuris trichiura), hookworms (Ancylostoma duodenale and Necator americanus), and the threadworm Strongyloides stercoralis [7]. Human transmission occurs through fecal contamination of soil in unsanitary environments, with subsequent ingestion or skin penetration of the infectious eggs or larvae.

In 2019, 92 countries were identified as having endemic levels of hookworm, T. trichiura, and A. lumbricoides infections, necessitating mass drug administration (MDA) with albendazole or mebendazole [5]. The global burden of STHs in 2016 was estimated at 1.5 billion infections, 6,300 deaths, and 3.5 million DALYs, highlighting the substantial impact of these neglected diseases [6]. Accurate quantification of S. stercoralis burden remains a challenge due to diagnostic limitations [8]. Libya, a North African country, has a long-standing history of schistosomiasis infections. The first documented case dates back to 1925 in the Ghat region, followed by another report in 1932 from Wadi Shati in the southern Fezzan region [9]. Both S. haematobium and S. mansoni species are indigenous to Libya, with an estimated national prevalence of 5% as of 2003 [10],[11]. However, the country's predominantly hot, dry, and sandy terrain, coupled with highly salinized water sources, has limited the widespread colonization of snail intermediate hosts, resulting in an irregular distribution of the disease [12].

In Libya, the intermediate snail hosts for S. haematobium are Bulinus globosus and Bulinus truncatus. After their initial discovery in the Ghat district in 1957, there was a prolonged period without reported human infections [9]. On the other hand, S. mansoni, transmitted by Biomphalaria alexandrina snails, is currently endemic in the Taourga region, while B. truncatus has been reported as endemic in one location in the Alfogaha district [13],[14]. Despite the limited endemicity of schistosomiasis in Libya and the World Health Organization's (WHO) efforts to eliminate the disease, sporadic new cases continue to emerge. This cross-sectional study aimed to investigate the current prevalence of Schistosoma haematobium transmission among school-aged children in the Misrata area of Libya. Additionally, the study sought to examine the relationships between these infections and factors such as age, gender, and the presence of anemia.

1.2 Research Problem

Schistosomiasis and soil-transmitted helminthiases (STHs) are neglected tropical diseases that pose a significant public health burden, particularly among vulnerable populations such as school-aged children in endemic regions. These parasitic infections can have detrimental effects on children's health, growth, and cognitive development, perpetuating cycles of poverty and hindering socioeconomic progress. Despite ongoing control efforts, the prevalence of these diseases remains a concern in many parts of the world, including Libya.

1.3 Research Questions:

The research question can be articulated as follows:

1. What is the current prevalence of Schistosoma haematobium and soil-transmitted helminth infections among school-aged children in the Misrata area of Libya?
2. Is there a relationship between the prevalence of these infections and factors such as age and gender?
3. Does the presence of Schistosoma haematobium and soil-transmitted helminth infections correlate with the occurrence of anemia in the studied population?

1.4 Significance of the research

This cross-sectional study holds significant importance in several aspects:

1. Epidemiological Data: The study will provide updated epidemiological data on the burden of schistosomiasis and STHs among school-aged children in the Misrata region of Libya, contributing to the understanding of the current disease landscape and informing targeted control measures.
2. Risk Factor Identification: By examining the potential relationships between infection prevalence and factors such as age and gender, the study may identify high-risk groups and inform targeted interventions and resource allocation.
3. Anemia Assessment: The investigation of the correlation between these parasitic infections and anemia status will shed light on the potential impact of these diseases on children's health and well-being, highlighting the need for integrated control strategies.
4. Evidence-Based Interventions: The findings of this study will provide valuable evidence to support the development and implementation of effective control programs, including mass drug administration, health education, and improved sanitation and hygiene measures, tailored to the specific needs of the Misrata region.
5. Contribution to Sustainable Development Goals: By addressing neglected tropical diseases, this research aligns with the United Nations' Sustainable Development Goals, particularly those related to good health and well-being, quality education, and the reduction of poverty and inequalities.

2. Materials and Methods

- **Study Area**

This cross-sectional study was conducted in the city of Misrata, located in the Misrata District of northwestern Libya. Misrata is the third-largest city in Libya, with an estimated population of approximately 881,000 inhabitants. It is situated on the Mediterranean coast, 187 kilometers (116 miles) east of Tripoli and 825 kilometers (513 miles) west of Benghazi. The city's location is characterized by golden sands dotted with palm and olive trees to the south, and the Mediterranean Sea to the north and east.

- **Study Design and Eligibility Criteria**

Regarding study design and eligibility criteria, Table 1 delineates the criteria for samples.

Table 1: Samples' criteria.

Criteria Type	Description
Study Design	Cross-sectional study focusing on school-aged children in the Misrata region.
Inclusion Criteria	1. School-aged children residing in the study area. 2. Willingness to participate in the study. 3. No intake of anti-helminthic medication within the last six months prior to the study. 4. Absence of any serious medical condition. 5. Parental or guardian consent for participation.
Exclusion Criteria	1. Unable to provide informed consent. 2. Lack of parental or guardian permission. 3. Unfit to participate due to illness or other reasons.

- **Sampling and Population**

The study population consisted of children enrolled in three schools within the Misrata region, including one primary and one secondary school. A total of 200 children aged 4 to 17 years were recruited for the study. Each participant provided one urine sample and one stool sample, which were collected in separate, sterile, leak-proof, wide-mouthed containers pre-labeled with the participant's identification number. The samples were transferred to the laboratory within two hours of collection for examination. Additionally, a blood sample was obtained from each participant to determine the packed cell volume (PCV).

Table 2: Methodologies for Determination of PCV and Detection of Helminth Infections.

Methodology Component	Description
Determination of PCV	- Procedure: Heparinized blood samples centrifuged at 10,000 × g for five minutes in sealed capillary tubes. - Analysis: PCV read using a micro-hematocrit reader. - Classification: Anemic if PCV < 31%. Further classified into mild anemia (PCV 21–30%), moderate anemia (PCV 15–20%), and severe anemia (PCV ≤15%).
Microscopic Examination	- Procedure: Microscopic examinations of helminth eggs using the Kato-Katz (KK) slide method. - Quality Control: Random re-examination of 20% of slides by a second blinded microscopist.
Urine Filtration Analysis	- Procedure: Filtration of 10 mL of freshly collected urine through a micro-filter membrane (MF) to detect Schistosoma haematobium eggs. - Analysis: Eggs observed under a microscope at 10× magnification. - Classification: <50 eggs/10 mL as light infection, ≥50 eggs/10 mL as heavy infection.
Detection of Intestinal Helminths	- Procedure: Use of the Kato-Katz thick smear method. - Quantification: Intensity of infection expressed as eggs per gram (epg) of feces, calculated by multiplying the total egg count by 24. - Classification: WHO categories: light (epg < 100), moderate (epg 100–399), or heavy (epg ≥ 400) infection.

- **Statistical Analysis**

The Statistical Package for Social Sciences (SPSS), version 26 for Windows, was used for data analysis. The chi-square test ($\chi 2$) was employed to evaluate the prevalence and variations in parasitism among the different age groups of children. Pearson's correlation was used to assess the correlation between sociodemographic data, PCV, and soil-transmitted helminth infection parameters. A p-value of <0.05 was considered statistically significant.

- **Ethical Considerations**

The study received approval from the Research and Ethics Committee of [institution name], Libya (reference number: [insert reference number]). Prior to sample collection, consultations were held with community leaders, educators, and community members. Informed consent letters were provided, and the purpose of the study, methods, types of specimens required, benefits to participants and the community, and associated risks were explained to parents and children. Verbal consent was obtained from parents and authorized guardians for their children's participation in the study. Due to the low literacy levels among many parents, the ethical committee approved the use of oral consent.

3. Results

- **Demographic Characteristics of Participants**

The cohort had a mean age of 10.82 years (SD = 2.649), predominantly male (61%). A significant age-based stratification was observed, with 62% of children aged 10 years or older. Statistical tests indicated significant differences based on sex (p=0.002) and age (p<0.001). Table 3 illustrates Demographic Characteristics. Moreover, the demographic analysis of the cohort reveals a mean age of 10.82 years with a standard deviation of 2.649, indicating a moderate spread around the mean age. The group is predominantly male, comprising 61% of the participants. This gender distribution is statistically significant with a p-value of 0.002, suggesting a notable difference in the number of males compared to females. Age distribution shows a significant stratification; 62% of the participants are aged 10 years or older, which is supported by a highly significant p-value of less than 0.001. This indicates a clear majority of older children within the cohort. Figure 1 presents demographic characteristics of participants.

Table 3: Demographic Characteristics.

Variable	Categories	Frequency (%)	p-value
Sex	Male	122 (61%)	0.002*
	Female	78 (39%)	-
Age	≤5 years	8 (4%)	<0.001**
	6-10 years	68 (34%)	-
	≥10 years	124 (62%)	-
General	Mean ± SD	10.82 ± 2.649	-
	Median	11 (4-17)	-

*p<0.05: significant; **p<0.001: highly significant; SD: standard deviation

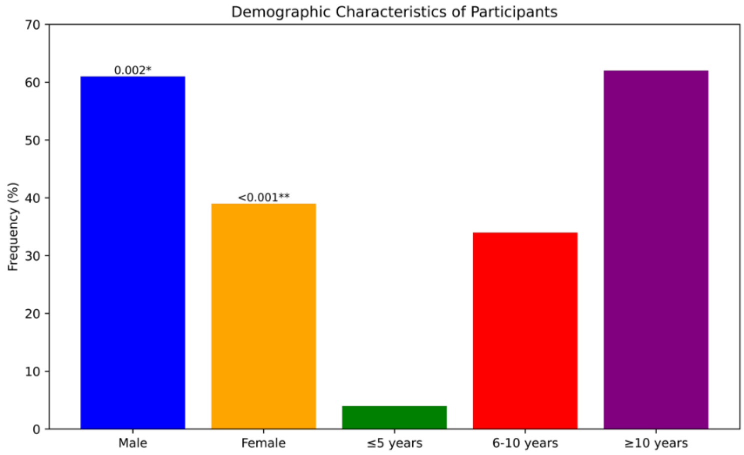

Figure 1: Demographic characteristics of participants.

The age categories further break down as 4% of participants being 5 years or younger, 34% between 6 to 10 years, and the majority (62%) being older than 10 years. The median age is 11 years, with an age range from 4 to 17 years. These statistics underscore significant demographic disparities based on sex and age within the study group, highlighting the need for careful consideration of these variables in further analyses and discussions.

- **Packed Cell Volume and Anemia Prevalence**

The mean PCV was found to be 31.82% (SD = 8.503%), with 23% of participants identified as anemic, underscoring a substantial burden of anemia within this population. The distribution of anemia severity was as follows: 9.5% severe, 4.5% moderate, and 9% mild. Table 4 presents PCV Values and Anemia Prevalence.

Table 4: PCV Values and Anemia Prevalence.

PCV (%)	Mean ± SD	31.82 ± 8.503	<0.001**
Median	35 (9-44)	-	-
Anemia status	Normal	154 (77%)	-
	Anemic	46 (23%)	-
	Mild	18 (9%)	-
	Moderate	9 (4.5%)	-
	Severe	19 (9.5%)	-

The analysis of Packed Cell Volume (PCV) and anemia prevalence in the cohort reveals a mean PCV of 31.82% with a standard deviation of 8.503%, indicating a considerable variation in PCV values among participants as presented in Figure 2. The median PCV is 35%, with a range from 9% to 44%, highlighting the broad spread of PCV levels within this group. Anemia affects a significant portion of the cohort, with 23% of participants classified as anemic. This prevalence is broken down into 9.5% with severe anemia, 4.5% with moderate anemia, and 9% with mild anemia. The majority of the participants, 77%, are categorized under normal anemia status. These findings underscore a substantial burden of anemia within the population, with a notable proportion of severe cases. The statistical significance of these findings is highly significant (p<0.001), emphasizing the critical nature of anemia as a health issue in this demographic.

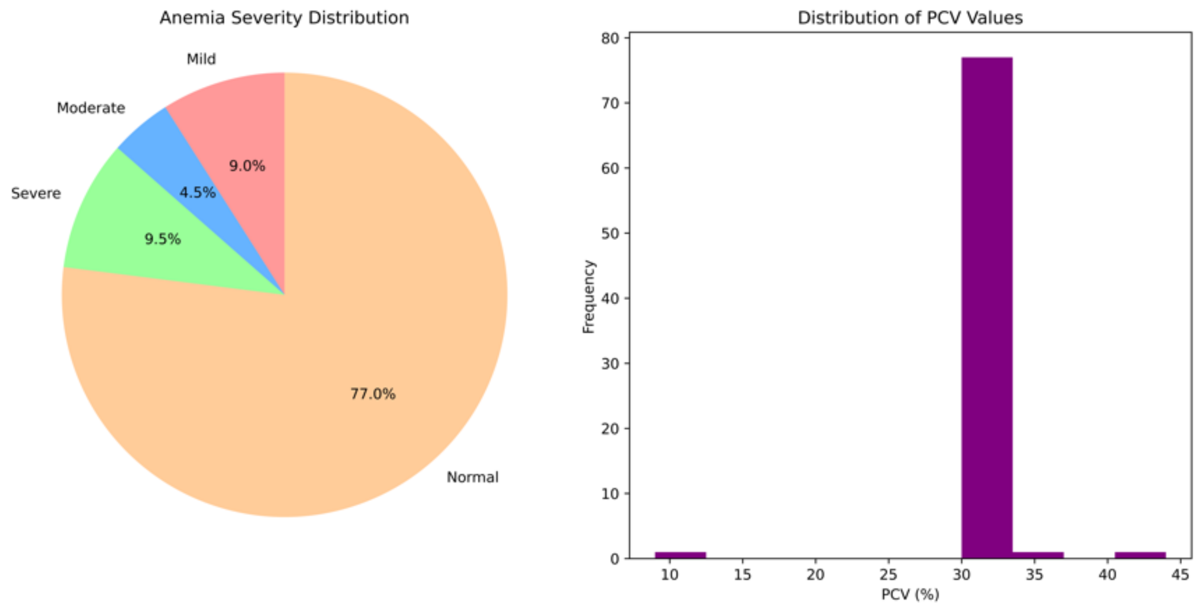

Figure 2: Anemia severity distribution and distribution of PCV values.

The pie chart on the left illustrates the breakdown of anemia severity among the participants, showing that a significant portion of the cohort is normal, with smaller proportions experiencing varying degrees of anemia. The histogram on the right displays the distribution of PCV values, highlighting the spread and central tendency of these values within the cohort.

- **Prevalence and Distribution of Soil-Transmitted Helminths**

The study highlights the significant prevalence and distribution of Soil-Transmitted Helminths (STH) among the participants, with Schistosoma haematobium emerging as the most prevalent at 15.5%. Other helminths such as Schistosoma mansoni and Trichuris trichiura were also detected with prevalence rates of 5% and 6.5%, respectively. Strongyloides stercoralis and Ascaris lumbricoides each showed a lower prevalence of 2.5%. Notably, no cases of hookworm infection were identified in the cohort. All detected infections, except for the absence of hookworm, have a highly significant statistical association with p-values of less than 0.001, indicating a strong epidemiological relevance of these findings. This data underscores the varied burden of STH infections within this population, with Schistosoma haematobium being the most dominant, suggesting targeted interventions could be beneficial. Table 5 shows prevalence of STH Infection.

Table 5: Prevalence of STH Infection.

STH	Positive (%)	Negative (%)	p-value
Strongyloides stercoralis	5 (2.5%)	195 (97.5%)	<0.001**
Schistosoma mansoni	10 (5%)	190 (95%)	<0.001**
Schistosoma haematobium	31 (15.5%)	169 (84.5%)	<0.001**
Trichuris trichiura	13 (6.5%)	187 (93.5%)	<0.001**
Ascaris lumbricoides	5 (2.5%)	195 (97.5%)	<0.001**
Hookworm	0 (0%)	200 (100%)	<0.001**

The below chart clearly depicts the comparative prevalence of each type of helminth, highlighting Schistosoma haematobium as the most common infection in the cohort as indicated in Figure 3. The absence of hookworm infections is also notably represented, emphasizing the specific STH challenges faced by this population.

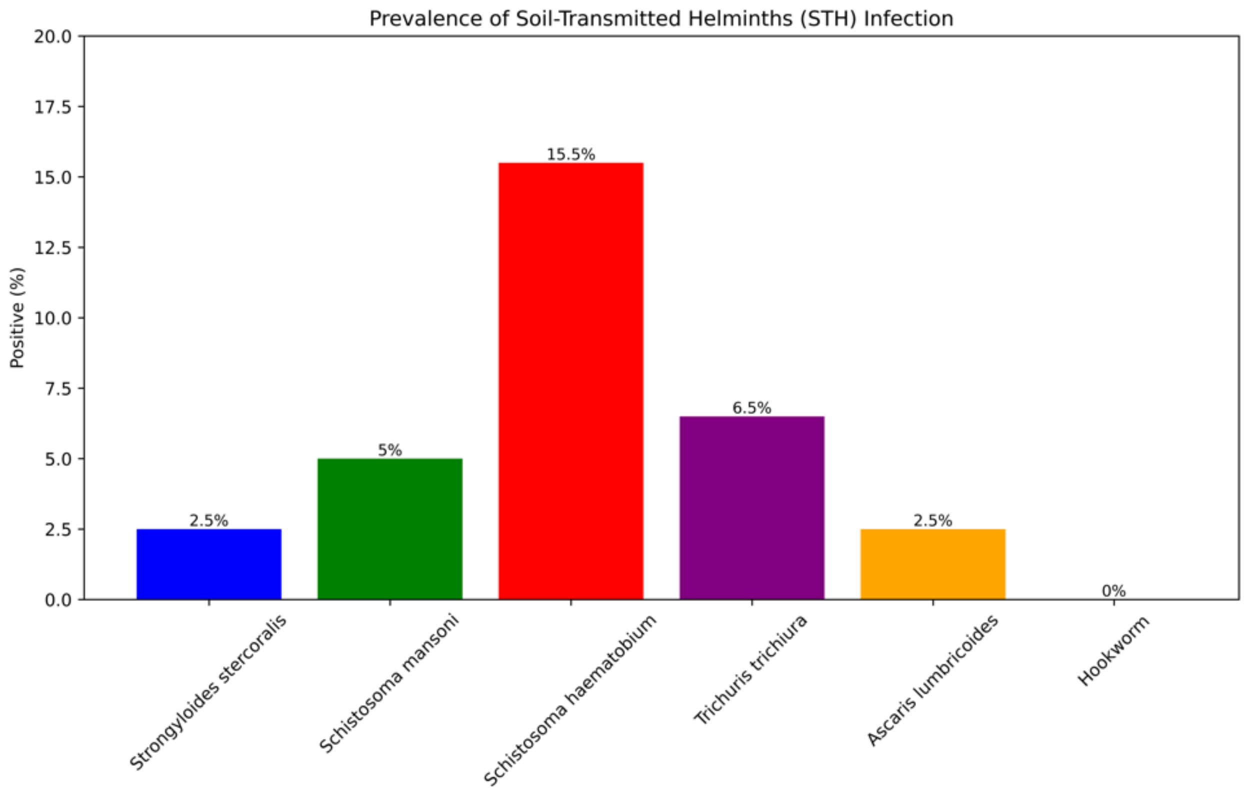

Figure 3: Prevalence of Soil-Transmitted Helminths (STH) infection.

- **Associations Between Demographic Data and STH Infections**

No significant associations were found between sex and STH prevalence. However, a detailed age-based analysisrevealed that younger child (≤5 years) had notably higher prevalence rates for certain infections such as Strongyloides stercoralis, Schistosoma mansoni, and Trichuris trichiura, though these findings did not reach statistical significance. Table 6 demonstrates Association between Sex and STH Infection Prevalence.

Table 6: Association between Sex and STH Infection Prevalence.

STH	Males (n=122)	Females (n=78)	p-value
Strongyloides stercoralis	4 (3.3%)	1 (1.3%)	0.378
Schistosoma mansoni	5 (4.1%)	5 (6.4%)	0.464
Schistosoma haematobium	22 (18%)	9 (11.5%)	0.216
Trichuris trichiura	8 (6.6%)	5 (6.4%)	0.967
Ascaris lumbricoides	4 (3.3%)	1 (1.3%)	0.378
Hookworm	0 (0%)	0 (0%)	-

The analysis of associations between demographic data and Soil-Transmitted Helminths (STH) infections reveals no significant correlations between sex and the prevalence of STH. Specifically, the prevalence rates among males and females for infections such as Strongyloides stercoralis, Schistosoma mansoni, and Schistosoma haematobium show minor differences, with none reaching statistical significance, as indicated by p-values well above the 0.05 threshold. In contrast, age-based analysis indicates a trend where younger children (≤5 years) exhibit higher prevalence rates for certain infections compared to older age groups, although these differences also do not achieve statistical significance. This suggests that while age may influence infection rates, the current sample size or infection distribution does not provide enough evidence to confirm strong demographic associations. These findings highlight the complexity of STH transmission dynamics and suggest that factors beyond simple demographic categorizations may influence infection rates. Table 7 presents association between Age and STH Infection Prevalence.

Table 7: Association between Age and STH Infection Prevalence.

STH	≤5 years (n=8)	6-10 years (n=68)	≥10 years (n=124)	p-value
Strongyloides stercoralis	1 (12.5%)	3 (4.4%)	1 (0.8%)	0.056
Schistosoma mansoni	1 (12.5%)	3 (4.4%)	6 (4.8%)	0.605
Schistosoma haematobium	1 (12.5%)	11 (16.2%)	19 (15.3%)	0.960
Trichuris trichiura	1 (12.5%)	6 (8.8%)	6 (4.8%)	0.440
Ascaris lumbricoides	0 (0%)	2 (2.9%)	3 (2.4%)	0.877
Hookworm	0 (0%)	0 (0%)	0 (0%)	-

The below chart compares the prevalence rates of each STH infection between males and females. It visually underscores the minor differences in infection rates across the sexes, which, as noted, do not reach statistical significance. This visualization aids in understanding the distribution of STH infections relative to gender within the studied cohort. Figure 4 shows prevalence STH infections by sex.

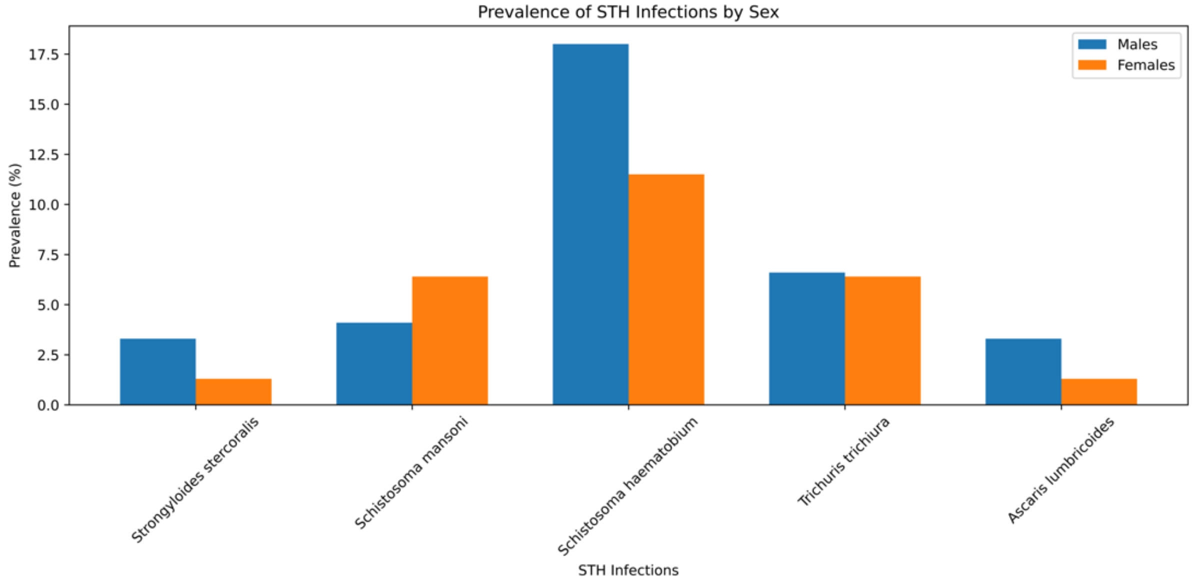

Figure 4: Prevalence STH infections by sex.

- **Correlation between STH Infection, Demographic Data, and PCV**

A significant negative correlation was observed between PCV levels and the prevalence of all detected STH infections, suggesting a detrimental impact on hematological health. Particularly, the strongest correlation was noted with Schistosoma haematobium (r=-0.582, p<0.001), indicating a severe impact on PCV levels. Table 8 indicates Correlation between STH Infections, Demographic Data, and PCV.

Table 8: Correlation between STH Infections, Demographic Data, and PCV.

Variable	Parameter	Strongyloides stercoralis	Schistosoma mansoni	Schistosoma haematobium	Trichuris trichiura	Ascaris lumbricoides
Sex	r-value	0.062	-0.052	0.088	0.003	0.062
	p-value	0.380	0.467	0.218	0.967	0.380
Age	r-value	-0.146*	-0.097	0.035	-0.058	-0.049
	p-value	0.039	0.173	0.621	0.412	0.487
PCV (%)	r-value	-0.231**	-0.328**	-0.582**	-0.427**	-0.223**
	p-value	0.001	<0.001	<0.001	<0.001	0.001

Note:

*Correlation is significant at the 0.05 level (2-tailed).

**Correlation is significant at the 0.01 level (2-tailed).

In an analysis of the correlation between soil-transmitted helminth (STH) infections, demographic data, and packed cell volume (PCV), a significant negative correlation was observed, particularly impacting hematological health. The data revealed that Schistosoma haematobium had the most pronounced negative correlation with PCV levels (r = -0.582, p < 0.001), suggesting a severe detrimental effect.

Other STH infections such as Strongyloides stercoralis, Schistosoma mansoni, Trichuris trichiura, and Ascaris lumbricoides also showed negative correlations with PCV, with correlation coefficients of -0.231, -0.328, -0.427, and -0.223 respectively, all significant at the 0.01 level. Demographic factors such as sex and age showed weaker and mostly non-significant correlations with STH infections, indicating that the impact of these infections on PCV is more substantial than the demographic variations within the studied population. This analysis underscores the critical impact of STH infections on hematological parameters, highlighting the need for targeted interventions to address these infections, particularly in populations vulnerable to Schistosoma haematobium. Figure 5 shows correlation of STH infections with PCV levels.

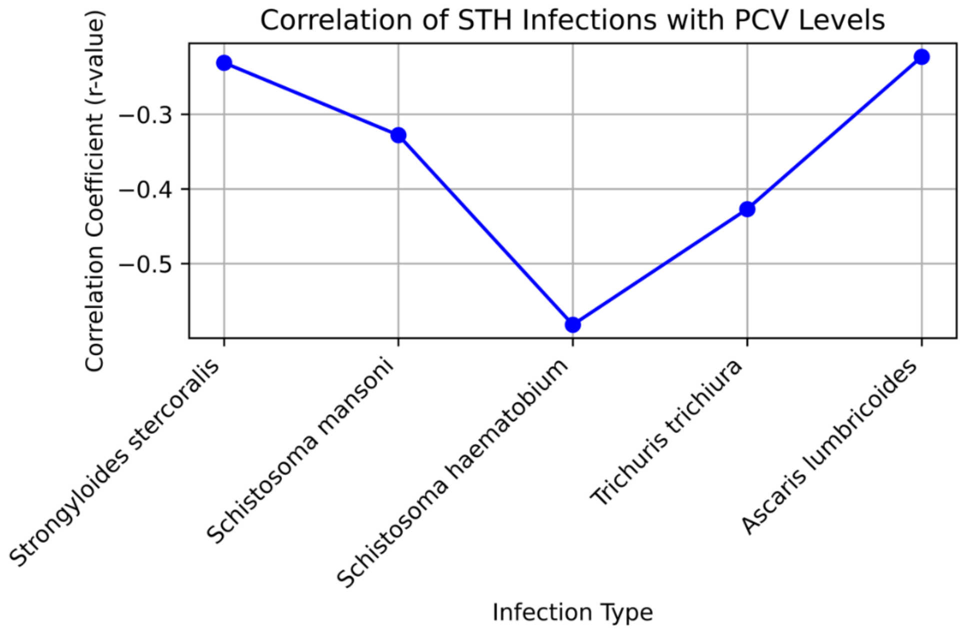

Figure 5: Correlation of STH infections with PCV levels.

4. Discussion

The present cross-sectional study aimed to investigate the prevalence of Schistosoma haematobium transmission and soil-transmitted helminth (STH) infections among school-aged children in the Misrata area of Libya. Additionally, it sought to examine the relationships between these infections and factors such as age, gender, and anemia status. The findings revealed a moderate prevalence of 15.5% for Schistosoma haematobium infection among the studied population. This rate is lower than the 38.4% prevalence reported by Alade et al. (2023) in the Zambezia province [19]. However, it aligns with previous studies that documented a low to moderate prevalence of schistosomiasis in Libya, ranging from 8% for S. mansoni to 15.2% for S. haematobium [3], [19]. The varying prevalence rates observed across different regions and studies may be attributed to factors such as snail distribution, local endemicity of the parasites, geographic location, and laboratory procedures employed.

Regarding intestinal helminth infections, the present study identified Schistosoma haematobium (15.5%) as the most prevalent, followed by Trichuris trichiura (6.5%) and Schistosoma mansoni (5%). These findings contrast with several other studies that reported Ascaris lumbricoides as the most common intestinal parasite [20], [23], [24]. The discrepancies in the observed prevalence rates could be attributed to differences in diagnostic techniques, stool sample volumes, or the number of stool samples examined using the Kato-Katz method. Interestingly, the current study did not find any statistically significant differences in the prevalence of intestinal parasites based on age or gender. This observation is consistent with some previous studies [19], [20], [21], [23], although others have reported age- and gender-related variations in parasite prevalence.

In terms of age-specific patterns, the present study revealed that Strongyloides stercoralis, Schistosoma mansoni, and Trichuris trichiura were commonly detected among younger children aged ≤5 years (12.5% each). The age group of 6-10 years exhibited the highest prevalence of Schistosoma haematobium (16.2%) and Ascaris lumbricoides (2.9%) infections. While no significant correlation was found between age and intestinal or urinary schistosomiasis in this study, Alade et al. (2023) reported an increased prevalence of schistosomiasis among children over 10 years old [19].

A notable finding of the current study was the negative correlation observed between packed cell volume (PCV) values and the prevalence of Strongyloides stercoralis, Schistosoma mansoni, Schistosoma haematobium, Trichuris trichiura, and Ascaris lumbricoides infections. This suggests that anemia may be considered a risk factor associated with human schistosomiasis and intestinal helminth infections. The observed correlation aligns with previous studies that have linked helminth infections, particularly schistosomiasis, to an increased risk of anemia [15],[27],[28]. The prevalence of anemia among the study participants was 23%, which is consistent with the alarming 39.6% prevalence reported by Alade et al. (2023) in Osun State, Nigeria [19]. Anemia represents a significant public health concern for school-aged children, especially in developing countries [24].

- **Implications**

1. The moderate prevalence of schistosomiasis and intestinal helminth infections among school-aged children in the Misrata area highlights the need for targeted control measures and interventions.
2. The observed negative correlation between anemia and parasite infections underscores the importance of integrated control strategies that address both parasitic diseases and nutritional deficiencies.
3. The findings emphasize the necessity for continuous monitoring and surveillance of neglected tropical diseases, as well as the implementation of preventive chemotherapy and health education programs in endemic areas.

- **Limitations**

1. The study was limited to a specific geographic region (Misrata area), and the findings may not be generalizable to other parts of Libya or other countries.
2. The cross-sectional design of the study provides a snapshot of the prevalence at a specific time point, and longitudinal studies may be required to assess temporal trends and the impact of interventions.
3. The study relied on microscopic examination of stool and urine samples, which may have limited sensitivity compared to more advanced diagnostic techniques.

- **Recommendations**

1. Implement targeted mass drug administration campaigns and preventive chemotherapy programs in the Misrata area, focusing on school-aged children and high-risk populations.
2. Strengthen health education and awareness programs to promote good hygiene practices, safe water sources, and improved sanitation facilities, particularly in endemic areas.
3. Conduct regular monitoring and surveillance activities to track the prevalence and distribution of schistosomiasis and intestinal helminth infections, and evaluate the effectiveness of control measures.
4. Integrate deworming programs with interventions aimed at addressing anemia and other nutritional deficiencies, as part of a comprehensive approach to improving child health and well-being.
5. Encourage inter-sectoral collaboration and coordination among relevant stakeholders, including health authorities, educational institutions, and community organizations, to ensure the sustainability and success of control efforts.

5. Conclusion

This cross-sectional study provides valuable insights into the burden of schistosomiasis and soil-transmitted helminth (STH) infections among school-aged children in the Misrata area of Libya. The findings reveal a moderate prevalence of Schistosoma haematobium (15.5%) and intestinal helminth infections, with Trichuris trichiura (6.5%) and Schistosoma mansoni (5%) being the most prevalent after S. haematobium. Notably, the study did not find any significant differences in the prevalence of these infections based on age or gender, suggesting that control measures should target the entire school-aged population in the region. However, the observed negative correlation between packed cell volume

(PCV) values and the prevalence of various parasitic infections highlights the potential impact of these neglected tropical diseases on the anemia status of children.

The 23% prevalence of anemia among the study participants further underscores the need for integrated control strategies that address both parasitic diseases and nutritional deficiencies. Targeted mass drug administration campaigns, preventive chemotherapy programs, and health education initiatives aimed at promoting good hygiene practices, safe water sources, and improved sanitation facilities should be prioritized in the Misrata area. Continuous epidemiological monitoring and surveillance are crucial to track the prevalence and distribution of schistosomiasis and STH infections, as well as to evaluate the effectiveness of control measures. Inter-sectoral collaboration and coordination among relevant stakeholders, including health authorities, educational institutions, and community organizations, are essential to ensure the sustainability and success of these efforts. By addressing the burden of neglected tropical diseases, particularly schistosomiasis and STH infections, among school-aged children, Libya can make significant strides towards improving child health and well-being, reducing the impact of these diseases on educational attainment and cognitive development, and ultimately contributing to the achievement of the Sustainable Development Goals.

References

[1] Dejon-Agobe, J.C., et al., Schistosoma haematobium effects on Plasmodium falciparum infection modified by soil-transmitted helminths in school-age children living in rural areas of Gabon. PLoS neglected tropical diseases, 2018. 12(8): p. e0006663.
[2] Leta, G.T., et al., National mapping of soil-transmitted helminth and schistosome infections in Ethiopia. Parasites & vectors, 2020. 13(1): p. 1-13.
[3] Aribodor, D.N., et al., Analysis of Schistosomiasis and soil-transmitted helminths mixed infections among pupils in Enugu State, Nigeria: Implications for control. Infection, Disease & Health, 2019. 24(2): p. 98-106.
[4] Molvik, M., et al., Co-infection with Schistosoma haematobium and soil-transmitted helminths in rural South Africa. South African Journal of Science, 2017. 113(3-4): p. 1-6.
[5] Organization, W.H., Ending the neglect to attain the sustainable development goals: a rationale for continued investment in tackling neglected tropical diseases 2021–2030. 2022: World Health Organization.
[6] Malecela, M.N. and C. Ducker, *A road map for neglected tropical diseases 2021–2030*. 2021, Oxford University Press. p. 121-123.
[7] Sumbele, I.U.N., et al., Polyparasitism with Schistosoma haematobium, Plasmodium and soil-transmitted helminths in school-aged children in Muyuka–Cameroon following implementation of control measures: a cross sectional study. Infectious Diseases of Poverty, 2021. 10(1): p. 1-16.
[8] Zerdo, Z., et al., Prevalence, intensity and endemicity of intestinal schistosomiasis and soil-transmitted helminthiasis and its associated factors among school-aged children in Southern Ethiopia. Scientific Reports, 2022. 12(1): p. 4586.
[9] Saadawi, W.K., et al., Urogenital schistosomiasis in libya, a case report and evaluation of the current situation. Libyan Journal of Medical Sciences, 2021. 5(2): p. 93-95.
[10] El-Gindy, M. and A. El-Edrissy, Present situation of schistosomiasis in the Libyan Arab Republic. I. Bilharziasis in Ubari District in Fezzan (Sebha Governorate. Egyptian Journal of Bilharziasis, 1975. 2(1): p. 117-130.
[11] Rollinson, D., et al., *Time to set the agenda for schistosomiasis elimination.* Acta tropica, 2013. 128(2): p. 423-440.
[12] Doumenge, J. and K. Mott, *Global distribution of schistosomiasis: CEGET/WHO atlas.* World health statistics quarterly, 1984. 37(2): p. 186-199.
[13] Jones, I., *The history of schistosomiasis in Libya.* Stanford Univ, 2015. 3: p. 1-2.
[14] WHO, E., Inter-country meeting on strategies to eliminate schistosomiasis from the eastern mediterranean region. World Health Organ Tech Rep Ser, 2007. 830: p. 6-8.
[15] Nkuo-Akenji, T.K., et al., Malaria and helminth co-infection in children living in a malaria endemic setting of mount Cameroon and predictors of anemia. Journal of Parasitology, 2006. 92(6): p. 1191-1195.
[16] Ojurongbe, O., et al., Efficacy of praziquantel in the treatment of Schistosoma haematobium infection among school-age children in rural communities of Abeokuta, Nigeria. Infectious Diseases of Poverty, 2014. 3: p. 1-9.

[17] Atalabi, T.E., U. Lawal, and S.J. Ipinlaye, Prevalence and intensity of genito-urinary schistosomiasis and associated risk factors among junior high school students in two local government areas around Zobe Dam in Katsina State, Nigeria. Parasites & Vectors, 2016. 9(1): p. 1-12.
[18] Wiegand, R.E., et al., Associations between infection intensity categories and morbidity prevalence in school-age children are much stronger for Schistosoma haematobium than for S. mansoni. PLoS neglected tropical diseases, 2021. 15(5): p. e0009444.
[19] Alade, T., et al., Prevalence of Schistosoma haematobium and Intestinal Helminth Infections among Nigerian School Children. Diagnostics, 2023. 13(4): p. 759.
[20] Olopade, B., ORIGINAL: Clinical Presentation and Intensity of Infection with Intestinal Helminths among School Children in Ile-Ife, Osun State, Nigeria: West Afr J Med. 2022 Jun 24; 39 (6): 568-572. West Africa Journal of Medicine, 2022. 39(6): p. 568-572.
[21] Agbolade, O.M., et al., Intestinal helminthiases and schistosomiasis among school children in an urban center and some rural communities in southwest Nigeria. The Korean journal of parasitology, 2007. 45(3): p. 233.
[22] Agbolade, O., D. Akinboye, and A. Awolaja, Intestinal helminthiasis and urinary schistosomiasis in some villages of Ijebu North, Ogun State, Nigeria. African journal of Biotechnology, 2004. 3(3): p. 206-209.
[23] Adefioye, O.A., et al., *Intestinal helminthiasis among school children in Ilie, Osun state, Southwest, Nigeria.* Sierra Leone Journal of Biomedical Research, 2011. 3(1): p. 43-48.
[24] Osazuwa, F., O.M. Ayo, and P. Imade, A significant association between intestinal helminth infection and anaemia burden in children in rural communities of Edo state, Nigeria. North American journal of medical sciences, 2011. 3(1): p. 30.
[25] Colley, D.G., et al., *Human schistosomiasis.* The Lancet, 2014. 383(9936): p. 2253-2264.
[26] Weerakoon, K.G., et al., *Advances in the diagnosis of human schistosomiasis.* Clinical microbiology reviews, 2015. 28(4): p. 939-967.
[27] Degarege, A., et al., Plasmodium falciparum and soil-transmitted helminth co-infections among children in sub-Saharan Africa: a systematic review and meta-analysis.Parasites & vectors, 2016. 9: p. 1-10.
[28] M'bondoukwé, N.P., et al., Prevalence of and risk factors for malaria, filariasis, and intestinal parasites as single infections or co-infections in different settlements of Gabon, Central Africa. Infectious Diseases of Poverty, 2018. 7(1): p. 1-17.