VER
Vascular & Endovascular Review

Epidemiological Investigation of Hymenolepis nana Infection Among Laboratory Visitors in Erbil Province

Raman Sherzad Jaafar[1], Zuber Ismael Hassan[2*]

[1,2,] Department of Medical Laboratory, Erbil Technical Health and Medical College, Erbil Polytechnic University, Erbil, Kurdistan Region, Iraq
*Corresponding author: zuberismail@epu.edu.iq

ABSTRACT

Hymenolepis nana, commonly known as the dwarf tapeworm, is a prevalent intestinal parasite found in regions characterized by high population density and inadequate sanitation. This study sought to determine the prevalence of Hymenolepis nana infections among patients visiting the public health laboratory management-Erbil, Iraq, from September 2024 to May 2025. A cross-sectional study was conducted, analyzing a total of 337 stool samples through direct smear microscopy. The overall infection rate was identified at 7.12%, with a higher incidence in males 4.45% compared to females 2.67%. The age group of 21-30 years exhibited the highest infection rate 33.33%. The majority of infected individuals were cleaners 33.33%, followed by workers 16.67% and chefs 16.67%. By nationality, the largest proportion of cases came from Bangladeshi nationals 45.83%, with local nationals constituting 25% of infections, and co-infection with Hymenolepis nana and Entamoeba histolytica in 9 cases 37.5% were positive, also 3 cases 12.5% had co-infection with Hymenolepis nana and Giardia lamblia.

KEYWORDS: Hymenolepis nana, epidemiology, laboratory visitors, Erbil Province.

How to Cite: Raman Sherzad Jaafar, Zuber Ismael Hassan., (2025) Epidemiological Investigation of Hymenolepis nana Infection Among Laboratory Visitors in Erbil Province, Vascular and Endovascular Review, Vol.8, No.15s, 40-45

INTRODUCTION

The dwarf tapeworm, *Hymenolepis nana*, represents a significant global public health challenge, particularly in areas with poor hygiene and sanitation practices. Often referred to as the most widespread tapeworm infection among humans, it predominantly impacts primary school aged residing in unsanitary and densely populated environments (Rawat et al. 2025; Wami 2022). Transmission typically occurs via the fecal-oral route through the ingestion of embryonated eggs found in contaminated food, water, or on hands, making it highly transmissible in community and institutional settings (Njambi et al. 2020).

Hymenolepis nana is a cestode belonging to the phylum Platyhelminthes, residing primarily in the small intestine, with adult lengths ranging from 15 to 40 mm (Brar, Singla, and Singla 2021). Its eggs are infectious immediately upon excretion, which significantly increases the risk of rapid transmission within communities (Weinstock and Leung 2022). Following ingestion, oncospheres hatch and invade intestinal villi, developing into cysticercoid larvae and eventually mature into adult worms, often within just two weeks (Mahamed 2024).

Hymenolepis nana apart from other parasitic infections is its ability to complete its life cycle within a single host, eliminating the need for an intermediate host. This unique lifecycle facilitates both external and internal (autoinfection) transmission (Ito and Budke 2021). Internal autoinfection allows the parasite to persist and multiply within the host, leading to long-term infections that are challenging to control (Hopkins et al. 2022). In many endemic regions, mild cases are often overlooked due to their minimal symptoms, yet severe instances can result in significant morbidity, particularly impacting adults in impoverished areas (Beermann et al. 2023).

Severe infections may manifest as gastrointestinal symptoms such as nausea, vomiting, and abdominal discomfort. In extreme cases, prolonged infections can lead to severe nutritional deficiencies and developmental delays (Montoro-Huguet, Belloc, and Domínguez-Cajal 2021), aggravating the cycle of ill health and socio-economic deprivation prevalent in areas already struggling with poverty and undernutrition (Sinhorin et al. 2023).

Recent research in Erbil and Duhok has indicated a persistent prevalence of intestinal parasites, including *Hymenolepis nana* , particularly among adult and rural populations(Murad, Al-saeed, and Mustafa 2018 ; Salih, Hassan, and Al-saeed 2022). As well the intestinal parasites are found in hospital patients, primary school students, food handlers, the general public, immunocompromised patients, malnourished patients, sicklers, and day-care center attendees in rural and urban areas. Prevalence rates are also shown by age and gender in Iraq (Nadham Kadham 2022). High infection rates have been linked to poor environmental conditions and limited access to clean water (Ismael et al., 2024). Parasitic cestodes like *Hymenolepis spp* in rats may cause human infections. Using a zoonotic perspective, this research examined parasite infection and risk factors in house mice from West Azarbaijan, northwestern Iran (Ebrahimi, Sharifi, and Nematollahi 2016).

Unlike other cestodes, the developmental cycle of Hymenolepis nana does not require an external host, further explaining its endemic nature in environments with compromised hygiene (Beermann et al. 2023). Among vulnerable populations, particularly

those with limited immune defenses, the parasite's autoinfection capability contributes to persistent and severe worm loads (Scott 2023). While not classified strictly as a soil-transmitted helminth (STH), its epidemiological characteristics align closely with these parasites in terms of transmission risks and health impacts (OYEBAMIJI 2023). The burden of helminth infections, including those caused by *Hymenolepis nana*, significantly contributes to global disease prevalence, particularly among school-aged children, where they adversely affect cognitive development and educational outcomes (Chen et al. 2024).

To combat the spread of such infections, community health education and improved sanitation practices are critical. The aim of the study is evaluating the prevalence of *Hymenolepis nana* infections in the public health laboratory management-Erbil and identify potential risk factors associated with these infections, including demographic variables such as gender, age, occupation, nationality, educational background, and length of residence.

MATERIALS AND METHODS

Study Design

This investigation utilized a cross-sectional observational design to ascertain the prevalence of *Hymenolepis nana* among patients attending the Public Health Laboratory in Erbil. This methodology is effective for assessing infection rates within a defined timeframe without extended follow-ups.

Study Area and Population

The research was conducted in Erbil City, the capital of the Kurdistan Region- Iraqi. Erbil is a rapidly urbanizing area with varying health and sanitation standards across its districts. The study population consisted of individuals visiting the Public Health Laboratory from different parts of the city, encompassing all age groups and genders.

Sampling Method

Participants were randomly selected from those submitting stool samples during the study period. This method ensured that each eligible patient had an equal opportunity for inclusion, enhancing the study's representativeness. Only sterile, properly labeled samples were analyzed.

Data Collection

Data collection occurred from August 2024 to July 2025. Stool samples were evaluated by the Public Health Laboratory using the direct smear method under light microscopy. A small sample of fresh feces was mixed with saline on a glass slide to create a thin smear, covered with a coverslip, and examined microscopically. This approach facilitated the direct identification of parasites, including protozoan trophozoites, cysts, and helminth eggs. The eggs of *Hymenolepis nana* were distinguished by their oval shape and polar filaments. Basic demographic information (age, gender, job's position and region) was recorded for each participant.

Data Analysis

Data were analyzed using GraphPad Prism software (GraphPad Prism V.7, CA, USA). Descriptive statistics were employed to calculate prevalence rates, while chi-square tests assessed associations between infection status and demographic variables. A p-value of less than 0.05 was considered statistically significant. Results were presented in tabular format.

RESULTS

Morphological characteristics of identified *Hymenolepis nana* This study identified *Hymenolepis nana*, based on their morphological characteristics. Figure 1 shows the identified species of the parasite based on microscopic examination. *Hymenolepis nana* eggs appeared slightly oval with a thin shell and eggs contain the oncosphere, which bears three pairs of hooklets surrounded by a membrane with two polar thickenings. The egg about 30 to 50 µm in length the measurement is done by (Cell Profiler 4.2.8), 4 to 8 polar filaments arising from the two poles, the eggs are directly infective over being passed in the stool of an infected host.

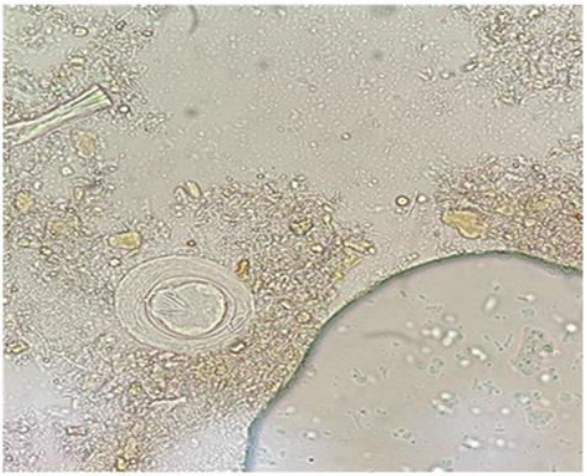

Figure 1: The *H. nana* egg observed in stool testing at ×400 magnification (The images were initially obtained from the present study specimens).

A total number of patients infected with dwarf tapeworm in this study was 24(7.12%), confirmed by direct wet mount. The frequency of *Hymenolepis nana* was higher in males 15(4.45%) than in females 9(2.67%) as shown in Table 1.

Table 1: Frequency of *Hymenolepis nana* infection according to the gender

Gender	No. of samples examined	Positive samples	
		Positive samples	Percentage of total (%)
Male	209	15	4.45
Female	128	9	2.67
Total	337	24	7.12

The result in table 2 showed that, most of infections were observed in the group of 21–30 years, representing 8 cases (33.33%), followed by group of 31–40 years with 6 cases (25%). The lowest prevalence, reported in individuals >50 years, was 2 (8.33%) as determined by microscopical method. Furthermore, the highest rate of *Hymenolepis nana* was found in age group (21-30) years which were 5(20.83%), 3(12.50%) in both male and female, respectively and the lowest rate was observed in age group >50 years which was 1(4.17%) in male, but the lowest rate in female was found in ≤20 and greater than 50 years which was 1(4.17%), respectively. Also, in our observation, after 31-40 years of age, the prevalence rate of *Hymenolepis nana* declined gradually. The difference between ages and gender is statistically not significant (P=0.9947)

Table 2: Frequency of Hymenolepis *nana* infection according to the age and gender

Age	Gender						P value
	Male	%	Female	%	Total	%	
≤20	2	8.33	1	4.17	3	12.50	0.9947
21-30	5	20.83	3	12.50	8	33.33	
31-40	4	16.67	2	8.33	6	25.00	
41-50	3	12.50	2	8.33	5	20.83	
>50	1	4.17	1	4.17	2	8.33	
Total	15	62.5	9	37.5	24	100	

Table 3 shows that among the 24 positive cases of H. *nana* infection, the highest proportion was observed among cleaners, accounting for 33.33% (8 cases) of infections, with 5 males (20.83%) and 3 females (12.5%) affected. Workers and chefs each represented 16.67% (4 cases) of the infections; male workers comprised all worker cases (16.67%), while chefs included 1 male (4.17%) and 3 females (12.5%). The bakery and receptionist position each accounted for 12.5% (3 cases) of infections, with bakery cases exclusively in males and receptionists including 2 males (8.33%) and 1 female (4.17%). Salon workers accounted for 8.33% (2 cases), both females. Overall, males constituted 62.5% (15 cases) of infections, while females accounted for 37.5% (9 cases). The association between job position and Gender infectious status approached but did not reach statistical significance (P = 0.0765), suggesting potential variation in infection risk by occupation that merits further investigation.

Table 3: Frequency of *Hymenolepis nana* infection according to the job position and gender

job's position	Gender						P value
	Male	%	Female	%	Total	%	
bakery	3	12.5	0	0	3	12.5	0.0765
chef	1	4.17	3	12.5	4	16.67	
worker	4	16.67	0	0	4	16.67	
receptionist	2	8.33	1	4.17	3	12.50	
salon worker	0	0.00	2	8.33	2	8.33	
cleaner	5	20.83	3	12.5	8	33.33	
Total	15	62.5	9	37.5	24	100	

According to Table 4, by nationality, Bangladesh had the highest number of cases, with almost half (45.83%, 11 cases) of the people infected in this group. Among them, 7 (29.17%) were males and 4 (16.67%) were females. Local nationals constituted 25% (6 cases), with an equal distribution of males and females (3, or 12.5% each). Indian nationals made up 16.67% (4 cases), with 3 males (12.5%) and 1 female (4.17%), and Nepalese nationals represented 12.5% (3 cases), with 2 males (8.33%) and 1 female (4.17%). Males accounted for 62.5% of the total, while females made up 37.5%. The analysis revealed no significant association between nationality and the status of infection (P = 0.8744).

Regarding educational level, cases were distributed as follows: 33.33% (8 cases) had only primary education, including 5 males (20.83%) and 3 females (12.5%); the group with a high school education contained the most cases at 37.5% (9 cases), among

whom 4 males (16.67%) and 5 females (20.83%) were found; cases with a university education accounted for 29.17% (7 cases), with the majority being males (6 cases, 25%) and 1 female (4.17%). No statistically significant relationship was found between educational level and gender (P = 0.2391). Furthermore, the years-of-residence analysis revealed that 45.83% (11 cases) of the infected had lived in the area less than a year: 8 were males (33.33%), whereas the other 3 were females (12.5%). The remaining 54.17% (13 cases) had lived in the area for more than a year, of whom 7 (29.17%) were males and 6 (25%) females. Again, there was no statistically significant association between the variable years of residence and gender (P = 0.3411).

Table 4: Frequency of *Hymenolepis nana* infection according to the nationality, educational level, years of residence, and gender

Chrematistics		**Gender**						**P value**
		Male	%	Female	%	Total	%	
Nationality	Local	3	12.50	3	12.50	6	25	0.8744
	Bangladesh	7	29.17	4	16.67	11	45.83	
	India	3	12.50	1	4.17	4	16.67	
	Nepal	2	8.33	1	4.17	3	12.50	
Educational Level	Primary only	5	20.83	3	12.50	8	33.33	0.2391
	High school	4	16.67	5	20.83	9	37.50	
	University	6	25.00	1	4.17	7	29.17	
Years of residence	Less than 1 year	8	33.33	3	12.50	11	45.83	0.3411
	More than 1 year	7	29.17	6	25.00	13	54.17	

Table 5 shows that among the 24 positive cases, *Hymenolepis nana* infection alone was identified in 12 individuals, representing 50% of the total infections. Of these, 8 were males (33.33%) and 4 were females (16.67%). Co-infection with *Hymenolepis nana* and *Entamoeba histolytica* was found in 9 cases (37.5%), including 5 males (20.83%) and 4 females (16.67%). Additionally, 3 cases (12.5%) involved co-infection with *Hymenolepis nana* and *Giardia lamblia*, with 2 males (8.33%) and 1 female (4.17%) affected. Statistical analysis indicated no significant difference in infection patterns between organisms and Gender (P = 0.8623).

Table 5: Distribution of parasite infections by organisms and gender

Organisms	**Gender**					**P value**
	Male	%	Female	%	Total	
H. nana	8	33.33	4	16.67	12	0.8623
H. nana* + *E. histolytica	5	20.83	4	16.67	9	
H. nana* + *G. lamblia	2	8.33	1	4.17	3	

DISCUSSION

The epidemiology of rodent-borne zoonotic helminths remains underexplored in the Kurdistan region. Limited reports exist regarding helminth infections in rodents from Iraq and neighboring Middle Eastern Countries. Evidence of *Hymenolepis nana* infections among humans in the Kurdistan region has been documented (Ahmed, Salih Mero, and Basheer Mohameed 2022; Salih, Hassan, and Al-Saeed 2022) due to same environmental factors at the area , alongside reports from Bahrain, Jordan, Palestine, and Yemen (Al Hindi and Abu-Haddaf 2013; Islam et al. 2020). The prevalence of *Hymenolepis nana* in this study (7.12%) is consistent with findings from other studies in the Kurdistan region, suggesting that the parasite remains endemic in urban centers of Iraqi Kurdistan.

The data indicate a slightly higher prevalence in males (4.45%) compared to females (2.67%), aligning with previous research in Iraq that associates higher infection rates in males with occupational exposure (Murad, Al-saeed, and Mustafa 2018). Males often engage in outdoor and labor-intensive roles, increasing their risk of fecal-oral transmission. Regarding to the result the relation between job position, Gender, and infection status not statistical significance (P = 0.0765). Males were also caught in larger numbers than females, perhaps because of their increased activity and broader home ranges, which make them more likely to fall into traps (Mohd-Qawiem et al. 2022; Tijjani et al. 2020). Because there were fewer females caught, the difference between the infection rates of males and females was not statistically significant. Other Tanzanian investigations have found higher rates of infection in males (Issae and Katakweba 2024). Additionally, a striking 33.33% infection rate was noted within the 21-30 age group, reflecting a demographic that sanitation workers in aged between 18 to 65 years (Adnan Ibrahim Al Hindi et al. 2025). This pattern is corroborated by studies highlighting the vulnerability of workers in food handling and sanitation (Sinhorin et al. 2023). According to Wakid (2020), the largest incidence of *Hymenolepis nana* was discovered among food handlers, cleaners, and barbers (22.8%, 5.1%, and 2.5%, respectively). There was no significant difference between intestinal parasitic infection and profession (P > 0.05).

Ul Haq et al. (2015) observed *Hymenolepis nana* prevalence of 52.8% in Karachi. In a rural part of Karachi, intestinal parasites were found in 47.5% of the cases. As well Wakid (2020) shows that the most common *Hymenolepis nana* illnesses were recorded among Bangladeshis (26.6%) and Indians (22.8%), while the least were among Nepalis (2.5%). There was no significant difference between nationality and total infection among workers (P >0.05).

Correlation between infection rates and education level was not statistically significant, a trend emerged indicating higher infection rates among individuals with lower educational attainment. This finding aligns with previous studies that suggest limited education correlates with inadequate hygiene practices (Salih et al. 2022).

The infection rate of *H. nana* alone was 8(33.33%) in males and in females was 4(16.67%). Co-infection with *Hymenolepis nana* and *Entamoeba histolytica* was found in 9 cases (37.5%), including males (20.83%) and females (16.67%). *Hymenolepis nana* frequently occurring alongside *Entamoeba histolytica* and *Giardia lamblia*. These results underscore systemic issues related to water quality and sanitation in the region (Sinhorin et al. 2023). A meta-analysis by Halidi et al. (2025) indicated that intestinal parasite co-infections serve as a marker for poor sanitation and hygiene standards, a principle that is applicable to both adults and children. Contrastingly, regional studies from Iran and Turkey have reported lower prevalence rates of *Hymenolepis nana* suggesting that improved sanitary conditions and public health initiatives are effective in reducing parasitic infections (Halidi et al. 2025; Hamid et al. 2023). The higher rates found in Erbil highlight ongoing public health challenges, particularly for marginalized populations such as migrants and laborers.

CONCLUSION

The findings of this study emphasize the necessity for strategic public health interventions in Erbil. Priority should be given to occupational health programs targeting food handlers and sanitation workers, with a focus on hygiene education and disease screening. Local governments need to make homes and workplaces cleaner and safer. Preventive measures should include early screening for newcomers, improvements in housing conditions, and multilingual outreach initiatives to mitigate outbreaks. To thoroughly understand transmission dynamics and evaluate intervention outcomes, future studies should adopt a community-based approach with longitudinal follow-ups. Addressing the infection at multiple levels, from occupational exposure to public health infrastructures, will be essential for sustainable control of Hymenolepis nana and other parasitic infections within vulnerable populations across the Kurdistan Region.

Acknowledgement

The author acknowledges Erbil Technical Health and Medical College/ Erbil Polytechnic university, public health laboratory in Erbil, Iraq and Gagro veterinary Center for assisting with the research.

Conflict of interest

The authors declare there is no conflict of interest

Funding

The author(s) declared that no funding was involved in supporting this work.

REFERENCES

1. Adnan Ibrahim Al Hindi, Fayez Shaldoum, Nahla Mezied, and Mariam Alreefi. 2025. “Prevalence and Associated Risk Factors of Intestinal Parasites among Sanitation Workers and Work Conditions at Gaza Municipality.” *Baghdad Journal of Biochemistry and Applied Biological Sciences* 6(2): 109–16.
2. Ahmed, Hamdea Ismail, Wijdan Mohammed Salih Mero, and Ahmed Basheer Mohameed. 2022. “Prevalence of Cryptosporidiosis and It’s Associated Risk Factors Among Human Population in Zakho District, Duhok Province, Kurdistan Region, Iraq.” *Science Journal of University of Zakho* 10(4): 153–58.
3. Beermann, Sandra et al. 2023. “Impact of Climate Change on Vector- and Rodent-Borne Infectious Diseases.” *Journal of health monitoring* 8(Suppl 3): 33–61. http://www.ncbi.nlm.nih.gov/pubmed/37342429%0Ahttp://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=PMC10278376.
4. Brar, S. K., N. Singla, and L. D. Singla. 2021. “Comparative Comprehensive Analysis on Natural Infections of Hymenolepis Diminuta and Hymenolepis Nana in Commensal Rodents.” *Helminthologia (Poland)* 58(3): 248–62.
5. Chen, Jin et al. 2024. “Global Burden of Soil-Transmitted Helminth Infections, 1990–2021.” *Infectious Diseases of Poverty* 13: 68–77.
6. Ebrahimi, Mansour, Yosef Sharifi, and Ahmad Nematollahi. 2016. “Assessment of Gastrointestinal Helminths among House Mice (Mus Musculus) Caught in the North-West of Iran, with a Special View on Zoonotic Aspects.” *Comparative Clinical Pathology* 25(5): 1047–51. https://doi.org/10.1007/s00580-016-2308-z.
7. Halidi, Ahmed Galip et al. 2025. “Prevalence of Intestinal Parasites in School-Age Children in Turkey: A Systematic Review and Meta-Analysis.” *PLoS neglected tropical diseases* 19(6): e0013186. https://doi.org/10.1371/journal.pntd.0013186.
8. Hamid, Laraibah et al. 2023. “An Insight into the Global Problem of Gastrointestinal Helminth Infections amongst Livestock: Does Nanotechnology Provide an Alternative?” *Agriculture (Switzerland)* 13(7).
9. Al Hindi, Adnan Ibrahim, and Eman Abu-Haddaf. 2013. “Gastrointestinal Parasites and Ectoparasites Biodiversity of Rattus Rattus Trapped from Khan Younis and Jabalia in Gaza Strip, Palestine.” *Journal of the Egyptian Society of*

Parasitology 43(1): 259–68.
10. Hopkins, Skylar R. et al. 2022. "Environmental Persistence of the World's Most Burdensome Infectious and Parasitic Diseases." *Frontiers in Public Health* 10(July): 1–7.
11. Islam, Md Mazharul et al. 2020. "Helminth Parasites among Rodents in the Middle East Countries: A Systematic Review and Meta-Analysis." *Animals* 10(12): 1–18.
12. Issae, Amina Ramadhani, and Abdul Ahmed Selemani Katakweba. 2024. "Prevalence of Gastro-Intestinal Parasites with Zoonotic Potential in Rodents Trapped from the Ngorongoro District, Arusha, Tanzania." *International Journal of TROPICAL DISEASE & Health* 45(11): 34–45.
13. Ito, Akira, and Christine M. Budke. 2021. "Perspectives on Intestinal Tapeworm Infections: An Evaluation of Direct and Indirect Life-Cycles with a Special Emphasis on Species of Hymenolepis." *Current Research in Parasitology and Vector-Borne Diseases* 1(March): 100023. https://doi.org/10.1016/j.crpvbd.2021.100023.
14. Mahamed, Samatar Abshir. 2024. Intestinal Parasites-New Developments in Diagnosis, Treatment, Prevention and Future Directions: New Developments in Diagnosis, Treatment, Prevention and Future Directions *Intestinal Tapeworm (Cestode)*. BoD–Books on Demand.
15. Mohd-Qawiem, Firdaus et al. 2022. "Detection of Zoonotic-Borne Parasites in Rattus Spp. In Klang Valley, Malaysia." *Veterinary World* 15(4): 1006–14.
16. Montoro-Huguet, Miguel A., Blanca Belloc, and Manuel Domínguez-Cajal. 2021. "Small and Large Intestine (I): Malabsorption of Nutrients." *Nutrients* 13(4): 1–36.
17. Murad, manal adil, adel talib mohammad Al-saeed, and awat abdulazeez Mustafa. 2018. "Prevalence of Intestinal Parasites Among Patients Attended Azadi Teaching Hospital in Duhok City-Kurdistan Region / Iraq." *The Journal of The University of Duhok* 21(2): 68–74.
18. Nadham Kadham, Mahdi. 2022. "Prevalence of Intestinal Parasitic Infections in Iraq during a Period from 2000-2020." *Journal of Infectious Diseases and Epidemiology* 8(7): 1–9.
19. Njambi, Elizabeth et al. 2020. "Prevalence of Intestinal Parasitic Infections and Associated Water, Sanitation, and Hygiene Risk Factors among School Children in Mwea Irrigation Scheme, Kirinyaga County, Kenya." *Journal of Tropical Medicine* 2020.
20. OYEBAMIJI, David Anuoluwapo. 2023. "ENVIRONMENTAL FACTORS AND CULTURAL PRACTICES INFLUENCING THE EPIDEMIOLOGY OF SOIL TRANSMITTED HELMINTHS IN IBADAN, NIGERIA."
21. Rawat, Shriya et al. 2025. "Transmission, Maintenance of Infection, and Consequences of Disease." In *Epidemiology and Environmental Hygiene in Veterinary Public Health*, , 67–79. https://doi.org/10.1002/9781394208180.ch4.
22. Salih, Janan Mohammed, Ayman Othman Hassan, and Adel Talib Mohammed Al-Saeed. 2022. "Intestinal Parasites And Associated Risk Factors among Primary School Children in Duhok City-Kurdistan Region/Iraq." *the journal of duhok university* 25(2): 50–56.
23. Scott, M. E. 2023. "Helminth-Host-Environment Interactions: Looking down from the Tip of the Iceberg." *Journal of Helminthology* 97.
24. Sinhorin, Gustavo Henrique et al. 2023. "Intestinal Parasite Infections Associated with Sociodemographic and Seasonal Factors in the Western Amazon." *Parasitology Research* 122(2): 419–23.
25. Tijjani, Mustapha, Roslaini Abd Majid, Sharif Alhassan Abdullahi, and Ngah Zasmy Unyah. 2020. "Detection of Rodent-Borne Parasitic Pathogens of Wild Rats in Serdang, Selangor, Malaysia: A Potential Threat to Human Health." *International Journal for Parasitology: Parasites and Wildlife* 11(January): 174–82. https://doi.org/10.1016/j.ijppaw.2020.01.008.
26. Ul Haq, Khan Abrar et al. 2015. "Prevalence of Giardia Intestinalis and Hymenolepis Nana in Afghan Refugee Population of Mianwali District, Pakistan." *African Health Sciences* 15(2): 394–400.
27. Wakid, Majed H. 2020. "Prevalence of Enteroparasites Among Non-Saudis in Bahrah, Saudi Arabia." *Cureus* 12(7).
28. Wami, Meleruchi. 2022. "Water, Sanitation and Handwashing Assessment and Determination of Critical Risk Factors for Diarrhoea among Pre-Schoolers and Students." https://repository.lboro.ac.uk/articles/thesis/Water_sanitation_and_handwashing_assessment_and_determination_of_critical_risk_factors_for_diarrhoea_among_pre-schoolers_and_students/22202590.
29. Weinstock, Joel V, and John Leung. 2022. "Parasitic Diseases: Helminths." *Yamada's Textbook of Gastroenterology*: 3039–78.