

IJHSM

Indonesian Journal
on Health Science
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UNIVERSITAS MUHAMMADIYAH SIDOARJO

Table Of Contents

Journal Cover	1
Author[s] Statement	3
Editorial Team	4
Article information	5
Check this article update (crossmark)	5
Check this article impact	5
Cite this article	5
Title page	6
Article Title	6
Author information	6
Abstract	6
Article content	7

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Indonesian Journal on Health Science and Medicine

Vol. 3 No. 1 (2026): July
DOI: 10.21070/ijhsm.v3i1.403

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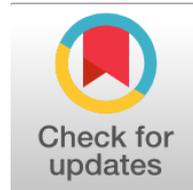
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Spatiotemporal Distribution Of Parasitic Infections In Al-Najaf Al-Ashraf Governorate And Its Association With Age, Sex, And Seasonal Factors: Distribusi Spasial-Waktu Infeksi Parasit di Provinsi Al-Najaf Al-Ashraf dan Hubungannya dengan Usia, Jenis Kelamin, dan Faktor Musiman

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Abstract

General Background: Parasitic infections remain a significant public health concern worldwide, particularly in developing regions where sanitation limitations and environmental conditions facilitate transmission. **Specific Background:** In Iraq, intestinal parasites continue to affect large segments of the population, with infection patterns influenced by demographic and environmental factors. **Knowledge Gap:** Despite previous epidemiological studies in Iraq, limited research integrates spatial distribution, temporal patterns, and demographic variables simultaneously within Najaf Governorate. **Aims:** This study investigates the spatiotemporal distribution of parasitic infections in Najaf Governorate and examines their association with age, sex, seasonal variation, and residential location. **Results:** A total of 422 stool and genitourinary samples collected between July and November 2025 were analyzed, revealing 292 positive cases (69.19%). Five parasites were identified, with *Entamoeba histolytica/dispar* complex (54.45%) and *Giardia lamblia* (40.07%) as the dominant species. Infection prevalence was highest among children aged 1-14 years (64.73%), followed by individuals aged 15-44 years (23.63%) and ≥45 years (11.64%). Males showed a higher infection proportion (59.25%) than females (40.75%), while rural residents accounted for 60.27% of positive cases. Seasonal analysis indicated peak infections during July and August. **Novelty:** The study provides an integrated spatiotemporal and demographic assessment of parasitic infections within Najaf using hospital-based surveillance data. **Implications:** These findings support targeted public health interventions focusing on sanitation improvement, child health monitoring, and rural disease prevention strategies.

Keywords: Parasitic Infections, Epidemiology, Intestinal Parasites, Spatiotemporal Distribution, Najaf Governorate

Key Findings Highlights

High infection prevalence detected among examined patients in Najaf.

Children aged 1-14 years represented the largest proportion of cases.

Rural communities recorded higher case distribution than urban populations.

Published date: 2026-03-05

Introduction

Parasitic infections represent one of the biggest public health challenges in the world today, particularly in emerging nations and subtropics. Due to their integral relation to environmental hygiene, water quality, public health awareness, climatic parameters that promote the parasite's life cycle and distribution, they represent a significant health and economic challenge [1],[2],[3]. Parasitic infections can be detected in the intestines, skin, and blood in Iraq, where a large epidemiological problem that can be addressed with continued monitoring due to environmental changes and infrastructure developments. Many studies have demonstrated that intestinal parasites remain a persistent prevalence problem in several governorates, including Erbil, Salah al-Din, southern Iraq, as well as some others[4],[5],[6].

Najaf Governorate stands out from all governorates, becoming a growing mega city-town and a holy city of global attraction for many people who have visited the governorates and other countries for the past few years, with millions coming in visiting annually from outside. Such a moving nature and high population density, as described in a study from Ethiopia, make the complex epidemiological settings possible and possibly impact the transmission dynamics for parasitic infection, very consistent with patterns seen in other low and middle income settings with high population movement[2],[7].

Understanding transmission dynamics does not merely depend on examining infection rates, but also requires a thoughtful use of time and space. Spatial analysis is important in disease outbreak identification and risk-category categorization, both at individual level, geographic level, as well as between rural and urban areas. Instead, temporal analysis draws attention to time-series epidemiological patterns, enabling prediction of the probability of disease outbreak and evaluation of control response[8].

Demographic factors, especially age and sex play a critical role including differences in health behaviors, natural immunity, and exposure to pathogens between humans of different genders and ages, play a pivotal role in susceptibility. Research conducted on the prevalence of parasitic infections has shown high prevalence of transmission of disease in school-age children due to higher prevalence of exposure and vulnerability in the school-aged children[8],[9].

Concomitantly, temperature, humidity and rainfall are some of the seasonal factors that determine the parasitic and vector activity and these factors contribute to the yearly trend in infection rates over the life of the whole season. These environmental factors are specially meaningful in subtropical and arid environments such as Iraq and the Middle East as a whole where water supply and sanitation practices depend on a particular season[1],[3]. While previous research has investigated and investigated parasites in Iraq, there are few such studies that combine epidemiological or comparative analyses with complex spatial and temporal analyses in Najaf population, particularly studies that link these factors with changes in the season of climate during the last year. Hence, this study is very significant as it aims to evaluate the epidemiological condition of the spread of parasite in Najaf Governorate, its geographical and temporal distribution, and the demographic variables (age and gender) as well as seasonal factors. The aim here is to develop a powerful database that should assist health policymakers in devising clearer and more effective measures to prevent and control disease or infection at the population level, and to support the overall improvement of prevention and control strategies.

Methodology

Data Collection: Data were collected from the Parasitology and Helminthology Unit at the Al-Sadr Teaching Hospital Laboratories, Najaf, Iraq for this study. Data were collected from July to November 2025. This data covered protozoan and helminthic infections, as well as sex and age differences, including individuals aged 1 to 45 years. In this period of analysis 422 patients were evaluated, and 292 were confirmed to have parasitic infections.

Statistical Analysis: The study data were assessed by descriptive analysis of the data, and frequencies and percentages were given to show the pattern of parasitic infection. The distribution of each parasite was analysed based on age, sex, the month of sample collection, place of residence (urban or rural), and the prevalence of the organisms investigated. No inferential statistics were used as this project's main focus was descriptive. These results are displayed in tables to clearly display the patterns and the proportions of the detected parasitic infections.

Result

A recent research study on the health condition in Najaf, Iraq, found that there were five forms of parasitic infections *Entamoeba histolytica/disparcomplex*, *Giardia lamblia*, *Trichomonashominis*, *Hymenolepis nana* and *Trichomonasvaginalis*. A systematic analysis of 422 samples showed that 292, or 69.19% of the total samples, tested positive for parasitic infections. The other 130 samples, representing 30.81%, produced no infection (Table 1).

Samples	No.	Percentages %
Positive Of Parasite	292	%69.19
Negative Of Parasites	130	%30.81
Total	422	%100

Table 1. **Table 1: The Number Of positive And Negative Samples**

The extent of different parasites found in the positive samples is detailed in Table 2. Five specific parasites were studied: *Entamoeba histolytica/dispar complex*, *G. lamblia*, *T. hominis*, *H. nana*, and *T. vaginalis*. Positive samples numbered 292,

including all instances of being found at all. *Entamoeba histolytica/dispar* complex was the most common parasite shown in the data, in 159 samples (54.45%) of the total samples. After this, *G. lamblia* was detected in 117 samples, which is 40.07%. The prevalence of *T. hominis*, *H. nana*, and *T. vaginalis* was comparatively smaller, corresponding to 6 (2.05%), 2 (0.68%) and 8 (2.74%) samples respectively.

Parasite Infections	<i>Entamoeba histolytica/dispar</i> complex	<i>G.Lambilia</i>	<i>T.Hominis</i>	<i>H.Nana</i>	<i>T.Vaginalis</i>	Total
No.	159	117	6	2	8	292
Percentages %	54.45%	40.07%	2.05%	0.68%	2.74%	100%

Table 2. **Table 2: Studied Parasitic Infections Frequency And Percentage Distribution**

Examining the data presented in Table 3, a clear pattern emerges concerning the distribution of parasitic infections across various age demographics. The individuals for the study fell into three groups: 1-14 years of age, 15-44 years, and 45 years old or older. Of note, the youngest cohort among participants aged 1-14 showed the highest prevalence rate of infections. In this group, an impressive 189 positive samples were collected, representing an enormous 64.73% of all positive cases. The next age range, aged 15-44, exhibited less incidence, with 69 positive samples, representing 23.63%. The older cohort (45+) had the fewest infections with 34 positively isolated samples, representing 11.64% of positive estimates.

Scrutiny of the table indicates the different species of parasites within the age range. Regarding *Entamoeba histolytica/dispar* complex, approximately two-thirds (100 or 62.89%) of the positive samples originated in ages 1-14. The 15-44 age group represented 40 samples [25.16% of all samples] and the 45 and older group represented 19 samples [11.95% of all samples]. For *G. lamblia*, the 1-14 age group also showed the most number of cases with 81 samples or 69.23%.

There were 21 (17.95%) samples for the 15-44 age group, and 15 (12.82%) samples for 45 and older age groups. *T.hominis* and *H. nana* were isolated exclusively in the 1-14 age group. A total of 6 samples (100%) were labeled as *T.hominis* and 2 samples (100%) were labeled as *H. nana*. Neither of these parasites was found in the older age groups. In contrast, all 8 cases of *T. vaginalis* described in the literature were within the 15-44 age range accounting for 100% of all cases reported.

Parasite Infections	<i>Entamoeba histolytica/dispar</i> complex	<i>G.Lambilia</i>	<i>T.Hominis</i>	<i>H.Nana</i>	<i>T.Vaginalis</i>	Total
1-14	100(62.89%)	81(69.23%)	6(100%)	2(100%)	0(0%)	189(64.73%)
15-44	40(25.16%)	21(17.95%)	0(0%)	0(0%)	8(100%)	69(23.63%)
45≥	19(11.95%)	15(12.82%)	0(0%)	0(0%)	0(0%)	34(11.64%)
Total	159(54.45%)	117(40.07%)	6(2.05%)	2(0.68%)	8(2.74%)	292(100%)

Table 3. **Table 3: Age-Wise Distribution Of Parasitic Infections**

The distribution of the parasitic infections among the positive samples (divided, in terms of gender, into male and female groups) is summarized in Table 4. A table summarizes the prevalence of the actual infection for each parasite type, the ratio of each parasite type within each gender type, and the total for each category. Of the positive samples, 173 were from males accounting for 59.25% of the total positive samples. Females had 119 positive samples, which is 40.75% of the total.

The table provides additional information for each parasite type by sex. For instance, in the case of *Entamoeba histolytica/dispar* complex, 94 samples were from males (59.12%) and 65 samples were from females (40.88%). For *G. lamblia* 73 samples came from males (62.39%) and 44 from females (37.61%). In relation to *T. hominis* of the population, 4 samples were detected in males (66.67%) and 2 samples in females (33.33%). Regarding *H. nana*, 2 samples (100%) were identified in males (2 in total), and not in females (none of those were detected). Lastly, all cases of *T. vaginalis* (8 samples, 100%) were exclusively found in females, with no instances in males.

Parasite Infections	<i>Entamoeba histolytica/dispar</i> complex	<i>G.Lambilia</i>	<i>T.Hominis</i>	<i>H.Nana</i>	<i>T.Vaginalis</i>	Total
Male	94(59.12%)	73(62.39%)	4(66.67%)	2(100%)	0(0%)	173(59.25%)
Female	65(40.88%)	44(37.61%)	2(33.33%)	0(0%)	8(100%)	119(40.75%)
Total	159(54.45%)	117(40.07%)	6(2.05%)	2(0.68%)	8(2.74%)	292(100%)

Table 4. **Table 4: Distribution Of Parasitic Infection According To Sexes**

Table 5 Monthly breakdown of parasitic infections of positive samples identified using positive samples is shown from July to November. It explains the amount of positive samples per parasite type, the monthly percentage of each parasite and total positive samples per month.

There were 83 positive samples, each containing 28.42% of the total taken in July. These were 45 of *Entamoeba histolytica/dispar* complex (28.30%), 35 of *G. lamblia* (29.91%) and 2 of *T. hominis* (33.33%). There was also one case of *T. vaginalis* (12.5%), no *H. nana*. In August 77 samples were positive - or 26.37%.

This included 42 cases of *Entamoeba histolytica/dispar* complex (26.42%), 30 of *G.lamblia* (25.64%), 2 of *T. hominis* (33.33%), 1 of *H. nana* (50.0%) and 2 of *T. vaginalis* (25.0%). For the September period, a total of 63 positive samples (21.58%) were recorded, of which 35 *E. histolytica/dispar* complex (22.01%), 25 *G. lamblia* (21.37%), and single isolated *T. hominis* (16.67%), *H. nana* (50.0%) and *T. vaginalis* (12.5%).

In October, 46 positive samples (15.75%) were obtained, including 25 (15.72%), 18 (15.38%), and single instances of *T. hominis* (16.67%) and *T. vaginalis* (25.0%) respectively. No *H. nana* was detected in this month.

in November, 23 positive samples (7.88%) were obtained in total, including 12 of *Entamoeba histolytica/dispar* complex (7.55%), 9 of *G. lamblia* (7.69%) and 2 of *T. vaginalis* (25.0%). No *T. hominis* nor *H. nana* were found in the samples for this month.

Months	<i>Entamoeba h istolytica/dispar complex</i>	<i>G.Lambilia</i>	<i>T.Hominis</i>	<i>H.Nana</i>	<i>T.Vaginalis</i>	Total
July	45(28.30%)	35(29.91%)	2(33.33%)	0(0%)	1(12.5%)	83(28.42%)
August	42(26.42%)	30(25.64%)	2(33.33%)	1(50.0%)	2(25.0%)	77(26.37%)
September	35(22.01%)	25(21.37%)	1(16.67%)	1(50.0%)	1(12.5%)	63(21.58%)
October	25(15.72%)	18(15.38%)	1(16.67%)	0(0%)	2(25.0%)	46(15.75%)
November	12(7.55%)	9(7.69%)	0(0%)	0(0%)	2(25.0%)	23(7.88%)
Total	159(54.45%)	117(40.07%)	6(2.05%)	2(0.68%)	8(2.74%)	292(100%)

Table 5. **Table 5: Distribution Of Parasitic Infections According To Months**

Table 6 presents the distribution of positive samples with different samples from urban and rural populations showing parasitic infections. The table shows count of positive samples per identified parasite species with number of percentage/s per category. In rural samples, 176 positive samples were recorded, comprising 60.27% of positive cases. Of these, 95 samples were positive for *Entamoeba histolytica/dispar* complex, accounting for 59.75% of rural cases, and 70 samples were positive for *G. lamblia* (59.83%). *T. hominis* was found in 4 (66.67%) samples, *H. nana* in 2 (100%), and *T. vaginalis* in 5 (62.5%) samples. The urban area had 116 positive samples, 39.73% of the whole number. Among the samples from this group: 64 were positive for *Entamoeba histolytica/dispar* complex (40.25%), 47 for *G. lamblia* (40.17%); *T. hominis* found in 2 samples (33.33%), and *T. vaginalis* in 3 samples (37.5%). As we noted, there were no cases of *H. nana* in the urban population.

Residence	<i>Entamoeba h istolytica/dispar complex</i>	<i>G.Lambilia</i>	<i>T.Hominis</i>	<i>H.Nana</i>	<i>T.Vaginalis</i>	Total
Rural	95(59.75%)	70(59.83%)	4(66.67%)	2(100%)	5(62.5%)	176(60.27%)
Urban	64(40.25%)	47(40.17%)	2(33.33%)	0(0%)	3(37.5%)	116(39.73%)
Total	159(54.45%)	117(40.07%)	6(2.05%)	2(0.68%)	8(2.74%)	292(100%)

Table 6. **Table 6: Distribution Of Parasitic Infections According To Residence**

Discussion

Intestinal parasites is prevalent in Najaf Governorate (69.19% infection rate of this stage) according to the present study. This relates to a recent study reporting the common occurrence of *E. histolytica* and *G. lamblia* in the governorate, which found it caused by insufficient water and sanitation facilities and low health consciousness[10]. This percentage is significantly higher than the reported number used for a study in Zakho Governorate in which 18.65% of protozoan parasites were recorded, and the population of *E. histolytica* was significantly higher than that of *G. lamblia*. It underlines the influence of various environmental and social factors in the two governorates[11]. Note that these percentages belong to the study sample of Najaf Governorate and thus might differ if larger samples have been taken or it was from another area. By parasitic species distribution, researchers found *E. histolytica* to be more prevalent (54.45%) than *G. lamblia* (40.07%).

For one, Iraqi population studies have reported *E. histolytica* as the most prevalent parasite, although the rates of the infection vary for different places and seasons[6]. A previous study from Mosul also reported that *E. histolytica* was more common in children that have diarrhea than *G. lamblia* [12]. The frequency is also confirmed by studies that have reported high infection rates in rural and neighbouring peripheral localities[13]. In terms of the age distribution of infections, the most infections were seen in 1-14 years old and that in children the general tendency was noted to reflect the study found in Duhok who found that children were more prone to *E. histolytica* than *G. lamblia* [14].

This can be linked to the underdeveloped immune system of children and to inadequate sanitary environments, as described in previous studies to estimate the disease burden of primary parasites in the surrounding areas[11]. As for the distribution by sex and region, the prevalence of infection was in males in the most of the intestinal parasites in the present study could be partly affected by the type of life-day environment and also by the greater environmental factors exposure of rural areas. *Hymenolepis nana* as a parasite was also found to be endemic in rural areas, especially among male adolescents, reflecting poor personal hygiene practices, exposure to sources of contamination, and overcrowded housing[15],[16],[17].

While the incidence of *Trichomonas vaginalis* was recorded in a ruralised manner, this infection was more concentrated in a rural setting, suggesting an increased epidemiologic specificity of the sexually transmitted parasite. Indeed, a lack of healthcare services and health education programs among the rural populations that have been recently studied in the governorates of Najaf, Babylon and Wasit were associated with the high incidence of infection also[18],[19],[20],[21]. Analysis of the pattern of seasonal distribution showed an alarming increase in infection during summer months, such as July and August. Indeed, this may be due to high temperatures and humidity, which favour a habitat for parasitic cysts to survive outside and in which water and food contaminated water can be more exposed to[6]. Most importantly, the findings indicated that rural communities showed significantly greater rates of infection than urban ones, which is in accordance with previous results that have correlated rural housing, inadequate water and sanitation facilities and risk for intestinal parasite infection suggesting environmental and social factors are playing important roles in the spread of

infection[10],[13].

Conclusion

The results of this study demonstrated the high prevalence of parasitic infections in the Najaf region of Iraq. The most popular parasites found were *Entamoeba histolytica/dispar* complex and *G. lamblia*. The number of such infections seemed to fluctuate, depending on, for example, the age and sex of those who were infected, the season and the area where they lived. Infection frequencies were greater among children (aged 1–14 yrs), males and those residing in the countryside. These results underscore the persistent public health risk associated with parasitic infections in this area and indicate that focused interventions are warranted.

Recommendations

Based on this study, it would be useful to initiate health education programs inside the community. This can mean emphasizing aspects of personal hygiene, the prevention of parasitic infections in these programs, and encouraging people to maintain such measures. Simultaneously, sanitation infrastructure must also be improved to minimize the risk of exposure to parasitic infections, especially in rural areas. Furthermore, the researchers recommend screening, especially at an early stage, in children and populations at risk, such as children and residents in rural areas. And long-term monitoring of parasitic infections is also critical in formulating effective public health measures, and interventions.

Ethics Statement

Oral informed consent was obtained from all participants prior to their inclusion in the study. Participants were told that they did not have to take part, and data collected could only be used for scientific research purposes.

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Indonesian Journal on Health Science and Medicine

Vol. 3 No. 1 (2026): July
DOI: 10.21070/ijhsm.v3i1.403

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