



Prevalence of Intestinal Parasites and Associated Risk Factors among Rural Areas in Duhok Province

Ayman Othman Hassan¹, Janan Mohammed Salih^{2*}, Adel Talib Mohammed Al-Saeed³

^{1,2,3}Department of Microbiology, College of Medicine, University of Duhok, Kurdistan Region-Iraq. ORCID: 0000-0002-3453-5586

*Corresponding author's E-mail: janan.mohammed@uod.ac

Article History	Abstract
Received: 06 June 2023 Revised: 05 Sept 2023 Accepted: 11 Sept 2023	<p>Background: Intestinal parasitic infections in humans are considered a significant global issue, particularly in rural areas. The study aimed to determine the prevalence of intestinal parasite infections and their associated factors in rural areas in Duhok province-Kurdistan Region-Iraq. Methods: A total of 620 stool samples were collected from individuals of various ages residing in rural villages within districts of Duhok province and were subjected to microscopic examination techniques. Results: Among the participants, 62.26% were found to be infected with at least one or two species of intestinal parasites. The prevalence of intestinal parasites was higher in males (68.65%) compared to females (31.35%). The highest prevalence rate (34.46%) was observed in the age group between 6 and 12 years. The infection were three protozoa: <i>Entamoeba histolytica</i> (73.83%), <i>Giardia lamblia</i> (16.84%), and <i>Blastocystis hominis</i> (8.81%). only one helminth was detected: <i>Taenia</i> spp. (0.52%). Protozoan infection was higher than helminths infections (99.48% and 0.52%, respectively). Abdominal pain and diarrhea were reported with high rates (33.16% and 32.12%, respectively). Participants who consumed water from wells exhibited the highest rate of intestinal parasitic infections (62.44%). Those who did not wash their hands before meals (70.47%), consumed raw or unwashed vegetables and fruits (61.66%), and had contact with animals (80.57%) showed significantly higher prevalence rates of intestinal parasitic infections ($P < 0.05$). Conclusions: The prevalence of intestinal parasites among rural populations was high in Kurdistan Region and it was associated with unhygienic conditions.</p>
CC License CC-BY-NC-SA 4.0	Keywords: Intestinal parasitic infections, IPIs, Protozoa, Helminths, Rural Areas, Duhok

1. Introduction

Various species of parasites, including both protozoa and helminths, are responsible for causing Intestinal Parasitic Infections (IPIs), which fall under the category of neglected tropical diseases (NTDs) and have become a significant global public health concern (Hotez *et al.*, 2015). Infections with intestinal parasites can lead to serious problems such as malnutrition and blood disorders (iron-deficiency anemia), particularly in children, resulting in growth retardation, physical weakness, and mental issues (El-Sherbini, 2013; Hotez and Kamath, 2009).

In general, preschool and school-age children are at the highest risk of contracting infections from intestinal parasites (Hotez *et al.*, 2010). Morbidity and mortality associated with pathogenic intestinal parasites are observed in both developing and underdeveloped countries, including protozoa like *Entamoeba histolytica*, *Giardia lamblia*, *Cryptosporidium* spp., *Balantidium coli*, *Dientamoeba fragilis*, and helminths such as *Ascaris lumbricoides*, *Trichuris trichiura*, and *Strongyloides stercoralis* (Haque, 2007).

High rates of IPIs have been reported in rural areas and villages, particularly among children. The main factors contributing to these high prevalence rates include poor hygiene practices, overcrowding, low socioeconomic status, inadequate medical care, and unsafe drinking water supplies, as well as farming activities and animal breeding (GebretSadik, 2020; Mahdi, 2022). Pathogenic intestinal parasites can infect humans of all ages, although certain environments and age groups are more susceptible (Clarke, 2019). Worldwide studies conducted in various regions have indicated that the prevalence of IPIs is influenced by individual circumstances, with children being particularly vulnerable (Gilgen, 2001).

Previous studies on the prevalence of IPIs in Duhok Province have primarily focused on children referred to hospital laboratories within Duhok center (Mero and Hussein, 2013; Hussein and Meerkhan, 2019; Jameel and Eassa, 2021; Salih *et al*, 2022), or patients attending Azadi Teaching Hospital in Duhok City (Murad *et al*, 2018). In contrast, the present study examines the prevalence of intestinal parasitic infections in relation to associated risk factors among people living in rural communities in Duhok province. Furthermore, the number of such studies conducted in Duhok province is limited, which prompted the execution of the current study. Moreover, there have been no previous reports on the status of IPIs in rural areas of Duhok Province, making this study essential. Therefore, we aimed to explore the prevalence of intestinal parasite infections and its associated factors in rural areas of Duhok province.

2. Materials And Methods

A surveillance cross-sectional study was conducted in rural areas and villages of Duhok province from March to August 2023, encompassing both genders (males and females) across various age groups. All participants were administered a structured questionnaire. The selected sampling locations comprised individuals residing in rural villages within Duhok province: Amedia, Sheladzi, Zaweta, Akre, Bardarash, Sheikhan, Semel, Sarsang, Fayda, Domez, and Zakho villages (Figure 1). An interview-based questionnaire was administered to each participant to collect data on individual, socio-demographic, and health-related information.



Fig 1: The geographical location of the rural areas in Duhok province

Stool Sample Collection and Processing: Stool samples were collected from each participant. Initial examinations were performed using wet smears prepared with normal saline (0.85% NaCl solution) and Lugol's Iodine solution. Samples negative for parasitic agents underwent re-examination through the formalin ethyl-acetate concentration method. Additionally, a modified Ziehl-Neelsen acid-fast technique was employed to detect *Cryptosporidium* spp. Oocysts in stool samples. Prepared slides

were observed under a light microscope at $\times 10$, $\times 40$, and $\times 100$ objective magnifications (John and Petri, 2006).

Statistical Methods: Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS version 21). Infection rates were compared using the Chi-square test. Furthermore, the Chi-square test was employed to analyze intestinal parasite rates in relation to associated risk factor variables. Differences with a significance level of $P < 0.05$ were considered statistically significant.

Ethical Approval: The present study received ethical approval in accordance with the guidelines outlined in the Research Ethics Committee form of the Duhok Directorate General of Health/Ministry of Health (Ethical approval No. 03052023-3-3).

3. Results and Discussion

Prevalence of intestinal parasitic infections

In the present study, a total of 620 stool specimens were collected from patients of different ages and genders. Overall, 62.26% (386 out of 620) of the participants were found to be infected with at least one or two species of intestinal parasites (Figure 2).

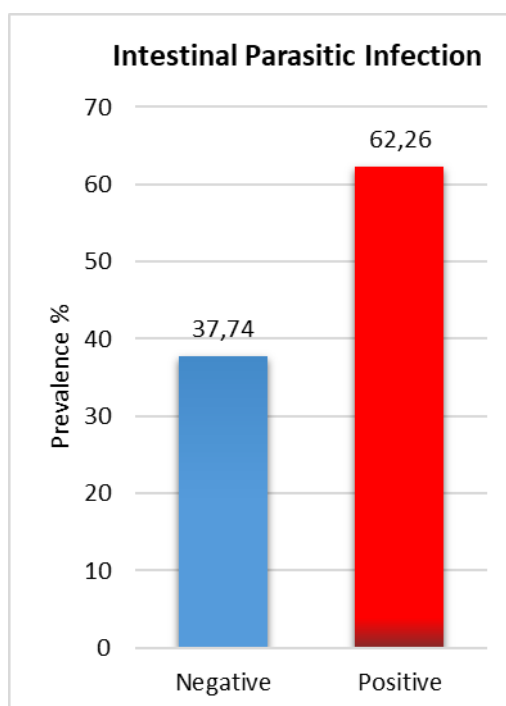


Fig 2: Prevalence of Intestinal parasitic infections among rural populations in Duhok province in 2023

When considering gender, the prevalence of intestinal parasites was higher in males (68.65%) compared to females (31.35%). However, there were no statistically significant differences between the two groups, with a p-value exceeding 0.05, as shown in Table 1.

Table 1: Prevalence of intestinal parasitic infections among rural populations in Duhok province based on gender

Gender	No. of participant	Percent	No. of positive cases	Percent
Male	400	64.52	265	68.65
Female	220	35.48	121	31.35
Total	620	100	386	62.26

$X^2=1.817$, $df=1$, $p\text{-value}=0.177$, non-significant

The highest prevalence rate was observed among the age group of 6-12 years, at approximately 34.46%. Conversely, the lowest prevalence rate was observed among individuals aged 25-32 years, with a rate of about 8.55%. These differences were statistically significant, as indicated in Table 2.

Table 2: Prevalence of intestinal parasitic infections among rural populations in Duhok province based on age groups

Age groups -years	Positive cases	
	Number	Percent
1-5	42	10.88
6-12	133	34.46
13-18	118	30.57
19-24	60	15.54
25-32	33	8.55

X²=87.62, df=4, p-value=< 0.00001, *significant

The distribution of intestinal parasite species across rural areas revealed four species. As a mono-parasitic infection, *Entamoeba histolytica* exhibited the highest prevalence rate, approximately 73.83%, whereas *Taenia spp.* showed the lowest prevalence rate at 0.52%. Moreover, only five cases displayed multiple parasitic infections. The most common multiple infection was *E. histolytica* + *B. hominis*, accounting for approximately 0.78%, followed by *E. histolytica* + *G. lamblia*, at around 0.52% (Table 3).

Table 3: Prevalence of intestinal parasite types (protozoa and helminths) among rural communities (mono and multiple infection)

Infection types	Number	Percent
Mono infection		
Protozoa		
<i>Entamoeba histolytica</i>	285	73.83
<i>Giardia lamblia</i>	65	16.84
<i>Blastocyst hominis</i>	34	8.81
Total	384	99.48
Helminths		
<i>Taenia</i> egg	2	0.52
Multiple infection		
<i>E.histolytica</i> + <i>B. hominis</i>	3	0.78
<i>E.histolytica</i> + <i>G.lamblia</i>	2	0.52

Overall, the prevalence rates of various intestinal parasites by age are presented in Table 4. Among individuals aged 6-12, *E. histolytica* and *G. lamblia* were the most common parasites, while *B. hominis* exhibited the highest prevalence rate (35.29%) in the age group 13-18. Only two cases of *Taenia* eggs were reported in males aged nine and ten years.

Table 4: The distribution of intestinal parasites species in rural areas in Duhok province according to age groups

Parasites species Total no. (%)	Number of positive cases in age groups no (%)				
	1-5	6-12	13-18	19-24	25-32
<i>Entamoeba histolytica</i> 285 (73.83%)	33 (11.58)	102 (35.79)	91 (31.93)	39 (13.68)	20 (7.02)
<i>Giardia lamblia</i> 65 (16.84%)	7 (10.77)	23 (35.38)	15 (23.08)	12 (18.46)	8 (12.31)
<i>Blastocyst hominis</i> 34 (8.81%)	2 (5.88)	6 (17.65)	12 (35.29)	9 (26.47)	5 (14.71)
<i>Taenia</i> egg 2 (0.52%)	0 (0)	2 (100)	0 (0)	0 (0)	0 (0)

The association between intestinal parasite infections and clinical symptoms is outlined in Table 5. Abdominal pain and diarrhea were the most frequent clinical symptoms, with relatively similar rates of occurrence (33.16% and 32.12%, respectively). Statistically, a significant correlation was observed between these symptoms and other clinical indicators.

Table 5: Prevalence of intestinal parasitic infections in rural areas in Duhok province according to clinical symptoms

Clinical presentations	Patients	
	Number	Percent
Diarrhea	124	32.12

Fever	40	10.36
Vomiting	26	6.74
D.& F.& V.	35	9.07
Abdominal pain	128	33.16
Bloody diarrhea	23	5.96
Unknown*	10	2.6

Unknown* for children <2 years, D. Diarrhoea, F. Fever, V. Vomiting
X²=216, df=6, p-value < 0.00001, *significant

Regarding other relevant risk factors associated with intestinal parasite infections, statistically highly significant differences were identified among different groups, as depicted in Table 6.

Table 6: Prevalence rates of intestinal parasitic infections in rural areas in Duhok province and their associated factors

Associated risk factors	Positive cases	P value
Source of drinking water		
Tap water	117 (30.31)	≤0.00001*
Well water	241 (62.44)	
River	28 (7.25)	
Hand washing before meals		
Yes	114 (29.53)	≤0.00001*
No	272 (70.47)	
Hand washing after defecation		
Yes	305 (79.02)	≤0.00001*
No	81 (20.98)	
Washing vegetables and fruits		
Yes	148 (38.34)	≤0.0001*
No	238 (61.66)	
Animals breeder		
Yes	311 (80.57)	≤0.001*
No	75 (19.43)	

* Significant differences.

Prevalence of intestinal parasitic infections

Worldwide, intestinal parasitic infections are recognized as a significant public health concern, prevailing as endemic afflictions in numerous tropical and sub-tropical regions (Dash *et al.*, 2010). The imperative to address this issue prompts the necessity for epidemiological studies, articles, and research investigations that delve into the prevalence rates of intestinal parasitic infections within rural areas, particularly in relation to associated risk factors. Such efforts serve to illuminate the elevated prevalence rates, thereby facilitating the formulation and implementation of appropriate control measures. While a limited number of studies have explored the prevalence of intestinal parasitic infections within general populations, primary school children, and hospital patients, this study distinctively centers its focus on the prevalence rates of these infections specifically among rural communities within Duhok province.

It is anticipated that the prevalence rates of Intestinal Parasitic Infections (IPIs) would be notably higher in rural areas compared to urban locales, with children being particularly vulnerable (Mahdi, 2022). The present study unveils the prevalence rates of IPIs within rural communities of Duhok province and establishes correlations between these rates and pertinent risk factors. The overall prevalence rate of IPIs stands markedly high at approximately 62.26%. This elevation could potentially be attributed to a multitude of factors, including subpar living conditions, overcrowding, inadequate sources of potable water, unhygienic personal practices, agricultural activities, and animals' husbandry (Taherkhani, 2019).

The observed high prevalence rate of intestinal parasites in rural areas is consistent with findings from prior studies conducted in Duhok city. For instance, a study by Hussein and Merkhan reported a prevalence rate of 65.90%, Salih and colleagues documented a rate of 59.58%. While Ali with his colleagues recorded a rate of 10.34% among rural residents. Moreover, similar trends are evident in

various studies conducted not only in Kurdistan but also in Iraq and other countries. For instance, in Mosul province-Iraq, Ahmed recorded high rates of 63.8%, in Wassit-Iraq, Jaffar reported elevated rates among rural residents (66.4%), and Dyab's study in Egypt showed a prevalence of 39.73%. The study by Hegazy and colleagues revealed a rate of 66.1% in rural areas, and Elmonir's research documented a prevalence of 52.8% among rural residents. Notably, Sungkar's study in the eastern part of Indonesia's rural areas found an even higher prevalence rate of 95.5%. These collective findings underscore the persistent and concerning issue of high intestinal parasite prevalence rates in rural settings, not only in Duhok but also in diverse locations across different countries. While there is generally agreement with the prevailing high prevalence of intestinal parasite infections in rural areas, there exists a minor discrepancy in findings. For instance, a study conducted by Jameel and Eassa in Duhok revealed a highest rate of 35.21% among children residing in camps, followed by a rate of 23.94% among children living in villages. This variation contrasts with the prevalent trend observed in other studies. Moreover, a study by Taherkhani among Iranian rural inhabitants reported a notably lower parasites infection rate of 8.7%. These nuanced differences highlight the complex interplay of factors that contribute to the prevalence of intestinal parasites, which can vary even within similar rural contexts.

Trends of intestinal parasitic infections based on gender and age

In the present study, the infection rates were observed to be higher in males 68.65% compared to females 31.35%. However, statistically, these differences were not found to be significant ($p > 0.05$). These findings align with previous studies conducted in Duhok city. For instance, Hussein and Merkhan documented rates of 63.98% for males and 36.02% for females. Similarly, Jameel and Eassa reported infection rates of 60.87% for males and 39.13% for females, and Salih with his colleagues found prevalence rates of 56.66% for males and 43.33% for females. The consistent trend across these studies reinforces the observation that higher infection rates may be observed among males, while the statistical significance of this difference is not established. In other Kurdistan regions such as in Erbil, Saida reported 64.3% in male and 35.6% in female. In Babylon province by Al-Taei, which reported higher male infection rates at 56.96% compared to 43.03% among females. Similarly, another study in Babylon by Oliewi revealed infection rates of 51.5% among males and 41.2% among females. Likewise, a study by Abed in Diyala in 2020 indicated infection rates of 55.12% among males and 44.87% among females. The consistent pattern of higher infection rates among males in various regions further supports the notion that gender-associated differences may play a role in the prevalence of intestinal parasitic infections. This variation in prevalence rates based on gender may be attributed to specific contextual factors. One plausible explanation for the higher prevalence rates among males, as suggested by Khoshnood (2015), could be their increased outdoor activities, such as playing in streets, interacting with potentially contaminated environments like dirty soils and sand, and swimming in polluted rivers. Additionally, their interactions with stray animals like cats and dogs could expose them to potential sources of infection. On the other hand, the lower prevalence rates among females might be due to their relatively more indoor-focused activities and reduced exposure to external contaminants (Yassin, 1999).

The age group spanning from 6 to 12 years exhibited the highest prevalence rate for IPIs, accounting for **34.46%**. This age range coincides with primary school children. A similar pattern was observed in a study conducted in Baghdad by Al-Moussawi in 2005, wherein a considerably high rate of 75.5% was reported among the age group of 6 to 10 years, along with significant differences. In contrast, previous investigations conducted in Duhok city yielded divergent results. A study by Hussein and Merkhan identified the highest rate (57.85%) among children aged less than or equal to 3 years, while the lowest rate (4.98%) was among children older than 9 years. Additionally, Jameel and Eassa's study indicated the highest rate among children aged 1 to less than 5 years, and the lowest rate within the 5 to 12 years age group. In Al-Diwanyia province, Al-Waaly's research revealed the highest infection rate (88.10%) among the age group of 4 to 6 years. Similarly, Elmonir's study in Egypt highlighted the highest IPIs rate among preschool-aged children, amounting to 76.9%. These variations in findings emphasize the complex interplay of factors contributing to different age-specific prevalence rates of intestinal parasitic infections across various geographic regions.

The results of the study indicated that children at school age exhibited a significantly higher rate of Intestinal Parasitic Infections (IPIs) compared to pre-school age children, as highlighted by Al-Malki in 2021. This finding suggests that the prevalence of IPIs tends to be greater among primary school-age children. One potential explanation for the elevated prevalence rate of IPIs among the age group of 6 to 12 years, which corresponds to primary school age, is their increased activity and movement. Children within this age range tend to be more exploratory, engaging in outdoor activities, and interacting with various environments. Their propensity to play in less hygienic conditions, such as dirty soils or sand, and their interactions with potentially contaminated surfaces could contribute to a higher risk of contracting intestinal parasites (Emile, 2013).

Species of intestinal parasitic infections

A total of four species of intestinal parasites were identified in the study, with three classified as protozoa and only one as helminths. Protozoa parasites were detected at a notably high rate of 99.48%, while helminths were found at a lower rate of 0.52%. Among the identified species, *E. histolytica* exhibited the highest prevalence rate at 73.83%, followed by *G.lamblia* at 16.84%, *B.hominis* at 8.81%. Furthermore, helminths, specifically *Taenia spp.* eggs was reported at a minimal rate of 0.52%. The study also indicated instances of multiple intestinal parasitic infections, with combinations such as *E. histolytica* with *B. hominis* presenting at a prevalence rate of 0.78%, and *E. histolytica* with *G. lamblia* at 0.52%. These findings are in partial agreement with previous research conducted in Duhok by Jameel and Eassa, who reported prevalence rates of *Entamoeba spp.* at 15.97% and *G. lamblia* at 4.78%. Similarly, Salih and colleagues documented a high prevalence rate for *E. histolytica* and *G. lamblia*, with rates of 21.76% and 5.46%, respectively. Moreover, a study by Saida in Erbil reported *E. histolytica* 61.2%, *G.lamblia* 26.6%, and *Taenia saginata* 0.03%. Al-Taei in Babylon revealed a substantial protozoa prevalence rate of 99.2% in comparison to a lower helminths rate of 0.79%. Notably, Al-Taei's findings showcased *E.histolytica* at 88.0%, closely followed by *G.lamblia* at 10.8%. Additionally, Dyab's research in Egypt presented the most prevalent protozoa as *E. histolytica* at 8.3%, followed by *G. lamblia* at 3.7%. The current study's outcomes showed a higher incidence of protozoa infections compared to helminths. This discrepancy can be attributed to the relatively simpler transmission process of protozoa-infected stages, in contrast to the transmission of helminths' larvae or eggs, which necessitate an intermediate host or development in the soil before becoming infectious (Jacobsen, 2007; Arani, 2008).

Furthermore, the study observed that *E. histolytica* exhibited elevated incidence rates among school-aged children (6-12 years old). This can be attributed to the direct transmission of the parasite to humans through consumption of contaminated food and/or water containing resistant parasite stages, specifically the cyst stages (Al-Warid, 2013). Importantly, this transmission does not rely on an intermediate host (Al-Hamairy, 2013). Another potential mode of transmission could be attributed to household flies acting as mechanical transmitters for the parasite (Al-Hamairy, 2013).

The current study identified abdominal pain and diarrhea as the most common and significant clinical symptoms associated with intestinal parasitic infections, with prevalence rates of 33.16% and 32.12%, respectively. These findings align somewhat with a previous study conducted in Duhok by Jameel and Eassa, which also reported a majority of clinical symptoms involving diarrhea (38.43%). Ahmed in Mosul showed abdominal pain in the highest rates of 46.2% followed by diarrhoea 18.48%. Additionally, research conducted by Liao and colleagues revealed significant associations between gastrointestinal signs and intestinal parasitic infections, specifically noting a high prevalence of abdominal pain (76.3%). Doni's study in Turkey also reported high-frequency symptoms, with salivation during sleep being reported by 50.0% of participants, followed by abdominal pain in 47.9% of cases.

Related factors to intestinal parasitic infections

The lack of a strong correlation between specific clinical symptoms and IPIs can contribute to a decrease in the incidence rates of IPIs. Many infected patients, especially children, do not receive appropriate medical care or treatment, which further exacerbates the issue. Routine periodic monitoring is essential to detect asymptomatic carriers and to provide timely and appropriate therapeutic interventions to eradicate the infection (Elmonir, 2021). Additionally, the prevalence rates

of IPIs are associated with various risk factors, including the source of drinking water, hand hygiene practices before meals and after defecation, consumption of raw vegetables and fruits without washing, and animal breeding. These risk factors have been found to be significantly associated with the occurrence of IPIs ($P < 0.05$).

Numerous studies have demonstrated that untreated water sources, such as rivers, streams, wells, and springs, pose a major risk for causing IPIs (Abed, 2019; Cociancic, 2020). Other studies have highlighted significant differences in terms of risk factors for IPIs, such as the importance of hand washing before and after meals, after defecation, and proper washing of fruits (Igoré *et al*, 2020). Even wearing shoes outside has been identified as a potential protective factor against IPIs (Suntaravitun, 2018). These variations in risk factors may be attributed to the unique characteristics of each community and environment. Furthermore, the study revealed that individuals who drank well or spring water had a higher prevalence rate of IPIs (62.44%) compared to those who consumed tap water (30.31%). In Mosul city -Nineveh, similar findings were concluded by Ahmed in addition to Al-Naemy. These findings are consistent with studies from different countries, such as a study in Turkey conducted by Doni, which reported higher prevalence rates of IPIs among children of farm workers who consumed water from untreated sources (38.6%) compared to those who drank tap water (28.5%). These results underscore the importance of addressing specific risk factors and promoting hygiene practices to reduce the prevalence of intestinal parasitic infections and improve public health outcomes.

4. Conclusion

The findings of the study reveal a significant incidence rate of intestinal parasitic infections (IPIs) in rural areas within the Duhok province. Both genders are affected by IPIs, but boys appear to be more susceptible to infection than girls. Among different age groups, children in the primary school age range (6-12 years) were found to be more affected by IPIs compared to other age groups. The most prevalent intestinal parasite identified was *E.histolytica*. Several important risk factors associated with IPIs were identified in the study. These include the source of drinking water, hand hygiene practices before meals and after defecation, and the consumption of raw or unwashed fruits and vegetables. Additionally, the practice of animal breeding was also identified as a significant risk factor for IPIs.

As recommendations based on the study's findings, there is a need for educational and health awareness campaigns to be implemented in rural areas. These campaigns should focus on improving living conditions, emphasizing the importance of safe and clean drinking water sources, promoting proper hand hygiene practices, and discouraging the consumption of raw or unwashed fruits and vegetables. Early diagnosis and effective treatment management are crucial for controlling and preventing the spread of IPIs in these communities. By addressing these risk factors and implementing appropriate interventions, it is possible to reduce the prevalence of IPIs and improve the overall health and well-being of individuals living in rural areas within the Duhok province.

List of abbreviations

1. **B. hominis:** *Blastocystis hominis*
2. **E. histolytica:** *Entamoeba histolytica*
3. **G. Lamblia:** *Giardia lamblia*
4. **IPIs:** intestinal parasites infections
5. **NTDs:** neglected tropical diseases

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