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The Prevalence of Parasite Eggs and Larvae in Stray Dogs' Fecal Samples Collected from Zakho City, Kurdistan Region, Iraq

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ABSTRACT

A significant number of zoonoses, such as cutaneous, visceral, and hydatidosis, are spread by stray dogs. Uncontrolled dog populations pose a serious threat to public health. Finding out how common intestinal helminthes parasites are in stray dogs in Zakho was the aim of this study. In dogs, intestinal parasites can result in anemia, vomiting, diarrhea, weight loss, and malnutrition. Numerous internal parasite species found in dogs' intestines have the potential to cause zoonotic illnesses. 400 stray dog fecal samples were taken from the soil surface at 17 distinct locations in Zakho city between January and July of 2025 as part of the study. Before the data were statistically processed, the feces were inspected using the direct wet mount and sedimentation approach to look for parasite eggs. In this study, 61.25% (245/400) of the samples tested positive for at least one parasite, indicating a high overall prevalence of parasitic infection. At 33% of infections (132/400), Taenia species were the most found parasites. *Strongyloides stercoralis* came in second at 16.75% (67/400) and *Toxocara spp*. at 7.5% (30/400). At far lower percentages, ranging from 0.25% to 1.75%, other parasites such as *Ascaris lumbricoides*, *Hymenolepis nana*, undifferentiated nematode eggs, and *Fasciola hepatica* were found too. a p-value of less than 0.001 and a highly significant chi-square value ($\chi 2$=409.200). It became apparent that in order to lower the danger of disease in both humans and other animals, an educational program for Zakho dog owners should be created.

INTRODUCTION

Zoonotic parasite infections are prevalent among stray dogs, presenting a significant global veterinary and public health problem (Cociancic *et al*., 2020). Stray dogs constitute approximately one-fifth of the world's dog population. Almost all dogs harbor zoonotic intestinal parasites (Abulude, 2020). Dogs can infect humans directly or indirectly by the consumption of contaminated eggs from contaminated water, vegetables, or soil, or by consuming improperly cleaned or cooked fruits and vegetables that include contaminated eggs excreted in the feces of infected dogs (Aziz *et al*., 2022). Dogs may contract intestinal parasites through multiple sources. Parasites are typically transmitted when animals consume polluted soil, water, excrement, or food. Tapeworms can be transferred to dogs by eating infected fleas. In contrast, puppies typically acquire intestinal parasites from their mother (Simone & Richard, 2017).

Symptoms of parasite infection in stray dogs vary depending on age, severity, location, and developmental stage of the worms. Some dogs may be asymptomatic (Ramírez-Barrios *et al*., 2004). Diagnosis of internal parasites is crucial for preventing parasitic infections in humans and animals. Intestinal parasites dwell within the host animal's gastrointestinal tract. Parasites include various types of worms, such as roundworms, whipworms, hookworms, and tapeworms. They can harbor a variety of intestinal parasites, including trematodes, tapeworms, and nematodes (Aziz *et al*., 2022) such as *Dipylidium caninum, Toxocara canis, and Echinococcus granulosus*, some of which have the capacity to spread disease (Weese *et al.,* 2011). Infected organs from killed animals, such as the liver and lungs with viable cysts, are typically consumed by dogs and other carnivores (Otero-Abad & Torgerson, 2013). Infection with intestinal parasites can lead to malnutrition, weight loss, vomiting, diarrhea, and anemia in dogs (Hall, 2011). Several studies have examined the prevalence of gastrointestinal parasites in stray dogs in Iraqi Kurdistan areas, including Sulaimani, Erbil, and Dohuk. Erbil province (Saida, 1989; Saeed *et al*., 2000), Kalar city (Bajalan, 2007) and Duhok city (Aziz *et al.,* 2022).

This study aimed to identify the prevalence of gastrointestinal parasites in stray dogs, as well as differences in the presence of each parasitic genus between places and months. On the other hand, understanding the types of intestinal parasites in dogs in a specific area is critical for identifying zoonotic risk in infection prevention and control.

MATERIALS AND METHODS

Study Area:

Zakho City is situated close to the Turkish border in the Kurdistan Region of Iraq's Duhok Province (Fig. 1). With a mean temperature of 30.5°C and a maximum temperature of 45°C, the city enjoys pleasant summer weather. 25.2°C is the lowest recorded average summer temperature. The humidity stays below 50% on an annual basis and falls to less than 30% during the day (Diyar; Bleej, 2020).

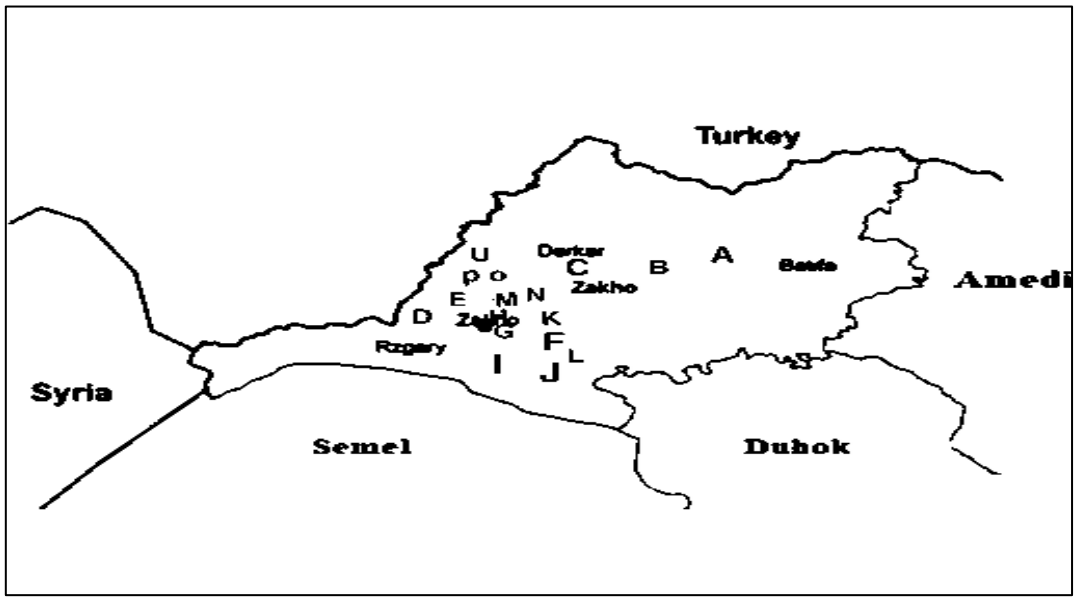

Fig. 1: Map of Zakho city showing the locations of the collected samples (Kurdistan Region Statistic Office, 2025).

A: Bankey, **B:** Bersve**, C:** Girk Sindi, **D:** Ibrahim Khalil, **E**: Bedare, **F**: Dashmer, **G**: New Zakho, **H**: Dar Alziyafa, **I**: Zakho University, **J**: Hasan Ava, K: Khalish, **L**: Betase, **M**: Dream City, **N:** Khrababk, **O**: Around Military College, **P**: Lava City, **U**: Chamishko Camp.

Collection and Examination of Fecal Samples:

A total of 400 fecal samples were randomly selected from the soil in 17 different climatic zones where stray dogs are prevalent. The samples were taken throughout the winter, spring, and summer months of January through July of 2025. Every stool sample was taken to the Parasitology Lab at the Biology Department, College of Science, Zakho University, in a plastic jar with a label. Until they were used to examine and identify parasite eggs, the samples were stored in a refrigerator at -20°C. In order to find eggs, the feces samples were analyzed using direct wet mount and normal saline sedimentation method techniques (Shukur, 2021). From each fecal sample, three smears were analyzed. To detect parasite larvae or eggs, a small piece of stool was removed using a wooden pick, combined with one drop of iodine solution, covered with a cover slide, and viewed under a microscope at 4X, 10X, 40X, and 100X magnification. Eggs were identified morphologically in accordance with (Zajac & Conboy, 2012).

Statistical Analysis:

SPSS (version 26) was used for statistical analysis, and a P value of less than 0.05 was considered statistically significant.

RESULTS

During this study, 400 fecal samples were analyzed. The total prevalence of the parasite detected in the samples was 61.25% (245/400), with the highest prevalence (33%) for Taenia species, as seen in Table 1 and Figure 2, followed by *Strongyloides stercoralis* at 16.75% (Figs. 3 and 4) and *Toxocara spp.* at 7.5% (Fig. 5). Other parasites, including *Ascaris lumbricoides* (Fig. 6), *Hymenolepis nana* (Fig. 7), undifferentiated nematode eggs (Fig. 8), and *Fasciola hepatica* (Fig. 9), were detected at much lower percentages, ranging from 0.25% to 1.75%. The chi-square value ($\chi 2$=409.200) with a p-value of less than 0.001 indicates that its highly significant.

Table 1: The prevalence of helminthic eggs and larvae in stool samples of stray dogs.

Parasite sp.	Number of parasites detected in the samples/total samples examined	Percentage of infection%
Taenia	132/400	33
strongyloides stercoralis	67/400	16.75
Toxocara spp	30/400	7.5
Ascaris lumbricoides	7/400	1.75
Nematode eggs	3/400	0.75
H. nana	5/400	1.25
Fasciola hepatica	1/400	0.25
Total parasites detected in the samples	245/400	61.25
$X^2 = 409.200$ $p < 0.001$		

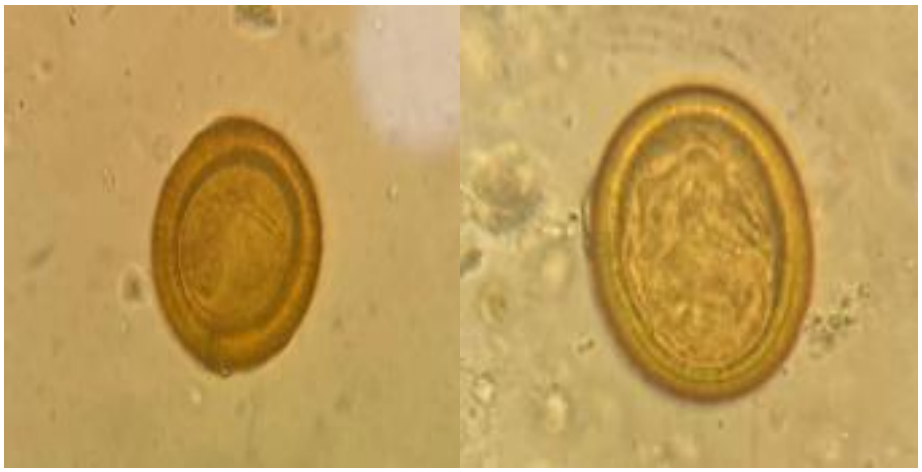

Fig. 2: Taeniid eggs in the feces of stray dogs/100x

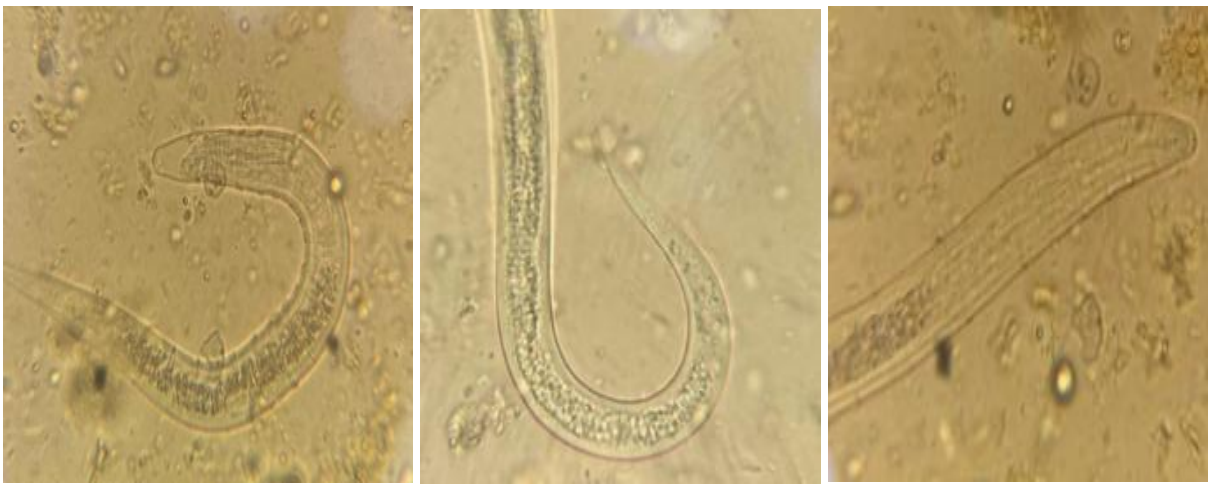

Fig. 3: larvae of *Strongyloides stercoralis* /100x

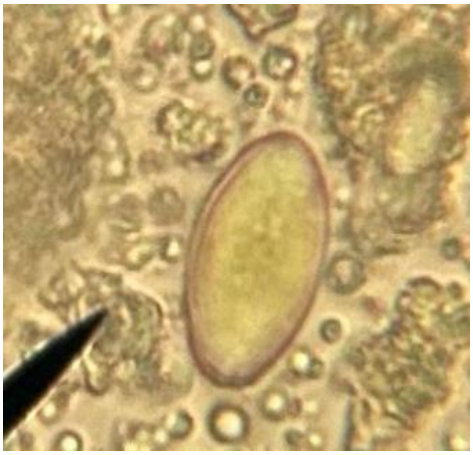

Fig. 4: Egg of *Strongyloides stercoralis*/100x

Fig. 5: Egg of *Toxocara* spp/100x

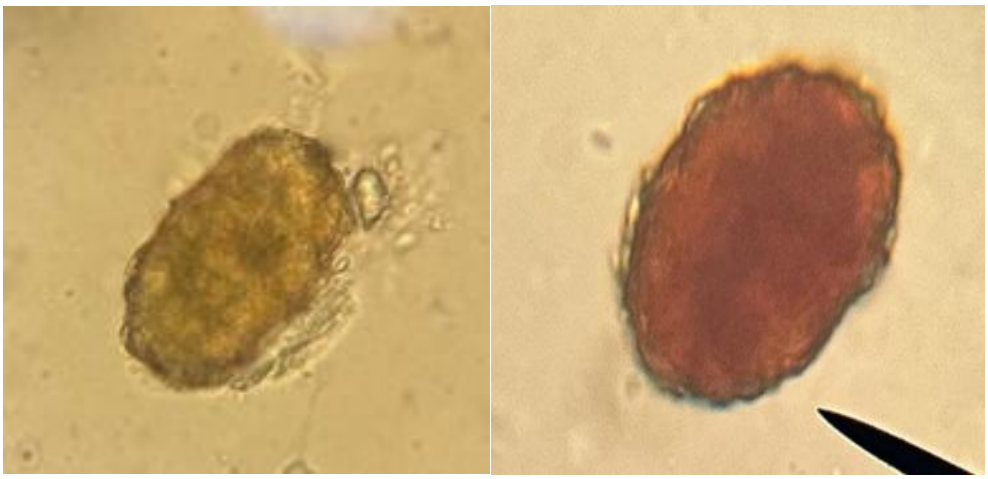

Fig. 6: Eggs of *Ascaris lumbricuides* /100x

Fig. 7: Un Diagnostic Nematode egg /100x

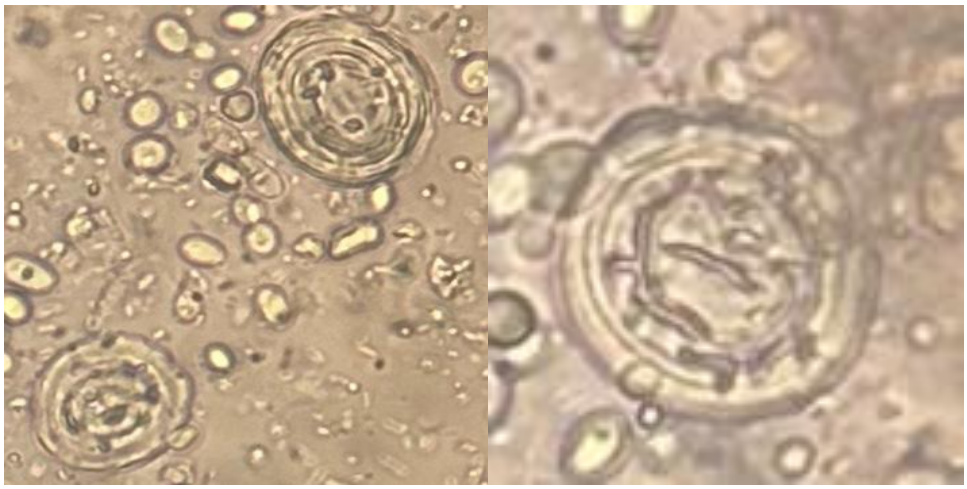

Fig. 8*:* *Hymenolepis nana eggs* / 100x

Fig. 9*: Fasciola hepatica* egg /100x

The data provided indicates that a significant portion of the examined stool samples, specifically 222 out of 400, tested positive for infection, resulting in an overall infection rate of 55.5%. A closer look reveals that single infections are the most predominant, accounting for 200 positive samples, or 50% of the total. In contrast, double infections were observed in a much smaller percentage of samples (5.25%, or 21 cases), and triple infections were exceedingly rare, with only one instance representing 0.25% of the samples (Table 2).

Table 2: Infection States and Prevalence in Stool Samples**.**

Infection state	Number of positive stool samples/total samples examined	Percentage of infection%
Single infection	200/400	50
Double infection	21/400	5.25
Triple infection	1/400	0.25
Total	**222/400**	**55.5**

The result of this study showed a considerable variation in infection rates among the different areas. For instance, "Around Military College" (88.89%) and "Lava City" (80%) exhibit notably higher infection percentages compared to areas like "Bedare" (41.18%) and "Dream City" (43.48%) as shown in Table (3).

Table 3: Distribution and Prevalence of Parasitic Infections in Different Areas of Zakho.

Area	Samples collected	Positive	Taenia	*Strongyloides stercoralis*	*Toxocara spp*	*Ascaris lumbricoides*	Nematode egg	*H.nana*	*Fasciols hepatica*	**Infection %**
New Zakho	36	21	13 (36.11%)	2 (5.56%)	6 (16.67%)	0 (0%)	0 (0%)	2 (5.56%)	0 (0%)	58.33
Around military college	9	8	5 (55.56%)	0 (0%)	2 (22.22%)	3 (33.33%)	0 (0%)	0 (0%)	0 (0%)	88.89
Bedare	17	7	3 (17.65%)	2 (11.76%)	0 (0%)	1 (5.88%)	1 (5.88%)	1 (5.88%)	0 (0%)	41.18
Aldarziyafa	18	8	3 (16.67%)	4 (22.22%)	1 (5.56%)	0 (0%)	1 (5.56%)	0 (0%)	0 (0%)	44.44
Betase	31	19	10 (32.26%)	9 (29.03%)	3 (9.68%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	61.29
Hasan ava	18	9	5 (27.78%)	3 (16.67%)	2 (11.11%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	50
Chamish ko camp	17	12	6 (35.29%)	8 (47.06%)	0 (0%)	2 (11.76%)	0 (0%)	0 (0%)	0 (0%)	70.59
Lava city	15	12	8 (53.33%)	4 (26.67%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1 (6.67%)	80
Dream city	23	10	5 (21.74%)	4 (17.39%)	1 (4.35%)	0 (0%)	1 (4.35%)	0 (0%)	0 (0%)	43.48
Bersve	36	20	15 (41.67%)	8 (22.22%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	55.56
Banky	20	11	6 (30%)	4 (20%)	1 (5%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	55
University of zakho	20	13	9 (45.00%)	2 (10%)	3 (15%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	65
khalish	31	16	8 (25.81%)	3 (9.68%)	4 (12.9%)	0 (0%)	0 (0%)	1 (3.23%)	0 (0%)	51.61
Ibrahim khalil	25	12	7 (28%)	3 (12%)	1 (4%)	1 (4%)	0 (0%)	0 (0%)	0 (0%)	48
Girk sindi	28	15	10 (35.71%)	5 (17.86%)	2 (7.14%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	53.57
Dashtmre	31	18	12 (38.71%)	3 (9.68%)	2 (6.45%)	0 (0%)	0 (0%)	1 (3.23%)	0 (0%)	58.06
Khrababke	25	11	7 (28%)	3 (12%)	2 (8%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	44
Total	400	222	132 (33%)	67 (16.75%)	30 (7.50%)	7 (1.75%)	3 (0.75%)	5 (1.25%)	1 (0.25%)	55.5

DISCUSSION

The current study's overall parasite infection rate was 55.5 %, whereas (Shukur, 2021) found a higher rate (65.9%) in the city of Duhok. In contrast, the city of Kalar had a lower rate (36.6%) by (Barzanji & Saida, 2019). Furthermore, the incidence of helminthic eggs in dog feces was significantly lower in Diyala and Basrah, with rates of 10.1% and 16.66%, respectively, according to Hasson (2014). Numerous factors, including temperature, geographic location, veterinary treatment, wetness, and dog counts, may be responsible for the variations in these rates (Al Zubaydi & Kadhim, 2017). The high prevalence of parasitic infection may be related to the fact that stray dogs roam the city looking for food and animal carcasses; it may also be related to the lack of health education among city dwellers who kill animals and discard the contaminated offal, which stray dogs will have access to (Bajalan, 2007).

A cross-sectional study examining infection rates at multiple collecting sites likely in or near Zakho city is presented in this data. 222 (55.5%) of the 400 samples that were gathered tested positive for at least one parasite infection, suggesting a high overall incidence in the area. Significant differences in infection rates between the various regions are shown by the data. For example, infection rates are significantly

greater in "Around Military College" (88.89%) and "Lava City" (80%) than in "Bedare" (41.18%) and "Dream City" (43.48%), indicating that transmission is influenced by local conditions.

With a prevalence of 33% overall and exceptionally high rates in "Around Military College" (55.56%) and "Lava City" (53.33%), Taenia species infections are the most frequently found. "Chamishko Camp" has the largest individual area prevalence (47.06%), followed by *Strongyloides stercoralis*, which has an overall prevalence of 16.75%. Infections with *Toxocara spp*. are less frequent, making about 7.50% of the total; "New Zakho" has the greatest rate (16.67%). *Ascaris lumbricoides* (1.75%), unidentified nematode eggs (0.75%), *H. nana* (1.25%), and *Fasciola hepatica* (0.25%) are less common parasites. The existence of *H. nana* in "New Zakho," "Bedare," "Ibrahim Kahlil," and "Dashtmre" and *Fasciola hepatica* in "Lava City" suggests the presence of a variety of parasite agents in these particular areas. The significance of focused public health initiatives and additional research into regionally specific behavioral and environmental risk factors is highlighted by this geographic variance in parasite incidence.

There was no discernible variation in infection rates between the collecting sites, according to the statistical analysis. Rather than reflecting a real underlying variation in infection prevalence among various sites, these discrepancies could just be the result of chance. Despite the absence of statistical significance, more research would be required to determine the mechanisms behind the observed variances.

Other studies conducted in different regions of the country have revealed varying rates of parasite infection. Using wet direct film and sedimentation methods to identify helminthic eggs, Hadi and Faraj (2016) analyzed 120 stool samples from stray dogs in the region of Baghdad and discovered that hookworm was most common (86.6%), followed by *Toxocara canis* (67.5%) and *Trichuris* vulpis (51.6%). *Giardia sp*. and *Cryptosporidium* sp. were detected in 24.1% and 20.8% of the total samples, respectively, whilst Taenia sp. was detected in 29.1% of the samples. The least common species was *Strongyloides sp.* (5%). Also, using flotation and sedimentation techniques, Aziz and his colleagues (2022) examined 400 dog fecal samples obtained from different locations in Sulaimani province and discovered that 24.55% of the samples contained *Echinococcus granulosus* eggs.

In their analysis of 160 fecal samples from stray dogs, other researchers like Issa *et al.* (2022) discovered that the overall parasitic prevalence was 46.25%, with Taenia spp. being the most common parasite (23.13%), followed by *Strongyloides stercoralis* (13.12%). After examining 35 stray dogs in Mosul, Al-Khalidi and his colleagues (1988) discovered that nine of them had *Toxocara canis* (25.7%), four had *Ancylostoma caninum* (11.4%), and one had *Toxascaris leonina* (2.8%). Of the dogs, 18 (51.4%) had *Dipylidium caninum*, 18 (51.4%) had Taenia spp., and 6 (17.1%) had *Echinococcus granulosus* eggs.

In Diyala, Hasson (2014) analyzed 30 fecal samples from stray dogs using flotation, sedimentation, and direct smear methods, and he reported *Dipylidium caninum* as the most common, with a rate of 28.6%. *Toxocara* spp. and *Isospora spp*. also showed significant presence at a rate of 21.4% for each. Less frequent parasites included Taenia spp., *Echinococcus spp., Mesocestoides spp*., and *Strongyloides spp*., each accounting for 7.1% of the observed cases.

Furthermore, Muhamed & Al-barwary (2016) used flotation, sedimentation, and direct smear techniques to examine stool samples from 270 sheep-keepers, owned, pet, and stray dogs that were collected from various locations in Duhok province. They found that for the first time, trematode eggs (1.9*%), Strongyloides spp*. (1.9%), *Ancylostoma*

caninum (2.2%), *Hymenolepis nana* (1.9%), Taenia spp. (13.7%), and *Diplydium caninum* (16.7%) were detected in dogs from Duhok province.

Also, Hassan & Barzinji (2018) examined 77 fecal specimens of stray dogs collected from different locations of Kirkuk province using a flotation procedure; the infection rates were *Toxocara canis* (25.98%), *Diphylobotherium latum* (23.38%), *Dipylidium caninum* (16.88%), *Ancylostoma caninum* (2.59%), and *Strongyloides* spp. (1.3%), and the rate of taenia eggs was 20.78%.

Moreover, using direct examination, Abdulhameed *et al.* (2020) discovered a slightly lower percentage (10.1%) in 335 fecal samples from stray dogs in the area of Basrah. The seldom availability of sheep carcasses for dogs to consume may be a factor in the low incidence of taeniid eggs (Hasson, 2014). By comparison, *Echinococcus granulosus* worms were detected in 79.1% of stray dogs in the province of Erbil (Molan & Saida, 1989). After examining the small intestines of 67 stray dogs from different locations throughout the province, they discovered that 79.1% of them had *an E. granulosus* infection. Additionally, in Kalar City, Sulaimani province, Bajalan (2010) analyzed 50 stray dogs from three different parts of the city and found that 78% of them were infected with *Dipylidium caninum* (26%), and 26% were infected with *Diphylobothrium latum.* The reported prevalence rates for the two intestinal nematodes, *Toxocara sp.* and *Ancylostoma caninum,* were 36% and 2%, respectively.

According to studies conducted in Iraq, the custom of killing sheep and other livestock in the home may be the cause of the high infection rate. Dogs are frequently fed contaminated offal during Islamic holidays like Al-Adha Eid. Numerous factors, including geographic location, socioeconomic level, sample type, usage of anthelmintic or deworming medications, and diagnostic technique, may be responsible for the difference across several investigations (Schär *et al.*, 2014).

Furthermore, dogs' food has a significant influence on intestinal parasite infection; dogs who consume raw or free mixed meat may have a high number of parasites, but dogs that eat cooked meat have a lower infection rate because cooking can inactivate gastrointestinal helminthes eggs or cysts (Getahun & Addis, 2012).

Finally, the current investigation discovered that the environment was contaminated with significant quantities of helminthic eggs, which could be dangerous for residents. Implementing deworming programs and educating the public about health issues are crucial to protecting livestock and reducing the number of stray dogs in these areas.

Conclusion:

With an overall incidence of 61.25%, this study unequivocally shows a significant burden of parasitic diseases among stray dogs in Zakho. Due to their life cycle requiring intermediate animals that dogs frequently devour, Taenia species were prevalent, underscoring the possibility of zoonotic transmission. The high frequency emphasizes how stray dogs serve as parasite reservoirs that can affect cattle and public health. Geographical differences in infection rates among Zakho's regions point to localized risk factors, most likely related to community hygiene standards, environmental contamination, and availability to animal offal. Instead of the tendency for several co-infections inside a single animal, the prevalence of single infections, with fewer double or triple infections, suggests extensive exposure. Regional variations are revealed when comparing these results with those of another Iraqi research. These variations are impacted by the environment, the density of dogs, and regional cultural customs such as customary animal killing. The results highlight the critical need for focused interventions, such as organized deworming campaigns for populations of stray dogs. In order to educate communities about the

dangers of giving dogs raw meat and how to properly dispose of garbage, particularly animal carcasses and offal, public health education is essential. Such actions are essential to reducing environmental pollution and protecting the region's animal and human health.

Declarations:

Ethical Approval: The study was performed in accordance with the Declaration of Helsinki - Ethical Principles for Medical Research, revised in 2008, and was approved by the Ethics Committee of Zakho Directorates of Health (NOV2024/ UOZE24 ON 12/11/2024) for examining students taking samples, consent and Data.

Competing interests: There is not any conflict of interest in this study.

Availability of Data and Materials: The data used in this study are available on request from the corresponding author.

Authors Contributions: All authors made substantial contributions to this manuscript Lolaf Isamel Sleman and Ahmed Basheer Mohammed. Ahmed Basheer Mohammed conceived and designed the work. Lolaf Isamel Sleman collected the data, analyzed them, and wrote the first draft of the manuscript.

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