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Traditional Detection of Intestinal Helminths in Stray Cats in Wasit Province, Iraq

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Abstract

The purpose of this study was to find out the prevalence and distribution of intestinal parasites namely helminths in stray cats in different areas of Wasit Province, Iraq with reference to zoonotic risks for improved public health intervention. The study included a survey of helminthes in the intestines of stray cats in several areas of Wasit province, to determine the extent of their spread among populations in the regions. Samples were collected from 96 stray cats distributed from several areas of the same province, 7 species of parasitic were observed, in the intestines and four species tapeworms. The highest observed was of Dipylidium caninum for 44.61% of cats stray infected with tapeworms. The other two species recorded nematodes as 46.51%, and 22.58% for Toxocara cains, and Toxascaris leonina respectively, note that T. cains infection is higher than the others; while, other species have been diagnosed with different rates 35.38%, 24.61%, 12.30%, and 27.90% for Taenia multiceps, Taenia ovis, Taenia pisiformis, and Ancylostoma sp., respectively. The infection rate in the northern regions of the province was higher in cats than in the southern regions of Wasit Province with nematodes and tapeworms. The extensive presence of stray cats across numerous Iraqi areas necessitates increased focus from relevant bodies, especially in public health and veterinary sectors, to mitigate associated risks and zoonotic concerns. Consequently, necessary to enhance the scope of studies and investigations concerning cats and their ailments, attributed to the proliferation of feline reproduction within communities and their interaction with stray felines.

Introduction

Reducing stray cat population has been a concern to communities especially the urban and rural areas as well as various sectors with complicated consequences of health wise, environmentally, and welfare of the felines (Twardek et al., 2017; Morelli et al., 2021). These animals that may be found within human proximity are the hosts to several parasitic diseases that may be communicated to human and other animals. These parasitic infections are rather dangerous and the risks connected with them are most acute in the areas where the government measures for stray animal's control are insufficient or absent at all (Welburn et al., 2015). One such region is Iraq and more specifically Wasit Province where the population of feral cats continues to expand in a and become a threat in terms of spreading diseases to humans as well as in endangering food security and agricultural production (Doherty., 2017: Lepczyk & Duffy, 2017).

Feral cats are hosts of several zoonotic parasites including tapeworms as; Dipylidium caninum and roundworms; Toxocara cati and Ancylostoma species (Rodríguez-Ponce et al., 2016). These parasites are not only potentiated to develop diseases that affect morbidity levels in animals, but also those that can transmit diseases affecting human health greatly (Hajipour et al., 2015). These parasites are zoonotic, and the mode of transmission is through water, food

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stuffs or through contact with infected animal, the problem is of concern to public health especially in areas where there is abundance of stray cats and poor toilet hygiene (Alfarras et al., 2022; Madjeed et al., 2022).

Thus, while the dangers are appreciated, the current scientific literature carries an identified dearth of information on the epidemiology of parasitic infections in stray cats in Iraq (Jafari-Shakib et al., 2024; Al-Hamada, 2021). Most past researches have estimated the occurrence of these infections in livestock or domestic animals with hardly any attention given to stray cats as reservoir hosts. It becomes alarming to find this lack of information because parasitic infections are potential sources of major economic losses especially in the agricultural field through contamination and degradation of organs of livestock that are used by humans for food (Hassan et al., 2023). The absence of robust data as to how widespread these parasites are among the feral cats is not only a challenge to our ability to comprehend the magnitude of the problem but also to the efforts that may be taken to prevent or mitigate their transmission (Grieco et al., 2021; Kiros et al., 2020).

Also, the peak infective rate among stray cats and the ecological characteristics of the parasites are not completely well understood especially with reference to the climate, urbanization, and peculiar farming practices in the area such as the Wasit Province, Iraq (Allen & Heldring, 2022; Adhikari et al., 2023). Feral cats are acknowledged to hunt rodents and other small mammals which are actual hosts of numerous of these parasites. This predator-prey not only contributes to transmission of parasitic diseases but also helps in understanding the diverse interactions of ecology of the transmission of these diseases (Saleem & Taher, 2022). It is important to comprehend these interactions in a bid to formulate the best methods of control that fits the ecological and environment of the area (Chatzis et al., 2014).

This study, therefore, undertakes a thorough epidemiological survey of intestinal helminths among stray cats in various parts of Wasit Province. This study therefore plans to extend such investigation to both the northern and southern regions of the province in other to develop a regional and specific analysis of the factors that can lead to the transmission of these parasites among these individuals. The results of this study shall complement the recorded information on parasitic infection in dogs and other stray animates while contributing to the formulation of specific measures that can be undertaken to reduce the risks of the said parasitic infections among stray animals with a view of minimizing the occurrence among the population and among stray animals in particular (Spada et al., 2013).

Methods

Research Design

Special attention was paid to design of this study in order to determine the prevalence and distribution of intestinal helminths in stray cats in Wasit Province of Iraq. This was so because Wasit Province covers areas that are urbanised as well as those areas that are more rural and associated with agriculture, thus making it easier to sample from in order to determine differences in the levels of parasitic infestation. It was done in six months, from January to June, 2024 this would enable the capture of any seasonal pattern of the parasitic encounters. To ensure a representative sample, stray cats were collected from six key areas within the province: The Al-Suwaira, Al-Aziziyah, Al-Numaniyah, Al-Kut, Badra and Al-Hay. These zones were selected as they are to different extents urbanized, populated by humans and located near agricultural lands, which are considered to impact helminths' circulation in stray cats.

ISSN 2721-1304 (Print), ISSN 2721-1207 (online)

Sample Collection

In total, 96 stray cats were trapped for this study, with endeavours being made to ensure that random sampling techniques were adopted with a view to reducing bias. They used banned iron trap for catching of the cats which though was effective and caused least form of discomfort to the cats. These traps were set in areas where feral cats roam, including around markets, at dumpsites and residential areas in order to ensure that the greatest possible number of cats of different origin would be caught. After that, the cats were taken to the laboratory at college of veterinary medicine, University of Wasit. On arrival all the cats were examined for any sign of ailment or discomfort, which would have a bearing on the results of the study. Then all these cats were somehow put to death through intraperitoneal injection of sodium barbitone as per the recommendations of the institutional ethics committee. This method was chosen because it does not cause pain and lead to a rapid death which will facilitate the examination of the intestinal tissues.

Sample Processing

An autopsy was performed with great care to accurately detect and measure the helminthic infection. Each cat's gastrointestinal tracts were very carefully dissected away from adjacent organs. To avoid cross-contamination, the digestive tract was then sutured at both poles, and pulled out of the body cavity. The intestines' outer layer was then rinsed with the PBS solution to reduce the chances of any interferences emanating from within the scopes of internal parasites (Grieco et al., 2021).

The samples of dissected intestines were later opened meticulously, and a dissection microscope was used to analyse the samples. This step was important in the enumeration of macroparasites especially the adult helminths which were then separated and washed in physiological saline and preserved in 70% ethanol to enhance their quality for morphological assessment. There was need to preserve these samples prior to microscopic analysis which was done after staining the samples with Erlich hematoxylin stains. Staining of the material with these reagents was chosen due to the fact that the staining increases the contrast of the parasite structures which makes it possible to identify the helminth species by their morphological features (Wong et al., 2014). Each specimen was examined under a compound microscope special efforts were made to identify cestodes and nematodes. The identification of parasites in the selected animals was done based on correctly identifying each parasite using reference materials on veterinary parasitology. Specific information contained in records included type of parasites present in the faecal samples, number of parasites in each sample, and tissue site of parasites identified in the GIT.

Statistical Analysis

The data obtained from the autopsies were analyzed statistically with much consideration to check the rate of helminthic infection and the probable factors that may lead to such infection in the different regions of Wasit Province. Descriptive analysis was done and One-Way ANOVA was employed in making comparisons as to prevalence rates of parasites from the regions with a significance level set at $P \leq 0.05$. This method was chosen to analyse the results to compare the infection rates in the various areas of the study regions and also due to geographical space. Apart from the described regional comparison, other inferential analyses were undertaken in an attempt to understand some other possible relationships, including the age and sex of the cats, as well as the seasonality of infection with parasites. Such analyses were intended to reveal whether there were some host-associated factors or temporal dynamics that would affect helminths distribution in stray cat populations.

ISSN 2721-1304 (Print), ISSN 2721-1207 (online)

GraphPad Prism software was used for all assessment: Statistical analysis, as it offered a powerful environment on the experimentation of tested statistics, and visualization. Parasite data was provided in the form of tables and graphs, which provided the prevalence studies but also risk factors and potential patterns regarding the parasites that perhaps could be used for targeted public health measures.

Ethical Considerations

As for the whole process of this study, a primary attention was paid to the principles of ethical conduct. All the procedures were established for trapping, handling, neutralizing, and postmortem examination of the stray cats were discussed and considered by the institutional ethic committee of the University of Wasit. The following concerns were considered ethical while conducting the study for instance, the level of discomfort that animal could experience in the entire process of the study was avoided as much as possible. In a way that minimized pains, humane euthanasia techniques were employed and all operations were performed by qualified individuals with great experience in dealing with and studying feral animals. Furthermore, the study had thought about the consequence that could occur due to the extraction of stray cats from their natural habitat. The required sample size was calculated to contain a degree of statistical significance, so as to reduce the impact on the unsaid stray cats living in the area. The study also employed the spirit of the 3Rs (Replacement, Reduction, Refinement) in animal use, to ensure that while using the animals to get the required scientific data, as much harm as possible was averted to the animals.

Results and Discussion

The current results showed that 7 parasitic species were recorded in the intestine; in which, 4 of them were Cestodes and 3 were Nematodes in stray cat's study regions in Wasit Province (Table 1). *Toxocara canis* was the most common followed by *Dipyidium caninum*. The current study also showed that stray cats in the city were infected with two or three species in one host more than they were infected with four or more species. Our findings were similar with that reported by other studies (Candela et al., 2022). Whilst the study showed that there are clear significant differences observed of tapeworm and thread worm infections in cats from different areas in Wasit Province. Our findings were in agreement with that showed by other researchers Aqeele, 2024).

Table 1. Distribution of tapeworm infection cats in the different areas of Wasit Province

Region	Total No.	Positive	
		No.	%
Al-Suwaira	17	14	82.35
Al-Aziziyah	15	12	80
Al-Numaniyah	23	20	86.9
Al-Kut	11	3	27.27
Badra	12	5	41.66
Al-Hay	18	11	61.11
Total	96	65	67.70

The number of tapeworms in this study was high compared to other nematodes, and the genus *Dipylidium caninum* was more widespread due to the frequent infection of the intermediate hosts. The cycle is completed when the cats and the rest of the canine family members feed on the infected viscera or remains, and a new cycle begins (Malaa et al., 2020). The regions of the province showed a high percentage of infection by *Dipylidium caninum* (Table 2). The study

ISSN 2721-1304 (Print), ISSN 2721-1207 (online)

is compatible with local (Soriono et al., 2010; Khushali, 2007), and international studies in Iran (Soroushianfar et al., 2024), and 47% in Qatar **(**Abu-Madi et al., 2010). The reason is due to the large number of infection and carries the *genus Dipylidium caninum* stray cats in the northern region (Chatzis et al., 2014).

Table 2. Distribution of infection in cats according to area

Region	Total No. of infected cats with Cestodes			
	D. caninum	***T. multiceps***	***T. ovis***	***Taenia pisiformis***
Al-Suwaira	6	3	1	4
Al-Aziziyah	6	2	4	0
Al-Numaniyah	8	6	4	2
Al-Kut	0	2	0	1
Badra	3	2	4	0
Al-Hay	6	8	3	1
Total	**29 (44.61%)**	**23 (35.38%)**	**16 (24.61%)**	**8 (12.30%)**

According the Khademvatan et al. (2014), the reason for this high percentage of disease is due to the large number of stray cats in regions of the province and because cats search for food in places where garbage is collected and where the infection is transmitted after feeding on animal waste containing larval stages (Spada et al., 2013**)**. Hajipour et al. (2016) reported that *Toxocara canis* and *Toxascaris leonina* are diagnosed at a rate of 46.51% and 25.58%, respectively, of the number of infections in stray cats in regions of Wasit Province (Table 3). These findings were agreed the results of other researchers (Otranto et al., 2015). These high rates are due to the increase in cats' hunting of mice and rodents, whose tissues contain the larvae of these two species of parasites.

Table 3. Distribution of Nematodes in cats in different areas of Wasit Province

Region	Total No.	Positive	
		No.	**%**
Al-Suwaira	17	11	64.7
Al-Aziziyah	15	8	53.33
Al-Numaniyah	23	9	39.13
Al-Kut	11	3	27.27
Badra	12	6	50
Al-Hay	18	6	33.33
Total	**96**	**43**	**44.79**

The infection rate of *Taenia muliceps* and *Taenia ovis* was 35.38% and 24.61%, respectively, which observed in cats eating their droppings with hunting rodents (Table 4). As for the *Taenia pisiformis* parasite appearance the infection rate of 12.30% in stray cats and the northern and southern regions of the province (Aqeele, 2024). The detecting rate was 9.23% and 3.07%, respectively, due to the widespread spread of the intermediate host, the flea carrier, in large numbers on the skin of cats according (Saleem & Taher, 2022).

Table 4. Distribution of type infection by Nematodes species infection

Region	No. of infected cats with Nematodes		
	T. canis	***T. leonina***	***Ancylostoma* sp.**
Al-Suwaira	7	4	-
Al-Numaniyah	-	4	5

ISSN 2721-1304 (Print), ISSN 2721-1207 (online)

Al-Aziziyah	5	-	3
Al-Hay	4	1	1
Al-Kut	-	-	3
Badra	4	2	-
Total	**20 (46.51%)**	**11 (25.58%)**	**12 (27.9%)**

Finally, the *Ancylostoma* sp. parasite showed an infection rate of about 27.90% of the total group of infected cats, and the rate was 18.60% and 9.30% in the northern and southern regions, respectively. This type of hookworm, and the adult worm sheds millions of eggs that turn into larvae that infect cats and even Humans then transform into adult worms that settle in the intestines (Jafeer et al., 2023; Al-Haboobi et al., 2022).

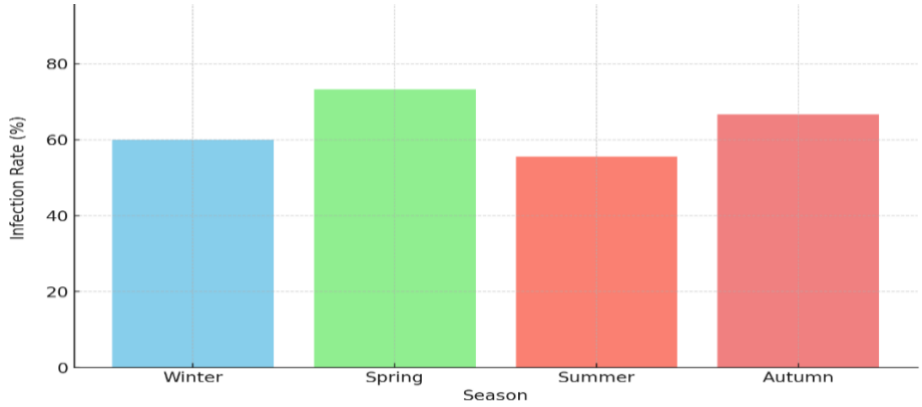

Figure 1. Seasonal Variation in Helminthic Infection Rates in Stray Cats

The bar chart shows the infection rates across different seasons. The highest infection rate occurs in the spring (73.33%), which could be due to favorable conditions for parasite transmission during this time. The lowest rate is observed in the summer (55.56%), potentially due to harsher environmental conditions that might reduce the survival or transmission of the parasites. Winter and autumn show moderate infection rates, suggesting a steady presence of parasites throughout the year, but with peak activity in the spring.

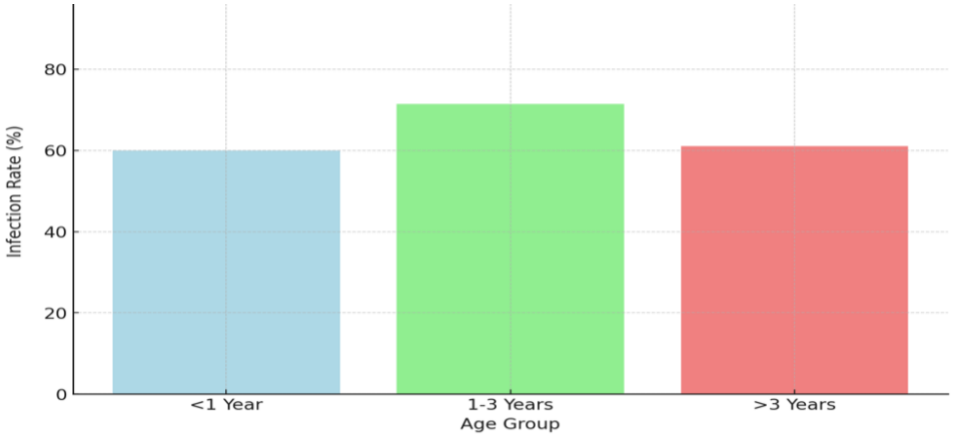

Figure 2. Helminthic Infection Rates by Age Group of Stray Cats

This chart indicates that the highest infection rates are found in cats aged 1-3 years (71.43%). This age group might be more exposed to environments where parasites are prevalent, possibly due to their increased mobility and foraging behavior compared to younger or older cats. The youngest cats (<1 year) and older cats (>3 years) have slightly lower infection rates, which could be attributed to different behaviors, immune responses, or environmental exposures.

ISSN 2721-1304 (Print), ISSN 2721-1207 (online)

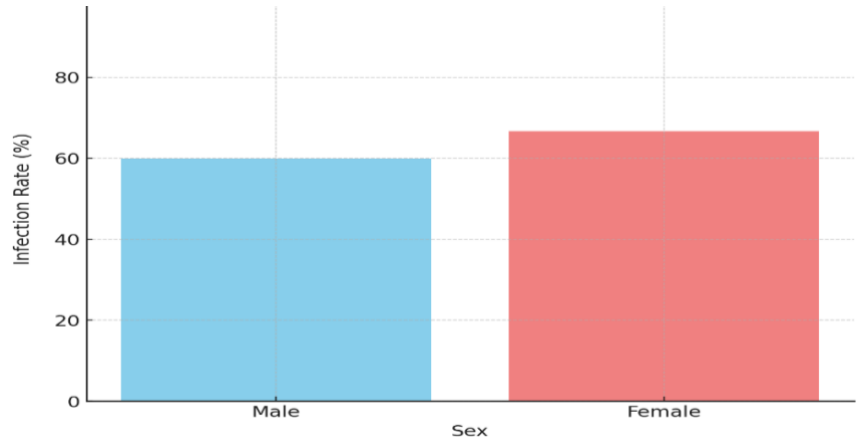

Figure 2. Helminthic Infection Rates by Age Group of Stray Cats

The comparison between male and female cats shows that females have a slightly higher infection rate (66.67%) compared to males (60.00%). This difference might be due to behavioral or biological factors, such as differing territories, feeding habits, or susceptibilities to infection. This data could suggest the need for gender-specific approaches in managing and treating helminthic infections in stray cat populations. Data collected from this study suggest a detailed view of the prevalence of helminthic infections in stray cats in Wasit Province, Iraq. These results include implications for public health, Large Animal Veterinary Practice and ecological effects and therefore requires an appropriate critical discussion of the data and the environment in which these infections occur.

From the data obtained, Addisu et al. (2020) observed that the overall infection rates of the various helminths were higher in the spring which corresponds to the various ecological models of parasitic transmission. The rise of infection rates in spring is due to greater activity of the middle hosts, which are rodents and fleas, in the warm and moist climate. This spatial-temporal pattern reinforces the question of the ecological and climate background in the treatment of parasites' diseases. However, since infection rates tend to decrease during summer, it might be attributed to the unfavourable conditions for the parasites that transmit the disease, and whether or not these rates remain low over several years, or was observed only during the period of the study. To provide a more comprehensive understanding of spatiotemporal trends in the prevalence of helminths in the future studies, a similar type of data collection with long-term follow-up observations should be used, as well as study the possible effects of climate change on the transmission dynamic of helminths in this area.

However, this study helps to address some vital fines related to the seasonality into the public health interventions. This shows prevalence of helminthic infections to be highest in spring for this reason, this period is likely to be important for control programmes such as deworming and public awareness. But the analysis of those factors revealing seasonal location-related fluctuations is insufficiently detailed. For instance, changes in rainfall, cover of vegetation, and contact between humans and animals, especially throughout the year, will affect the susceptibility and transmission of parasites by animals. Combining the environmental data with epidemiological models may improve the accuracy of the timing and aim of the interventions. The results of the current study with regard to the age distribution of infected cats especially the cats within 1-3 years of age indicates that exposure and behavioral aspects can partly help explain the transmission of parasites (Lepczyk et al., 2015). The middle aged cats can be expected to have higher risk of exposure to helminths and their environments because of their more extensive travelling and hunting. This age group may also have a higher basal metabolic

ISSN 2721-1304 (Print), ISSN 2721-1207 (online)

rate, more vigorous immune response that might in some way affect the patterns of the observed infections.

Nevertheless, this fact calls for an analysis of immunological and behavioral factors that may bring middle-aged cats closer to infection risk. Some of the current work in immunology indicate that the immune response to parasitic infections differs according to age with the young benefiting from passive immunity from the colostrum and older animals having some kind of immune mediated protection or low exposure rates. Future consideration should be given to the relationship between immunity and behaviour and the role of immunity behaviour interaction especially in the light of age. Knowledge of these patterns might afford potential structuring of interventions to age groupings, to enhance efficiency in the utilization of funding in measures aimed at controlling parasitic diseases. The same goes for the tierce result obtained for female cats, which indicates that biogrammar and behavioral disparities may influence helminth infection. Females might thus search for food in a different manner than the males, and may traverse territories with possibly higher parasite prevalence (Wheeler et al., 2022). Moreover, reproductive cycles could in some degree affect the susceptibility to infection, with regard to hormonal fluctuations affecting immunological response. Such findings call for further studies on the sex related differences on parasite-host relationships so that more appropriate ways and methods of controlling helminthic infections in stray cats could be developed.

These regional differences of helminth infection rates are particularly manifested in the higher prevalence in Al-Numaniyah and Al-Suwaira reflecting the effect of local environmental and socio-economic determinants of infection. These may be conditions that support persistence of the intermediate host or free living stages of helminth for instance appropriate microclimate, abundance of vegetation or poor hygiene. It is likely that a host of other factors at the socio-economic level that include the status of livestock rearing, people's density and the level of veterinary facilities also contribute to these infection patterns (Gebreyes et al., 2020). A comparison of results across the regions indicate that there is need to design strategies that address helminthic infections because a cookie cutter approach will not be effective. Rather, what is needed: is a more specific geographically sensitive approach, considering the environmental, socio economic and ecological characteristics of the territories in question. For example, certain zones with elevated prevalence could require stricter monitoring, regular selective administration of anthelmintics and local health promotion campaigns relying on the local conditions and customs connected with parasitic diseases.

Since several of the helminths reported in this study are zoonotic, there is an imperative need for inter connected programs that would combine the veterinary and medical management of diseases. This places Wasit Province 's stray cats in direct contact with human populations a clear cause for alarm regarding transmission of the above mentioned parasites especially in Province's area of human dwelling with little or no access to clean water, proper sanitation and health care as postulated by Murei et al. (2022). The term 'One Health', that unites human health, animal health and environmental health is useful in regards to this context. One Health measures that may be adopted to minimize the threat of zoonotic diseases may include reduction of stray cats, enhancing cleanliness in the community, and raising people's consciousness. In addition, the study also present policy imperative to the different levels of policy making. In the local level, municipal government could perhaps pursue programs that would help curb ecology of feral cats, which include but is not limited to, schemes that support trap-neuter-return (TNR), which has been cited to have helped reduce the population of feral cats and therefore rate of parasitic diseases. Therefore, developing parasite control policy

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within the framework of general national programmes of public health could improve the latter in the regions where helminthic infections are significant threats to public health.

Future Directions and Research Needs

For the epidemiology of helminthic infections in stray cats, this study offers insights in which particular directions require further investigation. Seasonal and geographical fluctuations in incidence, differences by age and sex also indicate intricate host–pathogen relationships, further studies of which are required. Studying these variables across time will likely create a more integrated understanding of the variables that actuate these infections rates. However, future studies should also assess the presence of other possible risk factors including dietary practices, other environmental factors (i. e., living in the urban or rural areas), and presence of other animals that may affect the prevalence of the infection. The adoption of molecular tools including the polymerase chain reaction based diagnostics could also improve the ability of detecting and identifying particular parasites within a community as well as getting a better understanding of the parasite-community structure among the stray cats.

Conclusion

This work explores the complex characteristics of helminth infections in stray cats paying attention to influences of environment, biology, and socio economics that define patterns of infection. The conclusions also reveal how current zoonotic parasitic threats jeopardise public health, and how it is necessary to determine what environment foster those parasites, especially in areas where free-roaming cats and humans interact. The observed seasonal variation, that the infection rates are highest in spring, those aspects of environmental conditions involved in transmission of helminths. Such trend implies that public health interventions including those for deworming should be timed to coincide with such periods of time more so during the spring season when the conditions for transmission of parasites are relatively high. Furthermore, significant differences of incidence according age dependably were described in all kinds of infection; however, the highest values were revealed in cats of middle age, these data prove the need for the further investigation of the influence of the different life cycle phases on the infection incidence. The marginally higher prevalence in female cats also points towards the fact that there might be factors based on behaviour and or biology that might have contributed to the above findings. It is also seen from the differences in the rates of infection across regions of Iraq where such parasites are more prevalent in Al-Numaniyah and Al-Suwaira and such regional disparities point towards local environmental and socio economic factors in influencing the spread of these parasites. These results call for the frameworks that are more focused on the conditions and problems of concrete regions they have to be specific and take into consideration all the peculiarities of a concrete region to be efficient in terms of public health. The zoonotic potential of the helminths revealed in the present study underscores the vigilance in observance of the OH approach. Combining approaches of veterinary and anti-epizootic, it is possible to reduce the threats posed by the presence of helminthes in a stray cat population for the population's health and that of the felines themselves.

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