Praca oryginalna *Original paper*

Investigation of gastrointestinal parasites of dogs in Burdur city, Türkiye

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Received 21.11.2023 *Accepted 27.12.2023*

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Summary

The aim of the present study was to determine the prevalence of gastrointestinal parasites of dogs in the Burdur city and to assess the risk factors for public health. The material of the study consisted of fecal samples collected from a total of 156 owned and stray dogs of different ages and sexes, including 82 animals from the city center and 74 from rural areas. The parasitological examination of the fecal samples was performed by native fecal examination, Fulleborn's flotation, and Benedict's sedimentation methods. Thirty-five of the samples (22.4%) were found to be positive for various parasites. Eight different parasite species were identified, including 4 nematodes, 3 protozoans, and 1 cestode. The most prevalent species were *Ancylostomatidae* spp. (9.6%), followed by *Toxocara canis* (5.1%), *Isospora* spp. (5.1%), *Giardia* spp. (1.9%), *Toxascaris leonina* (1.3%), *Taenia* spp. (1.3%), and *Sarcocystis* spp. (1.3%). It was determined that 28 of the 156 dogs (17.9%) were infected with a single parasite species, 6 (3.8%) with two parasite species, and 1 (0.6%) with three different species. Differences in prevalence rates between groups of different age, sex, or ownership status were not statistically significant, but the difference between dogs from different locations was highly significant ($P < 0.0001$). The present study found zoonotic parasites to be highly prevalent, which suggests that control measures are needed to reduce the risks of contamination and infection with these parasites for animals and humans, given the close relationship between dogs and humans.

Keywords: dog, Burdur, gastrointestinal parasites, prevalence

Dogs are among the most popular pets and they play a significant role in human life by performing a variety of tasks, such as hunting, herding, guarding, aiding the independent living of individuals with disabilities, search and rescue missions, or detecting drugs and explosives (59, 60). However, because of their potential as hosts for various pathogens, these adorable animals, which have become indispensable companions to humans, can also pose a danger to public health if necessary preventive measures are not taken, There are more than 60 zoonotic infections that can be transmitted from dogs to humans, and these can cause serious public health problems by affecting every individual in the community, especially children, the elderly, and immunocompromised individuals. An important group among these zoonotic pathogens are parasites (1). Some examples of gastrointestinal protozoa and helminths commonly found in dogs in different countries include *Dipylidium caninum*, *Echinococcus granulosus*, *Ancylostoma* spp., *Toxocara canis*, *Giardia* spp., *Sarcocystis* spp., and *Cryptosporidium* spp. (17, 36). While these parasites can cause serious diseases in animals, the zoonotic diseases they cause, such as visceral larva migrans, cutaneous larva migrans, hydatid cysts, and recurring infections, such as cryptosporidiosis and giardiasis, also pose a threat to human health (53). Furthermore, infections, such as sarcocystosis and cystic echinococcosis, are a health problem in livestock, resulting in economic losses (49).

In various studies conducted in Turkey, helminth infection rates in dogs have been reported to range from 19.4% to 100% (7, 10, 20, 23, 26, 29, 38-40, 42, 46, 47, 50, 53, 55, 56, 64). Studies on stray and owned dogs performed in Turkey by fecal examination and necropsy methods revealed the presence of cestode species, such as *Diphylidium*, *Taenia*, *Mesocestoides*,

and *Echinococcus*, as well as nematode species, such as *Toxocara*, *Toxascaris*, *Ancylostoma*, *Uncinaria*, *Trichuris*, and *Spirocerca* (2, 7, 29, 38, 62, 63).

Turkey, located in the subtropical climate zone, is suitable for the development of parasites (22). In addition, the abundance of stray dogs in almost every province poses a public health problem. This study aimed to determine the prevalence of gastrointestinal parasites in dogs in Burdur province and identify potential risk factors for public health.

Material and methods

Ethics approval. This study received ethical approval from the Animal Experiments Local Ethics Committee of Burdur Mehmet Akif Ersoy University by decision number 1117 of May 17, 2023.

Selection of animals and collection of fecal samples. The present study was conducted between November 2022 and January 2023 in Burdur province on a total of 156 randomly selected dogs of different ages, breeds, and sexes, including owned and stray dogs. The material consisted of 82 samples from dogs in the city center of Burdur, including 56 owned animals, and 74 samples from dogs in rural areas, 65 of which were owned. The samples were collected from the rectum of the dogs and promptly transported to the laboratory on the same day. The distribution of the dogs according to age, sex, ownership status, and location is presented in Table 1.

Parasitological examinations. After macroscopic evaluation, the fecal samples were microscopically examined by both direct smear and enrichment techniques, such as Fülleborn saturated salt flotation and Benedek sedimentation (9, 19). For each fecal sample, at least three preparations were examined under objectives with magnifications of 10 × and 40 ×, and the results were considered positive if at least one parasite egg or dispersion form was observed (32). The eggs were identified at genus and species levels (25, 49).

Fecal samples including coccidian oocysts were cultivated in 2.5% potassium dichromate for 10 to 15 days to induce sporulation, and the resulting sporocysts were observed to confirm the identification of *Cystoisospora* spp.

In addition, further investigations were needed to confirm whether the *Ascaris* spp. eggs detected in fecal examination had been produced and excreted by adult ascarids parasitizing the animal (real parasitism), or whether their presence in the feces was incidental. Incidental parasitism may be due to the dog's feeding habits, environmental contamination, ingestion of contaminated food or water, or previous incidental exposure to the parasite. The dogs in which fecal examination revealed eggs of *Ascaris* spp. were treated with antihelmentics. Their fecal samples were then collected and re-examined for adults and eggs of *Ascaris* spp. over a period of one week.

Statistical analysis. The data obtained from the present study was analyzed by the Chi-square test with the Statistical Package for Social Sciences (SPSS) version 15.0 for Windows. The Chi-square test was used to compare the prevalence of parasites in dogs differing in age, sex, location, and ownership status, and the differences observed were considered statistically significant at $P < 0.05$.

Results and discussion

At least one or more parasite oocysts/sporocysts or eggs were detected in 35 (22.4%) of the 156 fecal samples examined. A total of eight parasite species were identified in infected dogs: four species of nematodes (including *Ascaris* spp. observed incidentally), three species of protozoa, and one species of cestodes (Fig. 1). Out of the 156 samples, 28 (17.9%) were found to be infected with a single parasite species, 6 (3.8%) with two different parasites species, and 1 (0.6%) with three species. The distribution of single or mixed infections according to age, sex, location and ownership status is given in Table 2. Without distinction into single and multiple infections, Ancylostomatidae spp. (9.6%) were the most common among the species detected, followed by *T. canis* (5.1%), *Cystoisospora* spp. (5.1%), *Giardia* spp. (1.9%), *T. leonina* (1.2%), *Taenia* spp. (1.2%), and *Sarcocystis* spp. (1.2%). In addition, *Ascaris* spp. eggs were found in three samples. Among helminth infections, *Ancylostomatidae* spp. (9.6%) stood out proportionally, while *Isospora* spp. (5.1%) were the most prevalent among protozoan infections.

The infection rates in dogs younger than one year (23.4%) and older than one year (22%) were similar, and no statistically significant difference was observed between these groups ($P = 0.849$). Similarly, there was no statistically significant difference in infection rates between females (23.2%) and males (22%) ($P = 0.862$).

The prevalence in dogs living in urban areas (city center) and rural areas (village) was found to be 10.9% and 35.1%, respectively. The difference in prevalence between the two locations was statistically highly significant ($P < 0.0001$).

The positivity rate was higher in stray dogs (25.7%) than it was in owned dogs (21.4%), but the difference was not statistically significant ($P = 0.598$). However, *Giardia* spp., *Taenia* spp. and *Sarcocystis* spp., which were detected in owned dogs, were not found in stray animals.

Numerous studies have been conducted in different countries, including Turkey, to detect parasitic infections in dogs. Regional variations in prevalence rates are evident in these studies, which can be due to the living

Tab. 1. The distribution of the dogs according to age, sex, ownership status, and location

Sampling area	Number of dogs examined	Age		Sex		Owned/Stray	
		0-1	> 1	Female	Male	Owned	Stray
City center	82	28	54	26	56	56	26
Rural areas	74	19	55	30	44	65	9
Total	156	47	109	56	100	121	35

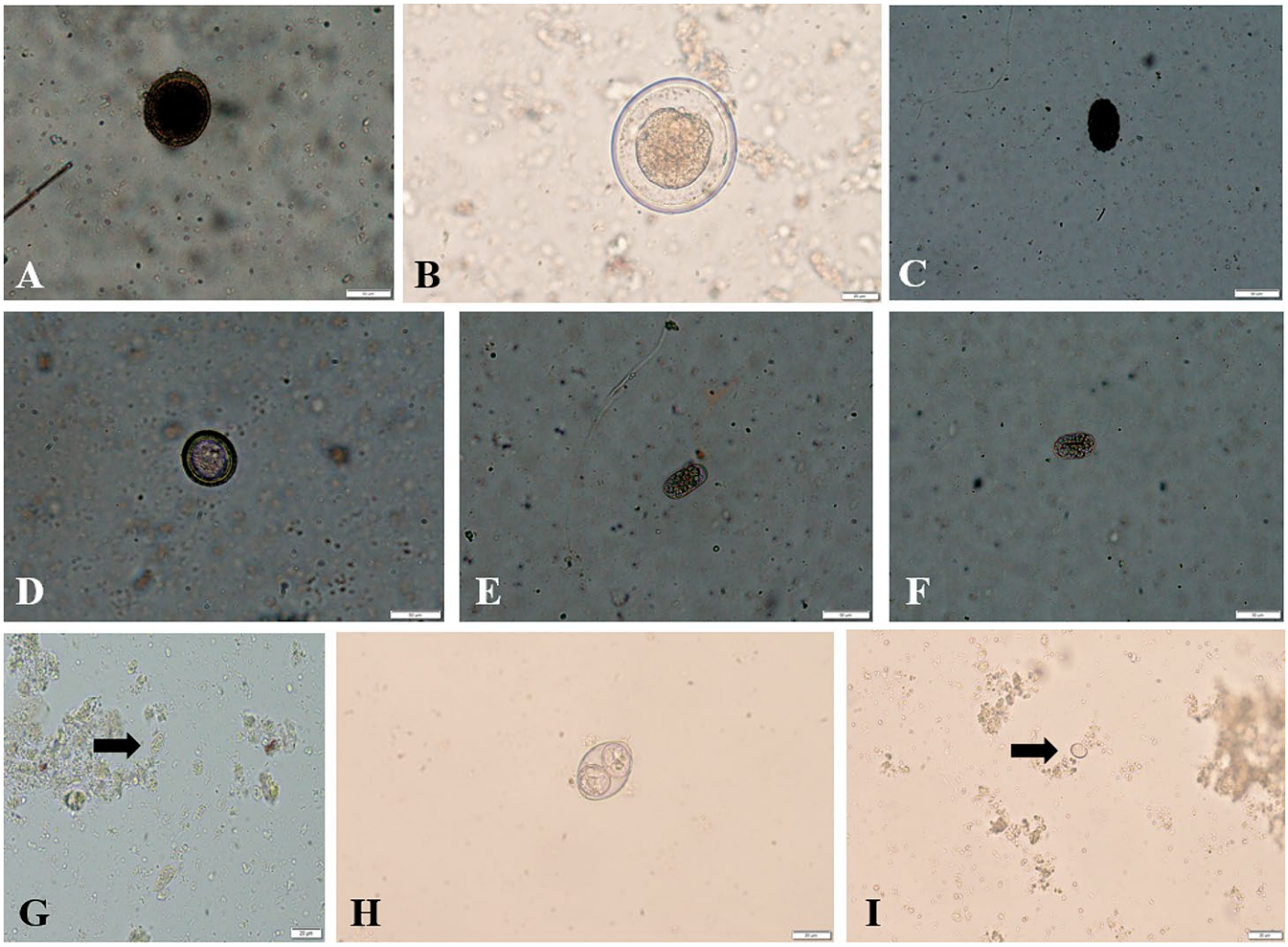

Fig. 1. Developmental stages of the detected parasites species: A) *Toxocara canis* egg (20 × objective, scale bar: 50 µm); B) *Toxascaris leonina* egg (40 × objective, scale bar: 20 µm); C) *Ascaris* spp. egg (20 × objective, scale bar: 50 µm); D) *Taenia* spp. egg (20 × objective, scale bar: 50 µm); E and F) Ancylostomatidae spp. eggs (20 × objective, scale bar: 50 µm); G) *Giardia* spp. cyst (40 × objective, scale bar: 20 µm); H) *Cystoisospora* spp. oocyst (40 × objective, scale bar: 20 µm); I) *Sarcocystis* spp. sporocyst (40 × objective, scale bar: 20 µm)

Tab. 2. Distribution of single/mixed infections according to age, sex, location, and ownership status

Single/mixed infections detected	Sex and Age (years)				Location		Owned	Stray	Total*
	Female		Male						
	0-1	> 1	0-1	> 1	City center	Rural areas			
Ancylostomatidae spp.	–	–	1	8	–	9	7	2	9 (5.7%)
T. canis	2	1	1	–	2	2	2	2	4 (2.5%)
T. leonina	–	–	–	1	–	1	1	–	1 (0.6%)
Taenia spp.	–	1	–	1	–	2	2	–	2 (1.2%)
Isospora spp.	1	3	2	1	2	5	5	2	7 (4.4%)
Giardia spp.	–	1	–	2	3	–	3	–	3 (1.9%)
Sarcocystis spp.	–	2	–	–	–	2	2	–	2 (1.2%)
Ancylostomatidae spp. + *T. canis*	–	–	2	–	2	–	–	2	2 (1.2%)
Ancylostomatidae spp. + *Ascaris* spp.	–	1	–	2	–	3	3	–	3 (1.9%)
T. canis + *Isospora* spp.	1	–	–	–	–	1	1	–	1 (0.6%)
Ancylostomatidae spp. + *T. canis* + *T. leonina*	–	–	1	–	–	1	–	1	1 (0.6%)
Total**	4	9	7	15	9/82 (10.9%)	26/74 (35.1%)	26/121 (21.4%)	9/35 (25.7%)	35/156 (22.4%)

Explanations: * – total percentages were calculated as percentages of all 156 dogs examined; ** – total percentages were calculated as percentages of dogs with a given parameter.

conditions of the animals included, as well as to the methods used, such as fecal examination or necropsy. In studies conducted worldwide, the prevalence rates of parasitic infections in dogs, revealed by fecal and necropsy examinations, have been reported as 32% to 87% (15, 18, 24, 33, 45, 54, 57). The prevalence rates of helminth infections in dogs in various countries according to studies using fecal examination were as follows: 39.2% in Greece (24), 64.33% in Egypt (15), 35.5% in Venezuela (44), and 86.97% in Nigeria (54). In studies conducted in Turkey, the prevalence of helminth infections in dogs, based on fecal and necropsy examinations, has been reported as 19.4% in Kayseri (63), 19.9% to 37.7% in Konya (20, 26), 28.4% in Samsun (23), 32.7% in Diyarbakır (47), 33.6% in Eskişehir and 46% in Afyonkarahisar (29), 34.5% in Isparta (2), 34.7% to 60% in Van (28, 38), 41% to 92% in Aydın (14, 56), 52.9% in Erzurum (7), 58.3% to 98% in Ankara (6, 10, 12, 13), 73.8% in Kars (55), 75% in Siirt (37), 87.6% in Elazığ (21), 94% to 100% in Sivas (46; 5), and 98% in Bursa (52). In the present study, the prevalence of gastrointestinal parasites in dogs in the Burdur province was found to be 22.4%. This rate was similar to those reported by studies conducted in Kayseri, Konya, and Samsun, but lower than the rates reported by studies conducted in Bursa, Sivas, Elazığ, Siirt, Kars, Ankara, Erzurum, and Aydın provinces. It may be concluded that the widespread use of antiparasitic drugs among pet owners in the Burdur province and measures taken by the relevant authorities with regard to stray animals contribute to the relatively low prevalence found by the present study.

According to the literature, there are regional variations in the distribution of parasite species in dogs. However, the most common species identified include Ancylostomatidae, *Taenia* spp., *Toxocara canis*, *Toxascaris leonina*, *Trichuris* spp., *Dipylidium caninum* and *Giardia* spp. (34). Studies conducted in different regions of Turkey (5, 11, 14, 20, 26, 29, 37, 41, 63) identified certain species, such as *Heterophyes heterophyes*, *Dipylidium caninum*, *Trichuris vulpis*, *Alaria* spp., and *Capillaria* spp., that were not found in the present study. Considering regional variations and the condition of animals included in this study, it can be concluded that the detection of commonly found species, with the exception of a few species that were not identified, seems to be in accordance with the results of the abovementioned studies. Furthermore, it is noteworthy that the presence of parasite species with zoonotic characteristics, such as Ancylostomatidae spp., *T. canis*, *Taenia* spp. (*E. granulosus*), and *Giardia* spp., revealed by the present study is highly significant for public health.

Hookworm species found in dogs are a serious threat to public health, as they can cause cutaneous larva migrans in humans. The most common among them are *A. caninum* and *U. stenocephala* (27, 30). In studies conducted in Turkey, the prevalence of *A. caninum* infection in dogs was reported as 0.3% in Konya (26), 1.1% in Kayseri (63), 1.1% in Ağrı (4), 5.6% in Van (28), 8.6% in Diyarbakır (47), and 13% in Samsun (23). The prevalence rate for Ancylostomatidae spp. found in the present study (9.6%) in Burdur is in line with the findings of other studies conducted in Turkey. The distribution of hookworm infections in dogs is closely related to age, sex, and immunity (8). In young animals, insufficient development of the immune system and galactogen transmission contribute to a higher prevalence and severity of infection compared to older animals (27). In the present study, although the rate of hookworm infections (*Ancylostomatidae* spp.) was higher in dogs older than one year (10%) than it was in dogs younger than one year (8.5%), there was no statistically significant difference between these age groups ($P = 0.759$). Nevertheless, the sample size was not sufficient to interpret the differences between age groups, and further studies with larger sample sizes are needed to better understand this issue.

Toxocara canis and *Toxascaris leonina* are roundworm species commonly found in dogs worldwide, including Turkey. *T. canis* is the causative agent of visceral larva migrans. The prevalence of *T. canis* has been reported as 3% in Kenya (58), 8.5% in the Netherlands (31), 9.3% in Brazil (48), and 36% in South Africa (35). In Turkey, the prevalence rates of *T. canis* have been reported as 13.9% in Konya (26), 22% in Sivas (5), 24-13.2% in Ankara (10, 13), 36.2% in Afyonkarahisar, and 47.8% in Eskişehir (63). In young animals, due to the incomplete development of the immune system and higher exposure to infections transmitted through milk, the spread and severity of infections are generally greater than they are in older animals (16). This was confirmed by the present study, in which the prevalence of *T. canis* was found to be higher (17.5%) in dogs younger than one year compared to adult dogs (0.9%), and the difference was statistically highly significant ($P < 0.0001$). In the present study, the overall prevalence of *T. canis* in Burdur (5.1%) was lower than reported by studies elsewhere in Turkey and other countries. Although *T. canis* is more commonly found in young animals, it can also be present in older animals, which play a significant role in the continuous contamination of the environment (54). The presence of this parasite in older animals, even if it was only one dog in our study, highlights the importance of expanding the measures taken to protect public health from this parasite.

Toxascaris leonine, on the other hand, has been detected by fecal examination in different regions of Turkey, with prevalence rates of 20% in Kars (55), 14.8% in Konya (20), and 42-43% in Ankara (10, 13). Its prevalence in various countries around the world has been reported as 9% in South Africa (35), 1.96% in Nigeria (54), 1.3% in Greece (24), 2.1% in Hungary

(18), and 0.5% in the Netherlands (31). The prevalence rate of 1.3% obtained for *T. leonina* in the present study is lower than that for *T. canis* and lower than the rates for *T. leonina* reported by other studies conducted in Turkey. However, it is similar to prevalence reported from Nigeria and Greece. It can be concluded that this situation is due mainly to intrauterine and lactogenic infections observed in *T. canis* infection. Additionally, the presence of *T. leonina* infection in rural areas suggests the possibility of paratenic host infection.

The prevalence of *Taenia* spp. in dogs in Turkey has been reported as 2.8% in Kayseri (63), 2.9% in Afyonkarahisar (29), 2.9% in Erzurum (7), 3.8% in Diyarbakır (47), 7.5% in Aydın (56), 14.8% in Van (38), and 23.9% in Eskişehir (29). In the present study, the rate of prevalence of *Taenia* spp. eggs was determined as 1.2%. *Echinococcus* spp. eggs are very similar in appearance to those of *Taenia* spp. and cannot be distinguished by microscopic examination alone. Therefore, the possibility of dogs carrying *Echinococcus* spp. should not be overlooked when eggs similar to those of *Taenia* spp. are observed. Echinococcosis is an important zoonotic disease that can lead to complications, including death. Therefore, animals in which such egg types are found should be promptly treated, and their feces should be collected and properly disposed of during the treatment process. In the present study, information was provided to individuals responsible for the two dogs in which *Taenia* spp. eggs were detected, emphasizing the need for treatment and preventive measures.

Although there is no species belonging to the *Ascaris* genus among the specific ascarids of dogs, there are publications reporting the presence of *Ascaris* spp. eggs in dogs (30, 61). In the present study, *Ascaris* spp. eggs were found in three dogs (1.9%) from rural areas which were used as hunting dogs. After administering anthelmintic treatment to these dogs, all of their fecal samples were collected one week later and examined macroscopically for adult nematodes and microscopically for eggs, but no adults or eggs of *Ascaris* spp. were found. The absence of adults and eggs in the post-treatment examination suggests that the initial detection of *Ascaris* spp. eggs may have been incidental. This may have been due to the dogs' coprophagy, their having been fed with the meat of pigs they hunted or the contamination of their food and living areas with human feces under inadequate sanitation conditions.

According to another study (43) on the distribution of gastrointestinal cestodes and nematodes in dogs in the Burdur region, 27 (54%) of the 50 dogs examined were infected with at least one parasite species, and the prevalence rates of those species were as follows: *T. canis* (32%), *Taenia* spp. (10%), *T. leonina* (8%), *Ancylostoma caninum* (6%), *Diphylidium caninum* (4%), *Uncinaria stenocephala* (2%), and *Trichuris vulpis* (2%). It is noteworthy that these prevalence rates are considerably higher than those found in the present study. The difference may be attributed to the fact that all dogs examined in that study were stray dogs, and the sample size may have been small. It is important to note, however, that parasites can have different prevalence in the same region in different periods. Therefore, it can be concluded that preventive veterinary practices, such as neutering and antiparasitic treatment, need to be consistent and regular, and animal movements should be controlled.

Isospora spp., commonly found in dogs, usually cause a simple enteritis, but can also lead to severe infections that can result in death. It typically affects young animals, while the severity of the infection decreases with age and can even be asymptomatic (51). In studies conducted in Turkey, the infection rate for *Isospora* spp. in dogs is reported as 0.4% to 23.4% (12, 20, 38). The prevalence rate of 5.1% obtained in the present study is consistent with the findings of other studies conducted in Turkey.

Giardiasis is characterized by malabsorption, maldigestion, and diarrhea. It is a zoonotic infection that also poses a threat to public health. There are limited studies on the prevalence of *Giardia* spp. in dogs in Turkey (12, 20, 38), and these studies report prevalence rates of 1% to 18.8%. In the present study, the prevalence of *Giardia* spp. in dogs in the Burdur province was found to be 1.9%. The lower prevalence observed in our study compared to other studies may be attributed to factors related to the transmission routes of *Giardia* spp., such as the contamination of food and water sources in the animals' living areas, as well as the infection of humans and other mammals that come into contact with these animals.

Sarcocystosis is typically a severe disease in intermediate hosts (ruminants) while causing a mild enteritis in definitive host, that is dogs. There are limited studies on the prevalence of *Sarcocystis* spp. in dogs in Turkey (12, 20, 28, 38, 55), which has been reported as 0.8% to 81.6%. The prevalence of *Sarcocystis* spp. of 1.3% found in the present study is consistent with the findings of other studies.

A study conducted on raw vegetables sold in Burdur (3) revealed potential zoonotic risks from *Taenia* spp. and *Toxocara* spp., as well as *Ascaris lumbricoides* eggs. The prevalence of 1.3% for *Taenia* spp., 5.1% for *Toxocara canis*, and 1.9% for *Ascaris* spp. found in our study aligns with the findings of the abovementioned study.

Another noteworthy finding of the present study is that *Giardia* spp., which can be transmitted through contaminated water, as well as *Sarcocystis* spp. and *Taenia* spp., which can be transmitted through raw or undercooked meats, were found in some owned dogs but in none of the stray animals. The owned dogs in which these parasites were detected are used as guard or shepherd dogs in rural areas. This means that they

have a higher likelihood of being exposed to raw meat and contaminated water. It is also probable that preventive antiparasitic treatments are administered irregularly or not at all. In urban areas, owned dogs receive more care in terms of nutrition and preventive measures. The absence of these parasites in stray animals can be attributed to the insufficient sample size. Furthermore, it may be explained by periodic antiparasitic treatments administered to stray dogs in municipal shelters in urban areas. Therefore, irrespective of whether dogs are owned or not, their parasitic infections are significantly affected by their urban or rural living environment.

This study provides important data on the prevalence of gastrointestinal parasites in dogs in the Burdur province, highlighting the significance of parasitic infections in dogs for both animal and human health. The presence of zoonotic parasites in dogs emphasizes the importance of combating these parasites. It is recommended that local authorities establish new dog care facilities and improve conditions in the existing ones, while also maintaining control over stray dogs and providing them with necessary care and treatment. Public health organizations should be informed about the prevalence of parasites and conduct educational campaigns on this issue.

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