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Dog owners' awareness of the zoonotic potential of endoparasites of their pets and potential risk factors for humans

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Aim: The aim of this research was to establish the attitudes of dog owners in Serbia towards caring for their dogs with particular emphasis on veterinary care and parasite control.

Methods: The study presents a social-medical approach to the problem of contamination of public urban areas in the city of Niš with intestinal parasites from dog faeces. Accordingly, a survey regarding attitudes, behaviour and the level of education of dog owners and people staying in the parks of the city of Niš was conducted. A total of 350 dog owners were surveyed. 198 (56.57%) of them were female, and 152 were male (43.43%).

Results: The largest number of respondents take their dog to a veterinarian when they have doubts about their dog's health (22.3%). The most common reason for visiting a veterinarian is vaccination. The largest number of owners give tablets against internal parasites every six months (29%), 22% of owners every 3 months, and 21% of owners once a year. The largest number of owners treat their dogs against fleas and other external parasites every 6 months (22%), while 21% of owners do it once a year. A third of dog owners have their dogs vaccinated against infectious diseases every year. The largest number of surveyed owners (62%) travel with their dogs, half of them even sleep next to their pets, and a third of them take their dog to the pet groomer. Regular coprological examinations of dogs are carried out by only a fifth of the surveyed owners. More than a half of the surveyed dog owners regularly use both anti-endoparasites and anti-ectoparasites to treat their dogs.

Conclusion: Main parks in the city of Niš, as well as other urban areas, seem to be the potential sources of zoonotic parasites. The results of this study show that the majority of dog owners are not adequately educated in terms of veterinary care requirements and parasite control.

KEYWORDS

dogs, zoonoses, public health, social medicine, veterinary

Introduction

Modern medical science views health as a dynamic balance within the systems of the human organism and the environment. The concept of prevention is based on preserving a balance of a healthy individual in a secure environment (Bogunović et al., 2022; Ristić et al., 2023).

Public areas contaminated with geohelminths from dog faeces pose a risk to human health, especially in cities where parks, children's playgrounds and sand pits can be a source of oral or percutaneous infection for humans. Although they have exceptional clinical and epidemiological importance, the importance of these pathogens is very often minimised by doctors of veterinary medicine, physicians and the general public (Ilić et al., 2023). Ten endoparasites (six at the species level and four at the genus level) were diagnosed in dog faeces, soil and sand samples in the three main approached parks of the city of Nish in our previous research: protozoas of the specius *Cystoisospora*, nematodes (*Toxocara canis*, *Toxascaris leonina*, *Ancylostoma caninum*/*Uncinaria stenocephala*, *Trichuris vulpis, Capillaria aerophila*), trematoda *Alaria alata* and cestode (*Dipyllidium caninum*, *Taenia* spp) (Ristić et al., 2020; Ristić et al., 2023).

For the majority of zoonotic parasites diagnosed in the three most visited public parks of the city of Niš in 2024, humans are a non-specific host. The biggest problem for doctors in differential diagnostics includes *T. canis*, *C. aerophila*, and *A. alata*, whose encysted larvae in the liver, lungs, kidneys, heart, and lymph nodes can calcify, necrotise, or degenerate, thus causing confusion even for the most experienced diagnosticians. Insufficient education about what to expect etiologically can result in serious errors in establishing a valid diagnosis (Ristić et al., 2020; Taha et al., 2024).

As reservoirs of infection, the greatest danger to human health involves stray dogs, which move freely and uncontrollably in city parks. Therefore, a long-term solution to this problem is necessary by adopting a strategy to regulate the number of abandoned dogs (Taha et al., 2024), with mandatory parasitological control of public areas and an appropriate social-medical approach to solving this current health and environmental problem in urban areas.

Since humans and dogs share living space and have very close contact, and since the basic assumption is that many owners do not take adequate care of their pets, there is a possibility of transmission of parasitic diseases from dogs to humans.

Therefore, it is necessary to raise public awareness about the necessity of implementing zoohygiene measures in dog breeding and the importance of causal planned deworming and anti-ectoparasite treatment. In addition, our goal would be also to start drawing up a Program of Health and Educational Measures to reduce the risk of human illnesses with zoonotic parasites from dog faeces in the public areas.

Methods

The study represents a social-medical approach to the problem of contamination of public urban areas in the City of Niš with intestinal parasites from dog faeces. Accordingly, a survey was conducted on attitudes, behaviour and the level of education of dog owners and people staying in the parks of the city of Niš. The interview with people was carried out in three city parks during the months of February, March and April 2024.

A total of 350 dog owners were surveyed - 198 (56.57%) of them were female, and 152 were male (43.43%). In "Park Chair" there were examined 123 of them; 117 were interviewed in "Sveti Sava Park", while the remaining 110 respondents were interviewed in "Tvrđava Park". The research was conducted in concordance with the Declaration of Helsinki. All participants were informed about the study and they provided informed consent.

Questionnaire characteristics

In order to examine citizens' knowledge, attitudes and behaviour, a modified questionnaire was used for people who often visit parks (Mekuzas et al., 2009; Pereira et al., 2016; Rubel and Carbajo, 2019).

Survey method

People were surveyed in those three parks mentioned by employing the interview method. The sample was selected by the method of random selection. It was conducted with randomly selected respondents. It is important to emphasise that none of them asked to participate refused to answer the offered questions from the survey.

In addition to socio-demographic characteristics, the questions refer to data on attitudes, behaviour and the level of education, as well as to the ownership of pets and possible risk factors for infection with zoonotic parasites.

Selection of questions for respondents:

- Do they conduct regular coprological examinations of their dogs 4 times a year?
- Do they use a plan and regularly use endoantiparasitics (that is, tablets against gastrointestinal parasites) to treat their dogs?
- How do they determine the dose of antiparasitics?
- How many times a year do they give their dogs anti-parasite pills?
- Do they check the effectiveness of the deworming treatment?
- Do they carry out regular ectoparasite protection treatments?
- Do they follow veterinarians' recommendation, which suggests giving anthelmintics 3–7 days before vaccinating dogs?
- Do they remove their pets' faeces from a public area?
- Do they defend their dog's contact with a stray dog and in what way?
- Does their dog have any contact with stray dogs?

- In the park while looking after their pet dog, do they talk to the owners of other dogs about the parasites that dogs can transmit to humans and do they exchange experiences on the use of anthelmintics?

Statistical data processing

The processing of the obtained results, which led to the preparation of the Proposal for Health and Educational Measures to Reduce the Risk of Zoonosis, was carried out at the Institute of Public Health in Niš. The research results have been presented tabularly. Statistical data processing included the application of descriptive tests (percentage representation, mean value), analytical parametric (Student's T-test) and non-parametric tests (Pearson's χ^2-test, Fischer's exact probability test), as well as a correlation test.

The null hypothesis was tested with a significance threshold of $p<0.05$. The data were processed in the SPSS 18.0 software package (SPSS Inc., Chicago, IL, USA).

Results

A total of 350 dog owners were surveyed. 198 (56.57%) of them were female, and 152 were male (43.43%) (Table 1).

The average age of the respondents is 45.8 ± 11.5 years. A slightly larger number of surveyed owners live in an apartment – 52.86% (185/350), while 47.14% (165/350) live in a house. There are 108 respondents (30.86%) who have higher education (Table 1).

Almost half of the dogs (48%) were acquired by their owners from kennels (i.e. dog breeders), 25% from friends, 13% from shelters, while 14% of the dogs were from the street. Dog owners have had their dogs for 7.8 ± 2.5 years, on average.

There were more females among the dogs, 52.86% (185/350), compared to males, 47.14% (165/350), with an average age of 6.5 ± 3.2 years and the youngest dog being one year old and the oldest sixteen years old. The majority of dogs were canine-certified – 70% (245/350). In terms of sterilization, a significantly higher number of females than males were sterilised (χ^2 = 22.58; p<0.001).

TABLE 1 Sociodemographic characteristics of dog owners.

DOG OWNERS		(n, %)	χ^2/t	p
Gender	women	198 (56.57)		
	men	152 (43.43)	0.138	0.535
Age	$\bar{x}$ ± SD (min – max)	45.83 ± 11.52 (22-75)	2.348	0.028
Place of residence	apartment	185 (52.86)		
	house	165 (47.14)	3.178	0.082
Education	aetiology	187 (53.43)		
	College	55 (15.71)		
	University	108 (30.86)	0.263	0.857

The largest number of respondents take their dog to a veterinarian when they have doubts about their dog's health (22.3%), 9.4% of respondents every 6–12 months, 56.3% of interviewed owners do not take their dogs to a veterinarian, and 12% every 1–3 months (Table 2). The most common reason for visiting a veterinary doctor is vaccination.

The largest number of owners give tablets against internal parasites every six months (29%), 22% of owners every 3 months, and 21% of owners once a year. The greatest number of owners treat their dogs against fleas and other external parasites every 6 months (22%), while 21% of owners do so once a year (Table 2).

One third of dog owners have their dogs vaccinated against infectious diseases each year (Table 2). The situation is slightly different with rabies vaccination, with a half of all dog owners surveyed getting it done every year. The largest number of interviewees (62%) travel with their dogs, a half of them even sleep with their pets, and a third of them take their dogs to the pet groomer.

Regular coprological examinations of dogs are carried out by only a fifth of the surveyed owners, while 35% of them follow recommendations of veterinary doctors for the use of anthelmintics as a part of preparing the dog for vaccination, and only 19% of dog owners remove their pets' faeces from public areas (Table 2). More than a half of the interviewed dog owners regularly use both anti-endoparasitics and anti-ectoparasitics to treat their dogs.

By comparing the characteristics of the surveyed groups of dog owners in relation to gender, age and educational profile, it has been determined that the distribution by gender was homogeneous (χ^2 = 0.132; p=0.732). No statistically significant difference has been found in the place of residence (χ^2 = 3.158; p=0.078), nor in the educational status between the studied groups (χ^2 = 0.303; p=0.862).

Women are more likely to take their dogs to dog shows (σ=-0.185; p=0.022) and more likely to remove dog faeces from public areas (σ=-0.253; p=0.002) (Table 3).

In addition, women more often touch abandoned stray dogs and have contact with them (χ^2 = 5.783; p=0.015) and very often visit friends who keep dogs (χ^2 = 13.282; p=0.001).

Older owners have owned their dogs for a longer period of time (σ=0.167; p=0.044), but they give tablets against internal parasites (σ =0.267; p=0.001) and external parasites (σ =0.177; p=0.032) to their dogs less often (Table 4).

Younger dog owners are more likely to have their dogs vaccinated against infectious diseases (σ = -0.335; p<0.001) and rabies (σ =-246; p=0.002), more likely to take their dogs to dog shows (σ =-0.292; p<0.001), more likely to travel with their dogs (σ =-0.372; p<0.001) and more likely to remove faeces from public areas (σ =-0.311; p=0.002) (Table 4).

Owners with higher educational status are more likely to take their dogs to a veterinarian (σ=0.315; p<0.001), more likely to treat their dogs against fleas and other external parasites (σ= -0.212; p=0.008), more likely to have their dogs vaccinated against

TABLE 2 Habits and behaviour patterns of dog owners.

HABITS AND BEHAVIOUR PATTERNS OF DOG OWNERS	n	%
How often do you take your dog to the veterinarian?		
I do not take it	197	56.28
When I have doubts about its health	78	22.28
Every 1 to 3 months	42	12.0
Every 6 to 12 months	33	9.44
How many times a year do you give your dog tablets against internal parasites?		
Never	35	10.0
Once a month	62	17.71
Every 3 months	78	22.29
Every 6 months	102	29.14
Once a year	73	20.86
How often do you treat your dog against fleas and other external parasites?		
Never	48	13.71
Once a month	68	19.43
Every 3 months	82	23.43
Every 6 months	78	22.29
Once a year	74	21.14
How often do you have your dog vaccinated against infectious dog diseases?		
Never	122	34.86
Sometimes, when it occurs to me	114	32.57
Every year	114	32.57
How often do you have your dog vaccinated against rabies?		
Never	78	22.29
Sometimes, when it occurs to me	94	26.85
Every year	178	50.86
HABITS AND BEHAVIOUR PATTERNS OF DOG OWNERS	NO (n, %)	YES (n, %)
About the way dogs are kept		
Do you ever take your dog to dog shows?	128 (36.57)	222 (63.43)
Do you take your dog to the dog groomer?	218 (62.29)	132 (37.71)
Does your dog travel with you?	132 (37.71)	218 (62.29)
Does your dog sleep next to you/your family members?	175 (50.0)	175 (50.0)
Coprological examinations		
Do you regularly conduct coprological examinations of your dog 4 times a year to check the effectiveness of the deworming treatment?	285 (81.43)	65 (18.57)
Coprological examinations		
Do you follow the veterinarian's recommendation to administer anthelmintics 3–7 days before having your dog vaccinated?	227 (64.86)	123 (35.14)
Do you remove your pet's faeces from public areas?	282 (80.57)	68 (19.43)
Does your dog have any contact with stray dogs?	118 (33.71)	232 (66.29)
Anti-endoparasitics and anti-ectoparasitics		
Do you regularly and systematically use anti-endoparasitic drugs to treat your dog?	231	66.0%
Do you regularly and systematically use anti-ectoparasitics to treat your dog?	187	53.43%

infectious diseases (σ=0.298; p<0.001) and rabies (σ=0.247; p<0.002), and more likely to remove faeces from public areas (σ=0.308; p<0.001) (Table 5).

Discussion

A variety of recent studies have shown that the contamination of public areas with parasite eggs is common across the world (Mekuzas et al., 2009; Pereira et al., 2016; Rubel and Carbajo, 2019; Ristić et al., 2020; Hajek et al., 2021; Ilić et al., 2023; Taha et al., 2024). The level of contamination in Serbia is shown to be similar to other compared countries (Bogunović et al., 2022; Ristić et al., 2023).

Actually, the presence of a large number of zoonotic agents in the examined samples is conditioned by daily contact between owners' dogs (dogs kept in apartments and yards) and stray dogs in the territory of public city parks, which further increases the risk to human health (Ristić et al., 2020; Bogunović et al., 2022; Ilić et al., 2023; Ristić et al., 2023). Urbanization of cities leads to the expansion of the urban belt to peripheral parts of the city and weekend settlements where only foxes lived until recently. With the expansion of cities, stray dogs and owners' dogs come into close contact with foxes, which causes a significant change in the parasitofauna of dogs, which dogs eliminate through faeces on public surfaces and represent a source of infection for human beings (Ilić et al., 2023).

Based on the data from the obtained results, a half of the owners acquired a dog from kennels. Due to the fact that dog breeders are often the first line of information for future owners about dog deworming, all people who are professionally engaged in dog breeding should have the right attitude about dog deworming treatments. Through the research results, it can be noticed that the respondents are not adequately or at all familiar with diseases of parasitic etiology. Dogs staying at the shelter should also be adequately treated with antiparasitics, and future owners who

TABLE 3 Correlation between gender of dog owners and monitored characteristics.

	r/σ	p
How long have you owned a dog?	0.111	0.154
Dog gender	-0.032	0.542
Dog breed	-0.155	0.068
Dog's age	0.077	0.326
How often do you take your dog to the veterinarian?	-0.082	0.382
How many times a year do you give tablets against internal parasites to your dog?	-0.157	0.062
Dog treatment against fleas and other external parasites	0.146	0.077
Vaccination of dogs against infectious diseases	-0.167	0.057
Vaccination of dogs against rabies	-0.018	0.928
Walking a dog with no control and supervision over it	-0.167	0.055
Dog shows	-0.185	0.022*
Taking a dog to the pet groomer	-0.055	0.513
Travelling with a dog	-0.037	0.688
Dog sleeping next to the owner	-0.222	0.013
Coprological examinations	0.018	0.872
Removing dog faeces from public areas	-0.253	0.002**
Preventing contact with stray dogs	0.028	0.796
Using anti-endoparasitic drugs to treat dogs	-0.105	0.211
Using anti-ectoparasitic drugs to treat dogs	-0.045	0.635
Information exchange with other dog owners	0.108	0.209

*p<0.05; **p<0.01.

TABLE 4 Correlation between the age of dog owners and some characteristics.

	r/σ	p
How long have you owned the dog?	0.167	0.044*
Dog gender	0.258	0.002*
Dog breed	0.128	0.152
Dog's age	0.145	0.077
How often do you take your dog to the veterinarian?	-0.123	0.126
How many times a year do you give tablets against internal parasites to your dog?	0.267	0.001**
Dog treatment against fleas and other external parasites	0.177	0.032*
Vaccination of dogs against infectious diseases	-0.335	<0.001**
Vaccination of dogs against rabies	-0.246	0.002*
Walking a dog with no control and supervision over it	0.219	0.007*
Dog shows	-0.292	<0.001*
Taking a dog to the pet groomer	-0.071	0.392
Travelling with a dog	-0.372	<0.001**
Dog sleeping next to the owner	-0.329	<0.001**
Coprological examinations	0.175	0.038
Removing dog faeces from public areas	-0.311	0.002*
Preventing contact with stray dogs	0.116	0.137
Using anti-endoparasitic drugs to treat dogs	-0.092	0.316
Using anti-ectoparasitic drugs to treat dogs	-0.217	0.012*
Information exchange with other dog owners	-0.085	0.345

*p<0.05; **p<0.01.

take these dogs should receive recommendations on planned deworming.

The highest risk comes from future owners who buy or get a dog from a friend because in this case their choice is related to a person who is actually their role model, which is why they decide to buy or take a dog from him/her. Our findings are very similar to recent researches on this topic in other countries as well (Powell et al., 2018; Hajek et al., 2021; Zablan et al., 2024). If the owner who provides the puppy has a bad attitude, i.e. is inadequately informed about deworming, new owners cannot be expected to carry out the treatments against parasites correctly and continuously (Cutt et al., 2007; Corridan, 2009; Konok et al., 2015; Cui et al., 2021). It is also considered that those people who live in an apartment with a dog are more at risk, because they have closer contact with the pet, compared to the owners whose pets stay in the yard (Dall et al., 2017; Rodriguez et al., 2021; Denis-Robichaud et al., 2022).

The research results indicate that owners take their dogs to the veterinarian mostly when they have doubts about their health, which is not good for the pet at all. Considering that the owners are not able to recognize real symptoms of the disease and that very often their pet is taken care of by other family members, their understanding and assessments of the pet's symptomatology and health condition are debatable. Moreover, their assessments are mostly subjective in nature and differ from each other. In a large number of families, there is poor communication between individual members, which additionally causes a poor or unsatisfactory exchange of information about the pet and its health condition (Chodzko-Zajko et al., 2009; Clements et al., 2021).

The majority of owners answered that every 6 months they treat the dog against fleas and other external parasites. If there is cohabitation with a cat in the apartment, an additional problem is the danger of another pet suffering from flea infestation. Owners are not aware that the number of several fleas they have observed on the dog is not a real number, but indicates the presence of a significantly larger number of these ectoparasites (Richards et al., 2014; Dunn et al., 2018; Goh et al., 2020; Law et al., 2022).

Dogs that undergo grooming treatments are certainly also treated against ectoparasites, because groomers do it or inform

TABLE 5 Correlation between the educational profile of dog owners and some characteristics.

	r/σ	p
How long have you owned the dog?	-0.108	0.197
Dog gender	0.088	0.285
Dog breed	0.092	0.256
Dog's age	-0.077	0.259
How often do you take your dog to the veterinarian?	0.315	<0.001**
How many times a year do you give tablets against internal parasites to your dog?	0.018	0.852
Dog treatment against fleas and other external parasites	-0.212	0.008*
Vaccination of dogs against infectious diseases	0.298	<0.001**
Vaccination of dogs against rabies	0.247	0.002**
Walking a dog with no control and supervision over it	-0.108	0.187
Dog shows	0.055	0.527
Taking a dog to the pet groomer	0.000	1.000
Travelling with a dog	0.083	0.298
Dog sleeping next to the owner	-0.047	0.292
Coprological examinations	-0.077	0.388
Removing dog faeces from public areas	0.308	<0.001**
Contact with stray dogs	-0.079	0.294
Using anti-endoparasitic drugs to treat dogs	0.178	0.033
Using anti-ectoparasitic drugs to treat dogs	0.092	0.275
Information exchange with other dog owners	0.085	0.297

*p<0.05; **p<0.01.

the owners if they see fleas. Some owners take their dogs for a haircut precisely because of the presence of fleas or ticks (Bajer et al., 2011; Lempereur et al., 2020). Owners who share a bed with their dogs are the most vulnerable group of dog owners. In this case, dogs literally leave developing forms of parasites in the bedding, some of which can even be inhaled into the organism of the owner.

Slightly less than a half of the surveyed dog owners indicated that they share information about parasitic diseases with other owners (Jolly et al., 2015; Symeonidou et al., 2017). However, regardless of the level of their education, or the level of commitment to their pets, one gets the impression that the owners' awareness of parasites is still at a minimum, as a result of lack of information. In support of this claim is the fact that the dog is usually taken care of and fed by a large number of people from the family, who do not exchange information about the dog, nor do they try to upgrade their knowledge regarding certain health problems of their pet and the risks that such conditions carry with them (Deplazes et al., 2015; Ma et al., 2018).

It has been found out from the research results that the majority of owners randomly treat their pets, without a previous parasitological examination, preventively against parasites by choosing the wrong antiparasitic. In order to avoid the problem of developing resistance to anthelmintics, which is caused by the owner's mistakes in the therapy and prophylaxis of parasitosis of pets, it is necessary to carry out regular coprological examinations immediately after acquiring the dog and during their stay with the owner.

Conclusions

From these results it can be concluded that many dog owners attending urban public parks in Niš (Serbia) are not adequately educated regarding veterinary care and parasite control. That is why it is important to comprehensively observe this public health problem through prevention, control and monitoring of parasite transmission in the environment. Education of the population is extremely important, especially for dog owners. In this way, the risk of emergence, spread and maintenance of zoonotic endoparasitic infections would be reduced.

In accordance with the recommendations of the ESCCAP (European Scientific Counsel Companion Animal Parasites) Guidelines from 2017, a proposal for measures has been defined, categorised into 3 groups through which this public health problem should be addressed:

1. Control of parasite transmission in the environment.
2. Instructions for dog owners in preventing the occurrence, maintenance and spread of zoonotic diseases.
3. Education of medical and veterinary personnel, pet owners and the social community.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by Faculty of Medicine, University of Niš, Serbia. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study. Written informed consent was obtained from the individual(s) for the publication of any potentially identifiable images or data included in this article. No animal studies were included as part of this research.

Author contributions

MR: Investigation, Methodology, Writing – original draft. AV: Investigation, Conceptualization, Data curation, Project administration, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The author(s) declare that no Generative AI was used in the creation of this manuscript.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fanim.2025.1577458/full#supplementary-material

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