Prevalence of *Dirofilaria immitis* in stray dogs from Sofia, Bulgaria

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**Abstract**

*Dirofilaria immitis* is a nematode parasite which is the causative agent of a serious pulmonary-cardiac disorder called Heartworm disease. It affects mainly dogs and rarely cats. The infection is transmitted by mosquitoes thus stray dogs and wild carnivores are expected to be an important reservoir of the infection. The aim of the study is to update the current knowledge about the distribution of *D. immitis* among stray dogs from Sofia, Bulgaria. The survey included 293 dogs which were examined with rapid blood test for circulating *D. immitis* antigens. The percentage of positive animals was 11.26% which is comparable with the results of similar studies from different regions of Bulgaria. The epidemiological data received indicates that *D. immitis* infection is endemic in stray dogs in Sofia.

**Keywords:** prevalence, stray dogs, *Dirofilaria immitis*, Bulgaria

1. **Introduction**

The progressive spread of vector-borne nematode diseases in the face of climate changes is a real veterinary challenge [1]. Heartworm disease (HWD) is a worldwide parasitic disorder caused by *Dirofilaria immitis* (Leidy, 1856), a representative of the *Onchocercidae* family. Despite the name the main residential location of the parasite is the pulmonary artery which leads to pulmonary hypertension and in some cases to right-sided heart failure. However the disease is often asymptomatic. Infection is transmitted by blood sucking arthropods – mosquitoes (*Culex* spp., *Aedes* spp. and *Anopheles* spp.) [5, 29]. The final hosts are mainly wild and domestic carnivores. *Dirofilaria immitis* possesses some zoonotic potential [24] although humans are usually affected by *D. repens* which is localized in the subcutaneous tissue [6, 10]. By the time this article is issued human dirofilariasis cases in Bulgaria are caused by *D. repens* only [34].

Heartworm disease shows almost worldwide spread. In Europe the long established endemic areas are around the Mediterranean basin (Italy, South France, Spain) and follow the distribution of mosquitoes. There is a progressive tendency of HWD spread to north and east Europe. It now became endemic in countries where it used to be a rare find. Underlying factors include the intense movement of infected dogs across Europe, increased attention toward the disease, emergence of new vector species, wild carnivore population dynamics as well as changes in ecosystem due to human activity [21]. However the climate changes and the introduction of new vector species are among the leading factors for HWD progression to wider territories [12]. The climate change in the past decades is the reason autochthonous heartworm disease to be detected also in central and northern parts of Europe [18].

A main reservoir of the nematode can be the domestic dog (*Canis familiaris, L., 1758*)-pet, stray, hunting etc. and different wild carnivores – wolf (*Canis lupus, L., 1758*), red fox (*Vulpes vulpes, L., 1758*), jackal (*Canis aureus, L., 1758*).

*Dirofilaria immitis* in dogs was detected for the first time in Bulgaria at the end of the XX century and since then there is increasing data for the distribution of the parasite among canines, mainly pet dogs, in different regions of the country. Bulgaria is located in south-eastern Europe in the southern part of the North Temperate Zone. However it has some subtropical influence. This transitional location between two zones gives its reflection over the climate, soils, flora and fauna [9]. Sofia is the capital of the country with...
app. 1.5 million citizens. It is located in the western part of the
territory at 550/600 meters above sea level. The city has
continental climate characterized by cold winters and warm
summers.

Stray dogs are a serious ecological, social, medical and veterinary
problem worldwide. In the last decade the number of
stray dogs in Sofia is gradually decreased as a result of
spay programs and legislation measures and nowadays their
count is app. 24,194 in 2017 in the country (unofficial data).
In Sofia district the figures point around 3844 [13]. In urban
and suburban areas stray dogs are an important source for
parasite distribution to pet dogs and eventually humans [10].
The aim of this study was to update the information about
*Dirofilaria immitis* prevalence in stray dogs from Sofia area.

2. Materials and Methods

2.1. Study area and animals

The survey was carried out in Sofia region between January
and December 2017. Study included 293 stray dogs from
different parts of the city and neighboring metropolitan areas.
All animals were mix breed, from both sex (male - 58 %,
female - 42 %), the age of all tested dogs was above 8
months. There was no information about prophylactic
measures against parasites.

2.2. Clinical materials

Blood samples were collected from *v. saphena lateralis* or *v.
cephalica anebracthit* through standard technique in tubes
with EDTA. The rapid diagnostic test was performed *ex tempore*.

2.3. Diagnostic assay

The used assay was *Anigen Rapid CaniV-4Test Kit* (BioNote
Inc., South Korea) - a chromatographic immunoassay which
includes the qualitative detection of *Dirofilaria immitis*
antigens. Sensitivity for heartworm is 94.4% and specificity -
100%. The tests were performed according to the
manufacturer’s instructions.

3. Results and Discussion

The prevalence of *D. immitis* in the studied canine population
was 11.26 % (33/293). By sex, male dogs showed a higher
incidence 66.7 % (22/33) compared to females 33.3 %
(11/33).

The results of the current study were comparable to Radev [28]
which reported 15 % positive dogs from 33 tested animals in
a shelter in Sofia. At the same time our data were inconsistent
with Stoyanova [30] which announced that 31.25 % (25/80) of
tested stray dogs in Sofia were carriers of *D.immitis*. By sex,
both studies confirmed that male dogs showed a higher
incidence.

Similar epidemiological survey for Sofia but for pet dogs
resulted in 7.5 % positive animals (12/160) [4]. Despite the
variation in *D. immitis* prevalence in different canine
populations, it can be inferred from the accumulated
epidemiological data that Sofia is an endemic area and both
domestic and stray dogs population are constant parasite
carriers.

If we follow the results of previous studies we can concluded
that at least for the few decades canines in various parts of
the country were stably infected with *D. immitis*. According to
Georgieva [13] 12.5 % of tested stray dogs and only 1.4 % of
pet dogs were carriers. Results of necropsies of Kirkova [16]
for Stara Zagora region (south Bulgaria) showed 10.7 % and
comparable were the results of Kostadinov [17] which included
56 stray dogs from Burgas (East Bulgaria) - 12.5 % were
infested. Another survey from Stara Zagora region indicated
that 16.2 % (27/167) of the examined with rapid antigenic test
were positive for HWD [30]. The percentage range of all these
surveys was 1.4 % - 16.2%. Our result for Sofia (11.26%) falls
in the same interval. All projects which included only pet
dogs disclosed lower HWD prevalence (1.4 % - 7.5 %). The
possible explanations can be that owned dogs in the city live
mostly indoors and are treated with repellent substances
which decreased the possibility for mosquito biting and
transmission of infection.

Wild carnivores are among the main reservoirs of vector-
borne nematodes. The necropsy of golden jackals (*Canis
aureus*, L.), red foxes (*Vulpes vulpes*, L.) and stray dogs from
different parts of Bulgaria demonstrated infection prevalence
of 37.54 %, 25.22 % and 33.33 % respectively [23]. The
distribution of HWD in jackals from Pazardzik region (100
km west of Sofia) was even more pronounced - 73.1 %
(19/26) [20].

Bulgaria borders with five countries – Greece to the south,
Romania to the north, Serbia and North Macedonia – to
the west and Turkey - to the south-east. According to Dicacou [8]
the prevalence of HWD in Greece was 4.1 % (31/750). In the
northern part of the country (Thessaloniki) the spread was 14
% in comparison to 0.7 % in Attica. The geographical
mismatch can be explained by the increased humidity and
mosquito distribution in the north. The results of Angelou [2]
were in conformity – *D. immitis* prevalence among 1000 pet
dogs was 9 %.

In Romania the reported prevalence of HWD was 3.3 %
(38/1146) with significant regional variations – between 2.9
% to 31% [19]. The highest percent was located in Tulcea
region near Danube delta where more favorable ecological
conditions for the vector development are available.

The distribution rate of HWD in Serbia (Vojvodina province)
was 7.2% [32] and in wild carnivores - golden jackals, red
foxes and wolves - 7.32 %, 1.55 % and 1.43 % respectively
[27].

Turkey has quite different ecological and climate regions
which can explain the divergence in results. In Sivas Province
of Turkey (central Anatolia) Atas [3] reported 3.7 % in stray
and 1.7 % in owned dogs and the highest prevalence in
Turkey was reported to be 46.2% in Van Province (east
Turkey) [1]. The huge difference can be due to the long snowy
winter and dry warm summer in Sivas province therefore
mosquito activity lasts less than 3 months.

In the European part of Turkey some of the available results
showed that in Istanbul the infection affects 1.52% of dogs [22]
and 2% in the area of Gemlik in Bursa [7].

The available epidemiological data from the neighboring
countries allows the conclusion that HWD is an endemic
parasite in domestic and wild canine species in whole
southeastern Europe. The retrospective study of Szell [31] based
on necropsy finding of the parasite demonstrated rise of HWD
prevalence from 0.5 % to 8.0 % for eleven years. Although
the survey concerned central Europe (Hungary), it clearly
demonstrated the rapid progression of infection spread within
a short period of time resulting from climate-driven ecological
changes and also the impact of wild carnivores in HWD
epidemiology.

Stray dogs are highly exposed to a range of zoonotic parasites
including *D. immitis* and may become important reservoir for
human and pet infection [23]. The limitation of stray dog
population should be in the focus of competent authorities,
health agencies and institutions in the country. According to
of „one health“ the control and prevention of social and economically important infections require a multidisciplinary approach based on coordinated collaboration between governments, citizens, medical, veterinary and ecological authorities to achieve improvement of human and animal health [14–33].

4. Conclusions
The current epidemiological survey demonstrated that Sofia, Bulgaria is an endemic area for Dirofilaria immitis and a significant part of stray dogs in the city are carriers. Because of the potentially substantial role in the life cycle of D. immitis, stray dog population in urban areas of Bulgaria should be further examined and tested for heartworm infection.

5. Conflict of Interest
The author reports no conflict of interests.

6. Acknowledgments
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7. References
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