



Amol University of Special  
Modern Technologies

Caspian Journal of Veterinary Sciences

doi: 10.22034/2026.573385.1059

Journal homepage: <https://Cjvs.ausmt.ac.ir/>

## Prevalence and risk factors associated with *Dirofilaria immitis* infection in dogs in Kerman city, southeast Iran

Mehdi Sadari<sup>1</sup>, Sepideh Asadi<sup>2\*</sup>, Ali Dodangeh<sup>3</sup>

<sup>1</sup>Department of Clinical Sciences, Faculty of Veterinary Medicine, Shahid Bahonar University, Kerman, Iran.

<sup>2</sup>Department of Pathobiology, Faculty of Veterinary Medicine, Amol University of Special Modern Technologies, Amol, Iran.

<sup>3</sup>Faculty of Veterinary Medicine, Science and Research Branch, Islamic Azad University, Tehran, Iran.

(\* Corresponding Author: [s.asadi@ausmt.ac.ir](mailto:s.asadi@ausmt.ac.ir))

Article Info	Abstract
<b>Article history:</b> Submit Date: 1 February 2026 Accept Date: 11 May 2026 Online Date: 17 June 2026	<p>Dogs are recognized as one of the primary reservoirs of <i>Dirofilaria immitis</i>, a zoonotic parasite affecting both humans and animals. Endemic cases of dirofilariasis caused by this parasite have been reported in various regions of Iran. The present study was conducted to update epidemiological data on the prevalence of <i>D. immitis</i> infection in both domestic and stray dogs in Kerman city, using the modified Knott's test and polymerase chain reaction (PCR), and to identify risk factors associated with positive test outcomes. Blood samples from 90 dogs (80 stray and 10 domestic) were subjected to hematological examination, modified Knott's test, and PCR analysis. Based on the results of the modified Knott's test and PCR, 7 stray dogs (7.77%) and 10 stray dogs (11.1%) were diagnosed as infected, respectively. PCR analysis revealed statistically significant associations between dirofilariasis and two clinical factors-sex and neutering status-both of which were identified as risk factors (<math>p &lt; 0.05</math>). Furthermore, none of the hematological parameters of dogs testing positive by the modified Knott's test showed significant deviations from normal values (<math>p &lt; 0.05</math>). This study provided updated information on the prevalence of <i>D. immitis</i> infection among dogs in Kerman city. The findings confirmed that <i>D. immitis</i> is endemic in Kerman and represented a potential threat to human health and public safety. The present research may contribute to a better understanding of the epidemiological characteristics of <i>D. immitis</i>, thereby supporting future control strategies and the development of effective therapeutic and preventive measures.</p> <p>©2026 Published by Amol University of Special Modern Technologies Press.</p> <p>This is an open-access article under the CC-BY4.0 license (<a href="https://creativecommons.org/licenses/by/4.0/">https://creativecommons.org/licenses/by/4.0/</a>).</p>
<b>Keywords:</b>	
<i>Dirofilaria immitis</i>	
Dogs	
Hematology	
Iran	
Modified Knott's test	

## Introduction

Dirofilariasis is a zoonotic disease caused by filarial nematodes of the genus *Dirofilaria*. Among these species, *Dirofilaria immitis* is recognized as the principal filarial parasite infecting dogs and inducing heartworm disease in animal populations (Sharifi et al., 2017). *D. immitis* is predominantly found in subtropical and temperate regions of the world, where mosquito vectors and canine reservoirs are abundant (Tabrizi et al., 2019). In Iran, this infection has been reported in several species, including humans, dogs, cats, and jackals (Norouzi et al., 2019; Narouei et al., 2020). Recent investigations in Iran have documented prevalence rates ranging from 0.95% to 78.6% across different regions of the country (Sharifi et al., 2021; Hosseini et al., 2022). The prevalence of infection is intertwined with multiple factors, such as rising temperatures resulting from climate change. Global warming can influence the distribution, abundance, and reproductive capacity of mosquitoes. In addition, variables, such as the methodologies employed to assess prevalence and variations in sampling approaches contribute to differences in prevalence rates, even within a single country (Mortarino et al., 2011; Narouei et al., 2020; Sharifi et al., 2021). Updating the status of filariasis in reservoirs can enhance our understanding of the current situation of the disease. Heartworm disease typically progresses slowly, initially causing vascular and pulmonary complications, and eventually affecting the right side of the heart. Early clinical signs in dogs include persistent coughing, fatigue, weight loss, dyspnea, reduced activity, hemoptysis, abdominal swelling, and, in more severe cases, intravascular hemolysis, pulmonary thromboembolism, and congestive heart failure-conditions that, if left untreated, often result in death (Saadati et al., 2019; Hosseini et al., 2022). Human cases have predominantly been reported in regions with high prevalence of canine dirofilariasis. In humans, *D. immitis* infection generally leads to the formation of pulmonary nodules and, occasionally, involvement of the eyes and subcutaneous tissues. In rare instances, the parasite has also been detected in the human heart and major blood vessels (Saadati et al., 2019; Sedighi et al., 2020). Various techniques, including parasitological and serological assays, can be employed to diagnose *Dirofilaria* infection in dogs (Sharifi et al., 2017; Sedighi et al., 2020). The most important diagnostic methods for heartworm infection include the modified Knott's test, polymerase chain

reaction (PCR), commercially available ELISA kits, and necropsy. In addition, radiography, echocardiography, and electrocardiography also play roles in the diagnostic process (Sharifi et al., 2017; Saadati et al., 2019; Sedighi et al., 2020; Sharifi et al., 2021). One of the limitations of direct methods (parasitological examinations) is their relatively lower sensitivity, as results depend on the presence or quantity of microfilariae in the examined sample (Mag et al., 2020; Lima et al., 2020). In contrast, molecular diagnostic methods demonstrate higher sensitivity and specificity (Saadati et al., 2019; Naderi et al., 2021). Moreover, genetic techniques allow definitive identification of *D. immitis* in both dogs and cats (Keller et al., 2011). The present study was conducted to update data on the prevalence of *D. immitis* infection in domestic and stray dogs using the modified Knott's test and PCR, as well as to identify factors associated with positive test outcomes in Kerman city.

## Materials and Methods

This cross-sectional study was conducted from April 2021 to July 2022 on 90 dogs (80 from animal shelters and 10 referred to the Veterinary Hospital of Shahid Bahonar University of Kerman) in Kerman city. All dogs were clinically healthy and complete information including sex, breed, age, living environment, medical history, and neutering status was recorded. Three milliliters of blood were collected from the cephalic vein of each dog with the consent of their owners and stored in EDTA-containing tubes. Complete blood count (CBC) was performed using an automated hematology analyzer (Abbott CELL-DYN 3700 Hematology Analyzer, Abbott, Germany). This test was applied only to samples that tested positive in the modified Knott's test. Blood samples were stored at  $-20^{\circ}\text{C}$  prior to DNA extraction. The modified Knott's test was employed for the detection of microfilariae in canine blood samples. Briefly, 0.5 ml of blood was added to 4.5 ml of 2% formalin and centrifuged at 2500 rpm for 5 minutes. Following centrifugation, the supernatant was discarded, and the sediment at the bottom of the tube was mixed with 1–2 drops of 0.1% methylene blue. After 5 minutes, a drop of the sediment was placed on a glass slide and examined microscopically for the identification of microfilariae.

Screening for *D. immitis* DNA was performed using PCR. DNA was extracted with a commercial

DNA extraction kit (Yekta TajhizAzma, Tehran, Iran) according to the manufacturer's instructions. DNA concentration and purity were measured using a NanoDrop-2000 spectrophotometer (Thermo Fisher Scientific), and extracted DNA was stored at  $-20^{\circ}\text{C}$ . Primer sequences and PCR protocol details were presented in Table 1 (Casiraghi *et al.*, 2004). PCR assays were carried out in a final volume of 25  $\mu\text{l}$  containing 1  $\mu\text{l}$  of DNA template, 0.5  $\mu\text{l}$  of each primer (20  $\mu\text{M}$ ), 10  $\mu\text{l}$  of ready-to-use Taq DNA Polymerase Master Mix (Pars Tous, Iran), and sterile distilled water. Each PCR run included a positive control (DNA extracted from confirmed positive cases) and a negative control (distilled water). PCR products were visualized under UV light following staining with loading buffer and electrophoresis on 1% agarose gel.

**Table 1.** Primer sequences and PCR conditions for the identification of *Dirofilaria immitis*.

References	Size (bp)	Cycle	(3' - 5')	Primer
Casiraghi <i>et al.</i> , 2004)	490	94°C (3 min),	GTTCCAG	<i>Dirofilaria</i> -12SF
		94°C (30 sec),	AATAATC	
		55°C (30 sec),	GGCT	<i>Dirofilaria</i> -12SR
		72°C (60 sec),	ATTGACG	
72°C (5 min)	GATG(AG)			
			TTTGTAC	

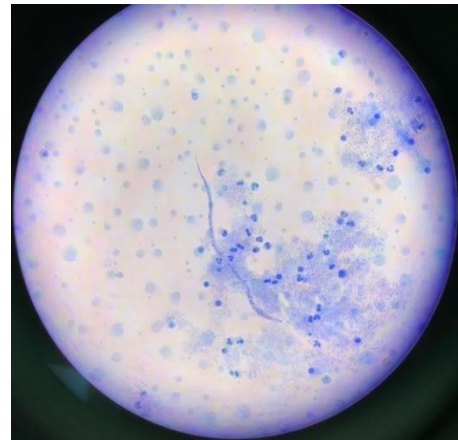
All data were analyzed using SPSS software, version 16, with a significance level set at  $p < 0.05$ . Logistic regression analysis was applied to determine the presence or absence of associations between disease prevalence and identified risk factors, including sex, living environment, and neutering status.

## Results

Data pertaining to 90 dogs were presented in Table 2. The mean age of the animals ranged from two to nine years. Of the seven dogs (7.77%) diagnosed with heartworm disease based on the modified Knott's test, three were males (85.42%), four were females (57.14%), and all were stray. Among these seven dogs, five (71.42%) were neutered and two (28.57%) were intact (Fig. 1).

**Table 2.** Demographic distribution of the examined dogs.

Percent	Frequency	
33.3	30	<b>Male</b>
66.7	60	<b>Female</b>
58.9	53	<b>Non-neutered</b>



**Fig. 1.** Result of the modified Knott's test in a dog infected with *Dirofilaria immitis*.

Based on PCR analysis performed on 90 dogs, 10 (11.1%) tested positive (Fig. 2), comprising five males (50%) and five females (50%). All 10 dogs that tested positive for *Dirofilaria* by molecular assay were stray. Among these, six dogs (60%) were neutered and four (40%) were intact. Logistic regression analysis indicated that neutering had no significant effect on the prevalence of infection ( $p > 0.05$ ). However, male dogs exhibited a higher risk of *Dirofilaria* infection compared to females (OR = 4.8,  $p = 0.04$ ) (Table 3). In addition, a significant association was observed between infection and age, with dirofilariasis being considerably more prevalent in cats older than five years ( $p < 0.05$ ). Hematological indices of dogs testing positive for *Dirofilaria* using the modified Knott's test were also evaluated. When compared to the mean reference values in dogs, none of these indices showed significant differences ( $p > 0.05$ ). Although eosinophil counts were elevated, the increase was not statistically significant.

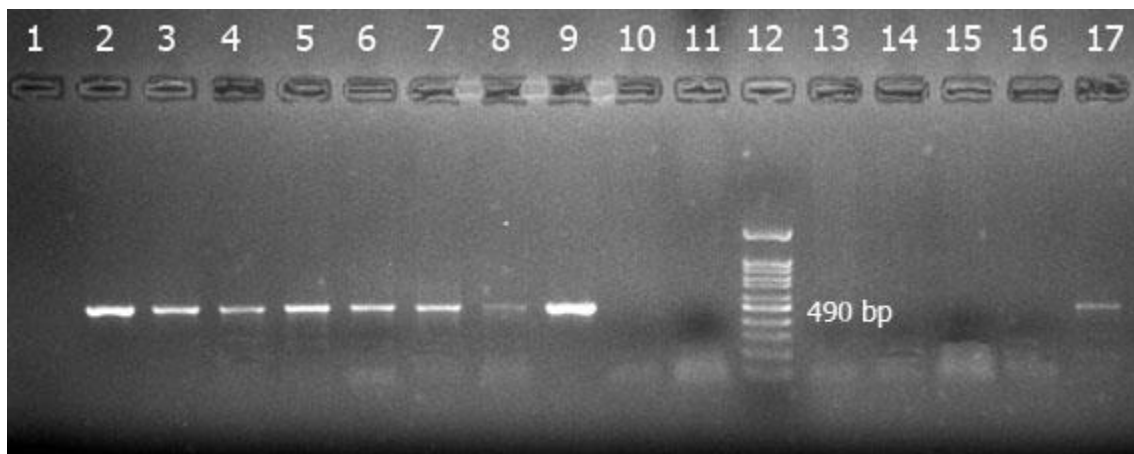
**Table 3.** Laboratory factors associated with the prevalence of *Dirofilaria immitis* in the examined animals.

P-value	OR	
		<i>Knott's test</i>
0.325	2.291	Sex
0.11	0.239	Neutering status
		<i>PCR</i>
0.40	4.854	sex
0.464	0.562	Neutering status

However, male dogs exhibited a higher risk of *Dirofilaria immitis* infection compared to females (OR = 4.8,  $p = 0.04$ ) (Table 3).

**Table 4.** Selected studies on the isolation of *Dirofilaria immitis* in Iran.

Reference	Prevalence (%)	Method	Number of samples	Year of sampling	Dogs	Climate	Region	Province
(Akhtardanesh, 2011; Hossein Radfar et al., 2011)	0	Necropsy	198	2008	Domestic	Hot and dry	Kerman	Kerman
	5	Serology						
	2	Microscopy						
(Bamorovat et al., 2017; Bamorovat, 2017; Sharifi et al., 2017)	5.4	Serology	149	2013	Domestic	Hot and dry	Kerman	Kerman
	2.7	Microscopy						
	6	PCR						
(Khedri, 2014; Radfar et al., 2014)	15.15	Serology	33	2013- 2013	Domestic	Hot and dry	Bam	Kerman
(Naderi, 2021; Sharifi et al., 2021)	10	Serology	100	2017 - 2018	Domestic	Hot and dry	Jiroft	Kerman
	4	Microscopy						
(Khedri, 2014; Radfar et al., 2014)	27.5	Serology	87	2012 – 2013	Domestic	Hot and dry	Zabol	Sistan and Baluchestan
	0.2	Necropsy						
(Anvari, 2019; Saadati et al., 2019)	30.3	Microscopy	99	2017	Stray	Hot and dry	Iranshahr	Sistan and Baluchestan
(Mohebbi, 2016)	8.3	Microscopy	60	2013	Unknown	Hot and dry	Iranshahr	Sistan and Baluchestan



**Fig. 2.** Agarose gel electrophoresis analysis of PCR for the detection of *Dirofilaria immitis* DNA in blood samples. Lane 12: molecular weight marker (100 bp DNA ladder); Lane 1: negative control; Lane 2: positive control; other lanes: selected tested samples.

## Discussion

Dirofilariasis caused by *D. immitis* is a serious disease in both humans and dogs, affecting their physiological status and survival (Genchi *et al.*, 2008; Sharifi *et al.*, 2021). The disease exerts diverse impacts on public health in communities with high prevalence and also carries social and economic consequences. Comparison of historical epidemiological data from previous decades reveals significant changes in the prevalence of dirofilariasis worldwide (Hosseini *et al.*, 2022). Current data from Western Europe indicate that regions once heavily affected by dirofilariasis now show either declining or stable trends. In contrast, countries in Eastern Europe and Asian regions have demonstrated a marked increase in prevalence rates (Rinaldi *et al.*, 2009). Further investigations are required to clarify the role of dogs as reservoirs and transmitters of human dirofilariasis through mosquito bites (Narouei *et al.*, 2020; Genchi and Kramer, 2020). Maintaining updated epidemiological data is essential for the design and implementation of effective control strategies. This study, employing the modified Knott's test and PCR, updated information on the prevalence of *D. immitis* infection in domestic and stray dogs and examined factors associated with positive test outcomes in Kerman city.

Our findings demonstrated that the prevalence of *D. immitis* in southeastern Iran (Kerman) was higher than that reported in previous studies conducted in this city, and the rate has increased over time. In the present study, the prevalence rates were 7.77% and 11.1% using the modified Knott's test and PCR, respectively. Danesh *et al.* (2011) reported the prevalence of this parasite as 2% using the modified Knott's test and 5% with commercial immunochromatographic kits (Radfar *et al.*, 2011). In another study, prevalence in samples collected in 2013 from dogs in Kerman was reported as 2.7%, 5.4%, and 6% using the modified Knott's test, ELISA, and PCR, respectively (Sharifi *et al.*, 2017).

According to previous studies, the prevalence of *D. immitis* in different regions of Iran ranges from 0.9% to 78% (Hosseini *et al.*, 2022). Variations in reported infection levels across regions and years may be attributed to factors, such as sample size, climatic conditions, environmental and ecological parameters including rainfall, public health monitoring, co-infections with external parasites, socio-economic

status, diagnostic methods (parasitological, serological, or molecular), age, and the type of population studied (stray or domestic). Data from studies conducted in southeastern Iran were presented in Table 4. It is believed that temperate climates with rainfall provide ideal conditions for the proliferation of arthropod intermediate hosts. In northern Iran, with its temperate Caspian climate, high prevalence rates of *D. immitis* in dogs have been reported, with the highest prevalence in Gilan Province reaching 78%. Although the hot and dry climate of Kerman might appear unsuitable for mosquito vectors of *D. immitis*, the prevalence rate remains relatively high given the desert climate of the region. One possible explanation for the increased prevalence of this parasite in Kerman compared to previous years may be the growing trade between local dog breeders and other regions of the country (such as northwestern Iran), where prevalence rates are considerably higher.

PCR proved to be more effective than the modified Knott's test in identifying infected dogs, detecting 10 positive samples compared to 7. Numerous studies have reported a high prevalence of microfilaremic infections (Radfar *et al.*, 2011; Sharifi *et al.*, 2017; Sharifi *et al.*, 2021). PCR offers advantages in species-level identification of filarial parasites and in diagnosing infections in animals previously classified as negative by microscopic methods. Microscopic examinations, however, retain the advantages of being rapid and inexpensive (Junsiri *et al.*, 2017).

The modified Knott's test, designed for the detection and identification of microfilariae, is the most widely used concentration method for parasite diagnosis. However, distinguishing between filarial species remains challenging, and the test may exhibit reduced sensitivity due to factors, such as nocturnal periodicity of the worms, low parasite burden, single-sex infections (caused by female worms), host immune responses to microfilariae, and prior administration of microfilaricidal drugs. Ivermectin and levamisole, commonly used anthelmintics in Iran, possess microfilaricidal effects and can gradually reduce microfilarial counts by sterilizing adult parasites (Genchi and Kramer, 2017, Junsiri *et al.*, 2017).

All infected dogs in this study were stray. Our findings are consistent with those of Borthakur *et*

al. (2015), who reported a higher prevalence of infection in stray dogs compared to domestic ones (Deka et al., 2015). The difference between these two populations may be attributed to the better quality of life and improved health status of domestic dogs due to veterinary supervision and adequate nutrition, in contrast to stray dogs. Moreover, domestic dogs receive anthelmintic treatments and are less exposed to mosquito bites (Akhtardanesh et al., 2022). Unfortunately, lack of cooperation from dog owners in sample collection, due to limited awareness of the importance of the disease, was one of the limitations of this study. This reduced the sample size of domestic dogs examined. In line with many previous studies, the present investigation demonstrated a significant association between *D. immitis* infection and increasing age (Vieira et al., 2014; Sharifi et al., 2021). Our results showed that the prevalence of this infection was considerably higher in dogs over five years of age. Infection in older dogs may be explained by repeated mosquito bites, long-term infections, prolonged microfilarial replication in the bloodstream, and weakened immune responses against adult parasites (Saadati et al., 2019).

It was also observed that the prevalence of dirofilariasis was significantly higher in male dogs. This finding is consistent with previous reports (Jost et al., 2005; Ica et al., 2007; Aste et al., 2010; Dumitrache et al., 2012; Vieira et al., 2014). Conversely, some authors have found no significant association between *D. immitis* prevalence and sex (Hossein Radfar et al., 2011; Hosseini et al., 2011; Saadati et al., 2019). The higher infection rate in males may be related to the physiological effects of sex hormones on susceptibility, as well as the tendency of dog owners to use male dogs as primary guardians responsible for protecting and securing their living environments (Saadati et al., 2019). Hematological findings revealed increased eosinophil counts in dogs infected with *D. immitis*, although this increase was not statistically significant. Eosinophils play an important role in eliminating nematode infections through type 2 immune responses (Sattasathuchana and Steiner, 2014; Crosara et al., 2018). Anemia and leukocytosis were not observed in dogs with dirofilariasis, which may be explained by the fact that the dogs were clinically healthy. Most dogs infected with *D. immitis* do not exhibit clinical signs; however, studies have shown that dirofilariasis may lead to certain clinical

conditions, such as weight loss, lethargy, anorexia, persistent coughing, dyspnea, reduced activity, pulmonary embolism, and congestive heart failure (Hosseini et al., 2011; Sharifi et al., 2017; Sharifi et al., 2021). Wherever canine dirofilariasis exists, there is also a risk of human infection (Auer et al., 2016; Carretón et al., 2018). In Iran, epidemiological data on human dirofilariasis remain limited, although several cases of human infection have been documented (Maleki et al., 2017; Sedighi et al., 2020). Thus, these apparently healthy dogs may pose a risk to individuals in contact with them.

The findings indicated a high and increasing prevalence of *D. immitis* compared to previous years, likely due to the hot and dry climate of Kerman. Given the zoonotic nature of this disease, preventive measures, such as reservoir control, administration of anthelmintic drugs, and the use of insect-proof nets are of great importance. Furthermore, strategies for managing stray dog populations and implementing monitoring programs in kennels and animal shelters located in urban areas are essential. Acquiring such specific information is critical for optimizing and enhancing the effectiveness of future control programs.

## Acknowledgment

This study was supported by the Faculty of Veterinary Medicine at the University of Kerman, Kerman, Iran.

## Conflict of Interest

There is no conflict of interest among the authors.

## References

- Akhtardanesh, B; Hossein Radfar, M; Voosough, D and Darijani, N (2011). Seroprevalence of canine heartworm disease in Kerman, southeastern Iran. *Comp. Clin. Pathol.*, 20: 573-577.
- Anvari, D; Narouei, E; Daryani, A; Sarvi, S; Moosazadeh, M; Hezarjaribi, HZ and Gholami, S (2020). The global status of *Dirofilaria immitis* in dogs: a systematic review and meta-analysis based on published articles. *Res. Vet. Sci.*, 131: 104-116.
- Anvari, D; Saadati, D; Siyadatpanah, A and Gholami, S (2019). Prevalence of dirofilariasis in shepherd and stray dogs in Iranshahr, southeast of Iran. *J. Parasitic Dis.*, 43: 319-323.

- Azari-Hamidian, S; Norouzi, B and Harbach, RE** (2019). A detailed review of the mosquitoes (Diptera: Culicidae) of Iran and their medical and veterinary importance. *Acta Trop.*, 194: 106-122.
- Bamorovat, M; Sharifi, I; Harandi, MF; Nasibi, S; Sadeghi, B; Khedri, J and Mohammadi, MA** (2017). Parasitological, serological and molecular study of *Dirofilaria immitis* in domestic dogs, southeastern Iran. *Iran. J. Parasitol.*, 12: 260.
- Borthakur, SK; Deka, DK; Islam, S; Sarma, DK and Sarmah, PC** (2015). Prevalence and molecular epidemiological data on *Dirofilaria immitis* in dogs from Northeastern States of India. *Sci. World J.*, 2015: 265385.
- Bourguinat, C; Keller, K; Prichard, RK and Geary, TG** (2011). Genetic polymorphism in *Dirofilaria immitis*. *Vet. Parasitol.*, 176: 368-373.
- Cabrera, ED; Carretón, E; Morchón, R; Falcón-Cordón, Y; Falcón-Cordón, S; Simón, F and Montoya-Alonso, JA** (2018). The Canary Islands as a model of risk of pulmonary dirofilariasis in a hyperendemic area. *Parasitol. Res.*, 117: 933-936.
- Casiraghi, M; Bain, O; Guerrero, R; Martin, C; Pocacqua, V; Gardner, SL and Bandi, C** (2004). Mapping the presence of *Wolbachia pipientis* on the phylogeny of filarial nematodes: evidence for symbiont loss during evolution. *Int. J. Parasitol.*, 34: 191-203.
- Duran-Struuck, R; Jost, C and Hernandez, AH** (2005). *Dirofilaria immitis* prevalence in a canine population in the Samana Peninsula (Dominican Republic)–June 2001. *Vet. Parasitol.*, 133: 323-327.
- Farkas, R; Mag, V; Gyurkovszky, M; Takács, N; Vörös, K and Solymosi, N** (2020). The current situation of canine dirofilariosis in Hungary. *Parasitol. Res.*, 119: 129-135.
- Fuehrer, HP; Auer, H; Leschnik, M; Silbermayr, K; Duscher, G and Joachim, A** (2016). *Dirofilaria* in humans, dogs, and vectors in Austria (1978–2014)–From imported pathogens to the endemicity of *Dirofilaria repens*. *PLoS Neglected Trop. Dis.*, 10: e0004547.
- Genchi, C and Kramer, L** (2017). Subcutaneous dirofilariosis (*Dirofilaria repens*): an infection spreading throughout the old world. *Parasites Vectors*, 10: 517.
- Genchi, C and Kramer, LH** (2020). The prevalence of *Dirofilaria immitis* and *D. repens* in the Old World. *Vet. Parasitol.*, 280: 108995.
- Genchi, C; Mortarino, M; Rinaldi, L; Cringoli, G; Traldi, G and Genchi, M** (2011). Changing climate and changing vector-borne disease distribution: the example of *Dirofilaria* in Europe. *Vet. Parasitol.*, 176: 295-299.
- Genchi, C; Rinaldi, L; Mortarino, M; Genchi, M and Cringoli, G** (2009). Climate and *Dirofilaria* infection in Europe. *Vet. Parasitol.*, 163: 286-292.
- Hosseini, SH; Manshori-Ghaishghorshagh, F; Ramezani, M; Nayebzadeh, H; Ahoo, MB; Eslamian, A and Otranto, D** (2022). Canine microfilaraemia in some regions of Iran. *Parasites vectors*, 15: 90.
- Jajarmi, M; Akhtardanesh, B; Yazdani, A; Hajipour, P; Mohseni, P; Ghanbarpour, R and Goudarztalejerdi, A** (2022). Molecular detection of *Bartonella henselae* in blood samples obtained from owned cats in Kerman city using Nested-PCR. *Int. J. Vet. Res.*, 2: 31-39.
- Kamyngkird, K; Junsiri, W; Chimnoi, W; Kengradomkij, C; Saengow, S; Sangchuto, K and Jittapalapong, S** (2017). Prevalence and risk factors associated with *Dirofilaria immitis* infection in dogs and cats in Songkhla and Satun provinces, Thailand. *Agri. Nat. Res.*, 51: 299-302.
- Khedri, J; Radfar, MH; Borji, H; Azizadeh, M and Akhtardanesh, B** (2014). Canine heartworm in southeastern of Iran with review of disease distribution. *Iran. J. Parasitol.*, 9: 560.
- Kramer, L; Crosara, S; Gnudi, G; Genchi, M; Mangia, C; Viglietti, A and Quintavalla, C** (2018). *Wolbachia*, doxycycline and macrocyclic lactones: new prospects in the treatment of canine heartworm disease. *Vet. Parasitol.*, 254: 95-97.
- Malmasi, A; Hosseini, SH; Aramoon, M; Bahonar, A and Seifi, HA** (2011). Survey of canine *Dirofilaria immitis* infection in Caspian Provinces of Iran; Short Paper.
- McCall, JW; Genchi, C; Kramer, LH; Guerrero, J and Venco, L** (2008). Heartworm disease in animals and humans. *Adv. Parasitol.*, 66: 193-285.
- Mirahmadi, H; Maleki, A; Hasanazadeh, R; Ahoo, MB; Mobei, I and Rostami, A** (2017). Ocular dirofilariosis by *Dirofilaria immitis* in a child in Iran: a case report and review of the literature. *Parasitol. Int.*, 66: 978-981.
- Mircean, V; Dumitrache, MO; Györke, A; Pantchev, N; Jodies, R; Mihalca, AD and Cozma, V** (2012). Seroprevalence and geographic distribution of *Dirofilaria immitis* and tick-borne infections (*Anaplasma phagocytophilum*, *Borrelia burgdorferi* sensu lato, and *Ehrlichia canis*) in dogs from Romania. *Vector-Borne Zoonotic Dis.*, 12: 595-604.
- Mohebbi, M** (2016). Investigate the prevalence of *Dirofilaria immitis* in dogs in the city of Zabol (Doctoral dissertation, University of Zabol).
- Naderi, A; Sharifi, I; Aflatoonian, MR; Mostafavi, M; Parizi, MH; Mashayekhi, J and Bamorovat, M** (2021). Dirofilariosis caused by *Dirofilaria immitis* in the south of Kerman province, Iran. *Microb. Pathog.*, 154: 104863.
- Parsa, R; Sedighi, A; Sharifi, I; Bamorovat, M and Nasibi, S** (2020). Molecular characterization of ocular dirofilariosis: a case report of *Dirofilaria immitis* in south-eastern Iran. *BMC Infect. Dis.*, 20: 520.
- Pedram, N; Tabrizi, AS; Hosseinzadeh, S; Pourmontaseri, M and Rakhshandehroo, E** (2019). Prevalence of *Dirofilaria immitis* and *Dirofilaria repens* in outdoor dogs in Tehran Province, Iran. *Comp. Clin. Pathol.*, 28: 1165-1169.

- Sattasathuchana, P and Steiner, JM** (2014). Canine eosinophilic gastrointestinal disorders. *Anim. Health Res. Rev.*, 15: 76-86.
- Trancoso, TAL; Lima, NDC; Barbosa, AS; Leles, D; Fonseca, ABM; Labarthe, NV and Uchôa, CMA** (2020). Detection of *Dirofilaria immitis* using microscopic, serological and molecular techniques among dogs in Cabo Frio, RJ, Brazil. *Rev. Bras. Parasitol. Vet.*, 29: e017219.
- Traversa, D; Aste, G; Milillo, P; Capelli, G; Pampurini, F; Tunesi, C and Boari, A** (2010). Autochthonous foci of canine and feline infections by *Dirofilaria immitis* and *Dirofilaria repens* in central Italy. *Vet. Parasitol.*, 169: 128-132.
- Vieira, AL; Vieira, MJ; Oliveira, JM; Simoes, AR; Diez-Banos, P and Gestal, J** (2014). Prevalence of canine heartworm (*Dirofilaria immitis*) disease in dogs of central Portugal. *Parasite*, 21: 5.
- Yildirim, A; Ica, A; Atalay, O; Duzlu, O and Inci, A** (2007). Prevalence and epidemiological aspects of *Dirofilaria immitis* in dogs from Kayseri Province, Turkey. *Res. Vet. Sci.*, 82: 358-363.