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Facilitated Deferred Transmmission a Risk to Public Health of Globalization and Intercountry Adoptions of Pets

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Abstract

Increased temperatures due to climate change may be facilitating that arthropods vectors of zoonotic diseases rapidly colonize new territories. 6472 dogs have been selected to check main Mediterraneum zoonotic vector-borne, two transmitted by fly bites, Leishmaniasis and Dirofilariasis, and tree transmitted by ticks, Ehrlichiosis, Anaplasmosis, and Babesiosis through IFA, ELISA, PCR and microscopy tests and calculate the ratio of this diseases hosts as well the destinations in north of Europe and other countries because these dogs have been adopted out of Spain, the main exported country for dogs to Europe countries, mainly of then are infected with at least one of five vector-borne diseases studied. This represents a risk for Public Health, as it speeds up the creation of new nodes of infected host through facilitated deferred transmmission caused by man.

Keywords: Zoonotic diseases, leishmaniasis, dirofilariasis, infectious diseases, vector borne

INTRODUCTION

At the time of raising the epidemiological situation of vector-borne zoonosis, we need assess not just pass and current facts, but future considerations such as future distribution, environmental changes that may have an influence both to the vector to the host [1].

The animal traffic between Northern and Southern Europe is an example. Mediterraneum shires of Europe is the point of origin before leaving several dogs bound for northern European countries [2]. Most of these animals are from shelters and kennels who rescue, host, and send to adoptive families in United Kingdom, Germany, Switzerland, Netherlands, or Norway. Some of these associations have funding for medical check-ups, mainly those who receive donations from destination countries [3]. Other partnerships and shelters did not have the means to enforce them. The problem is that most of the adoptive families and, especially, health authorities are currently unknown to the health status of these animals [4, 5]. The main health requirements for dogs to travel through Europe and other countries are Rabia antibodies test and helminthiasis or ecto-parasitosis treatment but exception of a few like Leptospirosis, any country requires health test to detect zoonotic vector-borne and these might not always be detectable on routine physical examination [6, 7].

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Furthermore, temperature increase revealed by warming climate change, will make the vectors reach new habitats further North to Mediterranean areas [8, 9]. This fact can facilitate the insects that act as vectors may successfully migrate to new habitats through natural processes but if they find parasitized hosts in those territories.

MATERIALS AND METHODS

To develop the study, 6472 dogs have been selected to check main Mediterraneum zoonotic vector-borne, two transmitted by fly bites, Leishmaniasis and Dirofilariasis, and tree transmitted by ticks, Ehrlichiosis, Anaplasmosis, and Babesiosis [10, 11]. Only Leishmaniasis has not vector in northern Europe by now [12].

Firstly, all subjects were listed, filed writing breed, age, tall, weight, color, sex, and reproductive status (sterilized or not) and booked for Out-Spain or In-Spain adoption [13, 14]. All of them were hosted in shelters and foster homes while were sterilized, vaccinated, and tested, as the same time they wait legal requirements to travel out of Spain (Rabia Vaccine 21 days before to travel, Equinococcus and tick treatments) [15].

All dogs were collected blood and tissue sample (Table 1) to detect, or the parasites or antibodies and diseases sings. Health signs were booked in their files as well.

The techniques used were:

- *Clinical examination:* nutritional status, body temperature, skin and mucous color, Capillary Refill Time (CRT), splenomegaly, joint inflammation, and other sings listed in Leishvet-guides©.
- Blood and tissues samples (Table 1)

Statistical Approaches

After organizing the data from the experiments into tables, graphs, and modified equations, the formula could be determined and percentage relationships by means of rate calculation, absolute frequencies "f_i" and percentages of absolute frequency "$h_i\%$", assigning the value of -1, o or +1 of continuous variables being "$a \frown b$" the range of normal values (example: uremia). Values under physiological ranges were designated as -1, normal values were written as 0 and values more than normal range were characterized as +1. For discrete variables 0 was assigned for negative results and 1 to positive results, including in this group the most diagnostic tests like IFA, ELISA, PCR [13]. After this, f_i and $h_i\%$ were calculated in a statistical table (Table 2).

RESULTS

First of all I point out that halfway through the investigation beginning of the epidemic SARS-COVID-19, which meant a considerable decline of international adoptions. In contrast, the annual census of deer continues to decrease year after year.

Shelters who have participated in this study send the dogs to destinations reflected in Figure 1. Germany and United Kingdom use to be the main receptor of adopted dogs and this trend is the same than other rescues associations that export dogs out of Spain.

The proportion of destinations is kept constant throughout the study (Figure 2) and extrapolating to each year extrapolating to each year the total number of tested dog (Figure 3), results show a continuous tendence on the evolution of the infected dogs with, at least, one zoonotic vector-borne disease.

Despite the fact that the total quantity of exports has fallen since Epidemic-2020, ratio tested-infected dog is similar and the prediction for the future keeps the trend showed.

Table 1. Origin of the samples, analytical techniques used, measured values and proportion of samples tested for each analysis.

Diagnostic technique	**Anaplasmosis**	**Leishmaniasis**	**Babesiosis**	**Ehrlichiosis**	**Dirofilariasis**
Serum	IFA (100%)		ELISA (100%)	IFA (100%)	ELISA (100%)
	Lateral Flow (10%)		-	Lateral Flow (10%)	
Blood	SMEAR (25%) FOR PCR (10%), MICROSCOPY (100%)				
Spleen and Lumphonodes	Fine needle aspirated (FNA) for PCR (5+5%) and microscopy (100%)				
Skin and mucoses	SCRAPING for PCR (5+5%) and microscopy (100%)				
Haemogram	Leukocytes, Basophils, Eosinophils, Segment/Nucleated Neutrophils, Monocytes, Immature Neutrophils, Hematocrit, Erythrocytes, Hemoglobin, Reticulocytes, Platelets, Microscopy Disturbances, Mean Cell Hemoglobin, Mean Corpuscular Volume, Red cell Distribution Width, Mean Corpuscular Hemoglobin Concentration, Mean Platelet Volume, Reticulocytes, Hemoglobin Concentration				
Proteinogramme	Structure of proteinsAlbumin, albumin/globulin, total protein, albumin/globulin, and globulin (alpha 1-global, alpha 2-global, betta-global, gamma-global).				
Biochemistry	Urea, Creatinine, SDMA, Glucose, Alkaline Phosphatase, GOT (AST), GPT (ALT), Bilirubin, Cholesterol, Triglycerides, Creatin-Kinase, Phosphorus, Cl, k, Calcium, Na, Na/k				

Table 2. For each subject (n_1, n_2….n_{6472}) was assigned one value according to results and calculated f_i and h_i%.

Subject	**Value**	**Absolute Frequency f_i**	**Relative Frequency h_i%**
N_1, N_2...N_{6472}	($N_n < a$) → **-1**	$\sum_{N=-1} [-(N_1 + N_2 \dots + N_n)]$	$\frac{f_i}{\sum N_{at}} \times 100$
	($a < N_n < b$) → **0**	$\sum_{P=0} (N_1 + N_2 \dots + N_n)$	$\frac{f_i}{\sum_{N<v}^{N>a} Nt}$
	($N_n > b$) → **1**	$\sum_{R=1} (N_1 + N_2 \dots + N_n)$	$\frac{f_i}{\sum N_{bt}} \times 100$

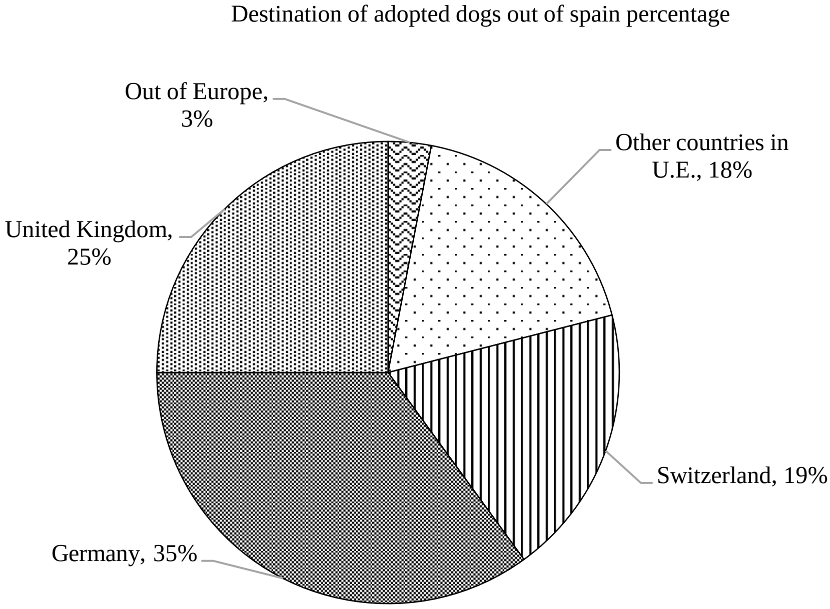

Figure 1. Destination of dogs studied since 2016 to 2022 from Spain.

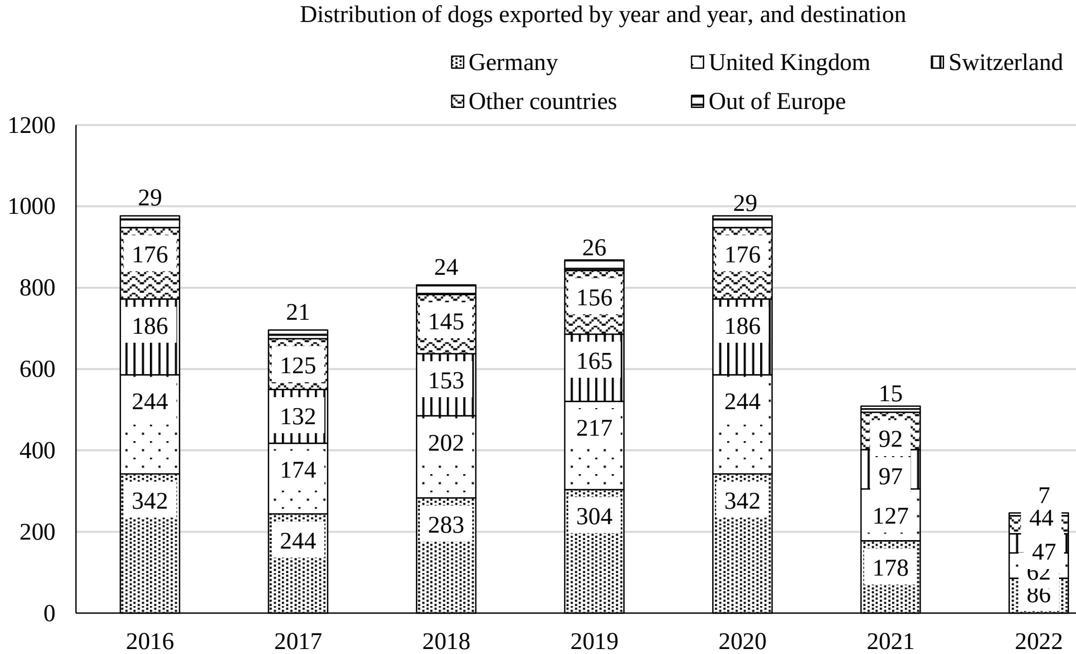

Figure 2. Comparison of proportional exportations to main destination every year since 2016 to 2022.

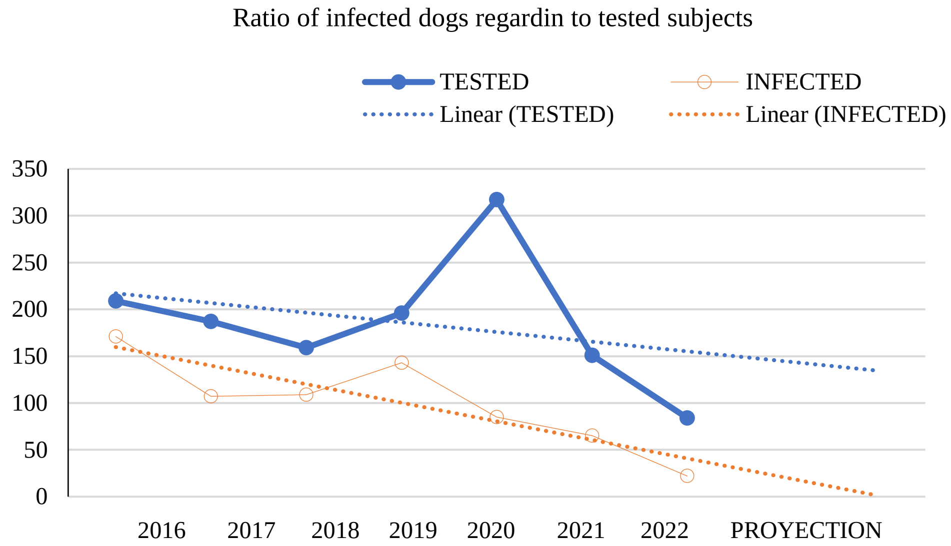

Figure 3. Dogs tested (blue) regarding infected (orange) in a comparison between total data (continuous line) to linear regression and future projection.

These results are the same if we compare absolute subjects number, how many more dogs exported, the greater the amount of carriers able to spread the diseases in the new territories (Figure 4).

Leishmaniasis was the main disease, more than double that of the other (Figure 5), 70% of the dogs were carriers of the parasite from 2016-2019 and scroll down to 49% from year on 2020. The rate of the rest of diseases is lower and in all of them, post-pandemic values are lower than pre-pandemic levels.

Dirofilariasis was the disease less numerous.

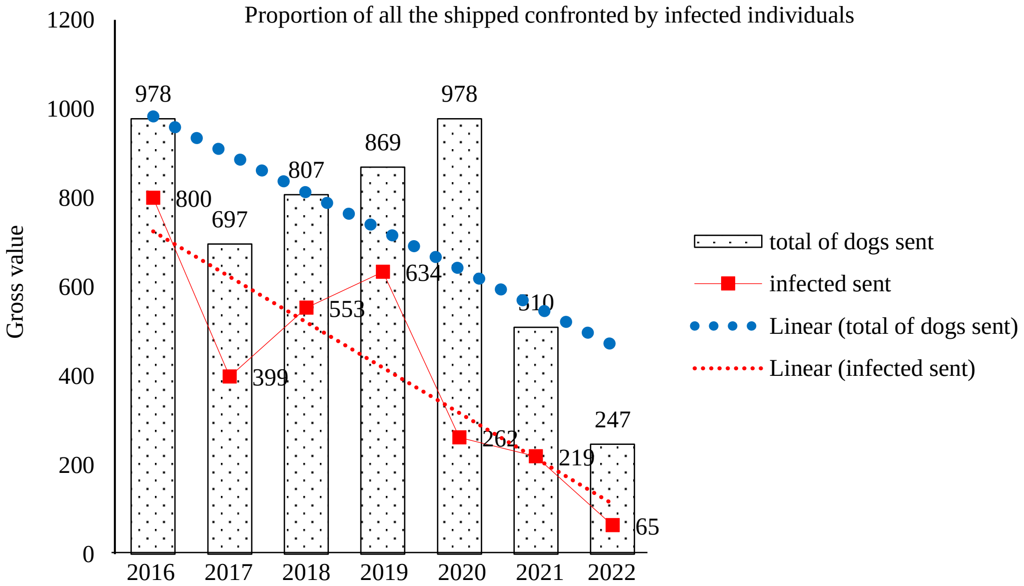

Figure 4. Absolute value and annual trend and linear regression that compares the evolution of diseases but all dogs send.

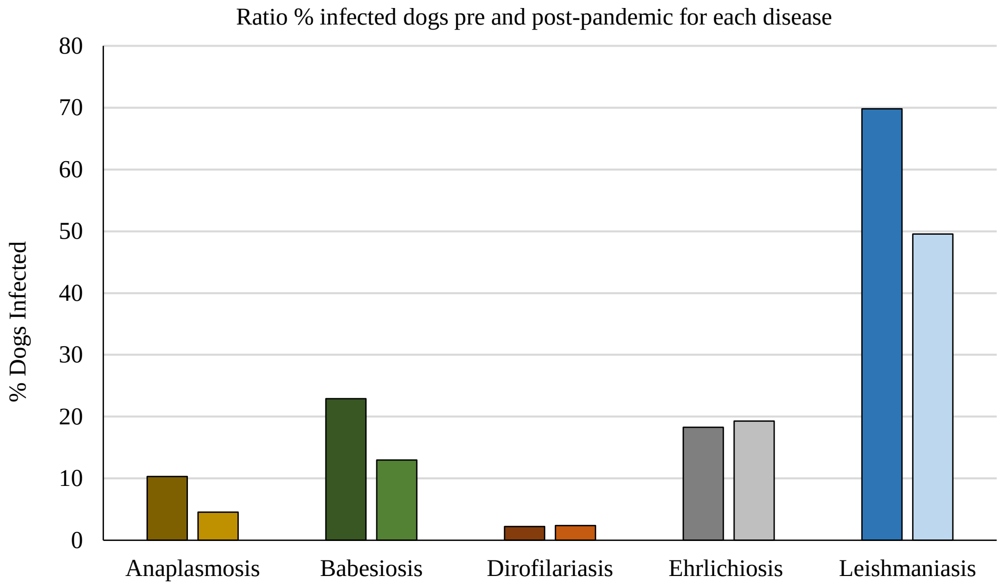

Figure 5. Ratio pre-post pandemic percentages of infected dogs with each zoonotic vector-borne disease. the data have been sorted by colors, Yellow for Anaplasmosis, green for Babesiosis, Brow for Dirofilariasis, Grey for Ehrlichiosis and blue for Leishmaniasis. Dark color columns correspond to pre-pandemic results and soft color columns correspond to post-pandemic results.

CONCLUSIONS

The genera Aedes, Anopheles and Culex are competent at keeping the etiological agents of Dirofilariasis, and they are present in all north of Europe. So *Dirofilaria immitis* is the rarer disease, it shows the minor risk for other dogs or humans in the new territories.

The genus Phlebotomidae is endemic in the Mediterranean coast but with rising temperatures due to climate change, is expected to occupy new territories northern. Leishmaniasis is the zoonotic vector-borne disease with greater probability to spread territory currently free disease.

Anaplasmosis and Babesiosis can be transmitted by *Ixodes ricinus and Rickettsia conorii* have as main vector genus *Rhipicephalus sanguineus.* All these vectors are present in E.U. territory.

With the data obtained and knowing the destinations of the dogs, we can know the flow of potential carriers that are being hosted In a new ecological niche becoming a risk of spreading concluded called facilitated deferred transmmission, a new epidemiological concept to describe the creation of new epidemiological nodes of diseases in territories that would have taken years to develop and establish a natural epidemiological cycle but the fast means of transport can help to shorten the time from years or decades to months. Health Authorities must know this and take protective measures in implementing export import certificates for pets that can carry zoonotic vector-borne diseases.

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