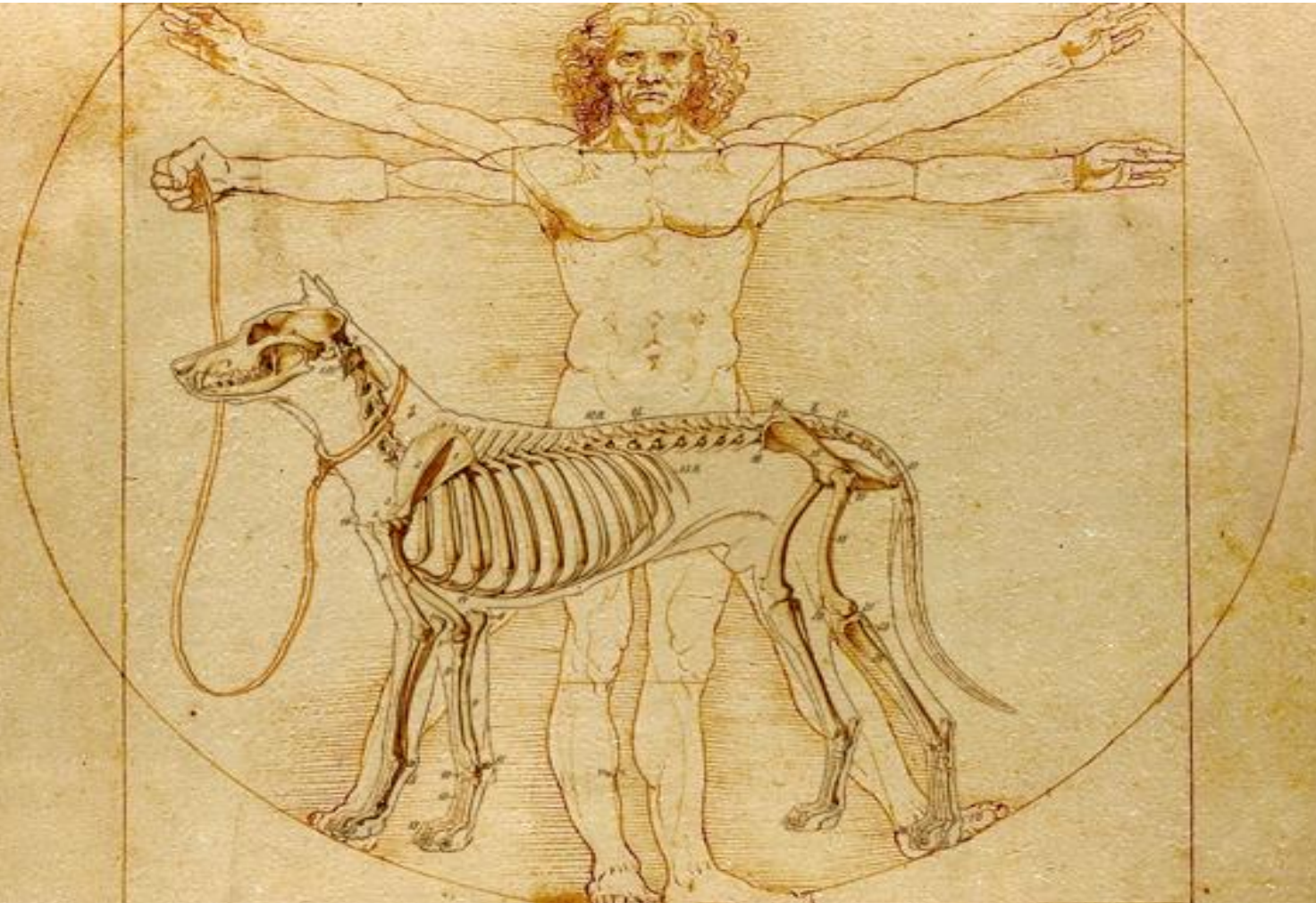


# Prevalence and awareness of zoonotic parasites of dogs on Curaçao



**Faculty of Veterinary Medicine, Utrecht University**

**Research report by:** Cassandra Meijer 3259528  
Renate Massar 3259501

**Supervisor:** Prof. dr. F. van Knapen  
IRAS, University Utrecht

**Local Supervisors:** Drs. J. Nicolina  
Drs. O.B. de Haseth  
Veterinary Services Curaçao

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**Universiteit Utrecht**

## Abstract

To study the perceived prevalence, awareness and client education of 7 selected emerging zoonoses on the island of Curaçao, 10 veterinarians and 10 general practitioners were interviewed. 300 inhabitants of Curaçao were asked to fill in a questionnaire about dog ownership and knowledge of zoonoses. The selection of the 7 included zoonoses was based on a literature study; *Anaplasma spp*, *Ancylostoma spp.*, *Dipylidium caninum*, *Dirofilaria immitis*, *Giardia lamblia*, *scabies*, and *Toxocara canis* were thought to be of most interest on Curaçao. All of these were diagnosed frequently by the veterinarians. General practitioners diagnosed *G.lamblia* and *scabies* in humans on a regular basis, whereas the other zoonoses were never thought of or never seen by most general practitioners. Both professions did not educate clients preventively about zoonoses, but informed patients, especially in *scabies*, if the zoonosis was diagnosed in dogs or humans. Of the 300 random inhabitants asked to fill in the questionnaires, 64.3% were dog owners. 62% of the non-dog owners knew of the existence of zoonoses, compared to 52% of the dog owners, but dog owners did know more different zoonoses. When asked what extra precaution they would take to lower the risk of zoonoses, most people answered to clean better, better hygiene, and 185 wanted more information. Education and awareness are powerful tools in reducing the prevalence and incidence of zoonotic parasitic infection in both dogs and their owners, and both veterinarians and general practitioners can play a more active role in this.

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## 1.0 - Introduction

Curaçao is an island situated in the southern part of the Caribbean Sea, 12 degrees North latitude, 86 degrees western longitude.(1) Up to 10<sup>th</sup> of October 2010, Curaçao was part of the Netherlands Antilles. The island has a tropical climate which stays rather constant during the whole year, with an average temperature of 28.2 degrees and an average humidity of 80.(2,3) The island exists of an area of 444 square kilometres. The population density per square kilometres is 328, with a number of 145.406 inhabitants.

A rough estimate of the number of dogs is 90.000. Due to its history with The Netherlands and the location between Central and South America, the main import and export countries are the USA, the Netherlands, Venezuela, Puerto Rico, Panama and the other islands that previously belonged to the Netherlands Antilles.(4)

Dogs play an important role in the life of man on Curaçao. The dog population on Curaçao exists of feral, semi-domesticated and domesticated dogs. The domesticated dogs are mainly used as pets, guard dogs and guide dogs. Close contact with dogs is inevitable.(5) It is known that pets have a positive effect on society, but there are also well documented health hazards associated with owning a pet. Animal bites and allergies are the most common hazards, but infections transmittable from pets to humans also constitute a risk. These infections include parasites, bacteria, fungi and viruses. Worldwide 61 % of human pathogens are classified as zoonoses.(5-7) Uncontrolled population of stray dogs and semi-domesticated dogs in close proximity to human population, in conjunction with the lack of veterinary attention and zoonotic awareness, increases the risk of disease transmission. Close contact between dogs and humans constitutes a high potential risk for transmission of zoonoses. Vectors such as fleas, ticks and mosquitoes can also transmit parasites from animals to man.(5, 8) Children, elderly people, pregnant women and the immune compromised are at higher risk of acquiring zoonoses. Also pet owners, veterinarians, the veterinary nurses and breeders have an increased risk for zoonoses.(6) Several factors predispose humans to zoonotic transmission, including pica, dog ownership or contact, socio-economic status and geographic locations.(9)

Geographic location and a tropical climate with high humidity and temperature, causes a higher diversity in parasites. The survival time in the environment of the developmental stages (cysts, eggs and larvae) is longer in a tropical climate.(10)

Endoparasites are commonly encountered by veterinarians in pets; reports vary from 5% up to 70% worldwide. They are the main cause of pathology of the intestinal tract in dogs. Puppies have a higher prevalence due to the fact that both their intestinal tract and immune system are not fully developed. With parasitic infections the clinical signs can vary from asymptomatic, diarrhea to even death.(9, 10)

Zoonoses can be emerging pathogens.(7) The clinical manifestations of parasitic zoonoses in man can vary, but include visual (*Toxocara*, ocular larva migrans), neurologic (*Toxocara*, infection of children), dermatologic (*Ancylostoma*, cutaneous larva migrans) and enteric disorders (eosinophilic enterocolitis by hookworms).(9)

Bundy et al.(11) stated that the first review of parasitic zoonoses in the Caribbean dated from 1953, and that since then, zoonotic parasitic diseases have received relatively little attention in the region. Up till 1975 these islands have not been systematically explored for the presence of intestinal helminths in dogs and cats.(2) Most of the articles concerning Curaçao date back to around 1980. In more recent literature, the tropic regions or the Caribbean are mentioned, but none of them specific to the island Curaçao or even the Netherlands Antilles.

Studies in other countries have shown that most owners are not aware of the zoonotic potential of the parasites carried by their dogs, or their mode of transmission to humans. Increasing the knowledge on parasites, the methods of control and the awareness of zoonotic infections may result in reduction of parasites.(6) The goal of this research was to see if the literature is still valid on the recent status of zoonotic parasites of the dog and to get a general view of the recent clinical situation and awareness concerning zoonotic parasites on Curaçao.

## 2.0 - Materials and methods

To research the recent status of zoonotic parasites of the dog on Curacao, a literature study, interviews with veterinarians and general practitioners (GPs), and a survey among inhabitants of Curacao were done.

### 2.1 - Literature study

To select zoonoses that are of public health significance on the island of Curaçao, a literature study was done. PubMed, Google scholar, CAPCvet.org and cdc.gov (centres for disease control and prevention) were searched. The search started using the keywords such as “zoönose”, “Caribbean”, “tropical climate”, “parasite”, etc, or a combination of those words. 33 articles were included in the final study and based on these, 7 parasitic zoonoses of interest were selected; *Anaplasma spp*, *Ancylostoma spp.*, *Dipylidium caninum*, *Dirofilaria immitis*, *Giardia lamblia*, *Scabies*, and *Toxocara canis*.

### 2.2 - Selection of study sample

In order to examine the knowledge and perceived prevalence of our selected zoonoses both veterinarians and GPs were interviewed. 10 veterinarians of different clinics were approached for a interview of proximally 15 minutes. All veterinarians approached were willing to cooperate. There are about a 100 general practitioners on the island, and based on the distribution on the island 10 GPs were asked to cooperate. Because of the timing of our research (June 2012), a few were on holiday, and another GP in that region of the island had to be asked. This way, the GPs and their patients are distributed all over the island and contribute to a general view of the prevalence of zoonoses of the whole island of Curaçao.

Random people, all inhabitants of Curaçao, were asked to fill in the questionnaire. To get people from all different economic status, we collected the questionnaires at different locations (veterinary clinics and the districts Punda and Otrobanda; the veterinary clinics are expected to represent a high economic status, Punda a more moderate economic status and Otrobanda a lower economic status).

### 2.3 - Interviews

The interviews were always obtained by the same two interviewers, at the clinic where the veterinarians and GPs were stationed at. The interviews with the veterinarians contained 4 subjects: demographic factors, recommended vaccination and deworming protocols, perceived prevalence of zoonotic diseases and client education. Demographic information was obtained through questions regarding type of practitioner (small or mixed animals), the location of the practice and the economic status of the clients/neighbourhood, the number of veterinarians working in the clinic and the number of dogs visiting the clinic each week.

Deworming protocols and vaccination schemes were asked, both for puppies and adult dogs. An estimation of the loyalty of the clients and the methods of motivating clients to come back every year were also discussed in the interview. Information regarding frequency of the diagnosis of the zoonoses of interest was required by asking the veterinarians if they ever diagnosed the disease and if yes, how often. Though the selection of zoonoses was based on the literature study and was expected to contain diseases of most importance on Curaçao, the veterinarians were asked if there were other zoonoses that they had diagnosed that were not on the list.

To discuss client education, the veterinarians were asked when they discussed the zoonotic potential hazards with their clients; never, only when asked, whenever one of the above was diagnosed in clients pets, routinely with clients with puppies, new clients, clients with children or all clients.

The interviews with the general practitioners contained fewer questions. Demographic factors were asked; the number of clients every week, the location and the economic status of the clients/neighbourhood. To test general knowledge of zoonoses, we asked the general practitioner if they had ever diagnosed zoonoses. After, the same list was given as to the veterinarians. The question was if they had ever diagnosed these, if yes how often, and if the fact that these infections are potentially zoonotic and may come from dogs was discussed. Explicitly discussed in the interview was, if during anamnesis dog ownership was asked to clients as a diagnostic tool, and what advice was given after diagnosing one of the listed diseases.

## 2.4 - Survey questions

The questionnaire that was handed to 300 inhabitants of Curaçao, collected data on dog ownership and knowledge, and experience with the same diseases as asked of the professionals. Dog owners also answered questions about the living conditions of the dog, use of anti flea products and anthelmintics, removal of ticks and if the dog was ever taken abroad. In the questionnaire we included an example of a well known zoonosis, rabies. Robertson(6) described in his research that the Australian population was more aware of rabies and how this is transmitted than endemic parasitic zoonoses such as *T.canis*. The information about rabies was given after the question “do you think that there are diseases that can go from humans to dogs?” and before the list of selected zoonoses, to explain what a zoonosis is. The questionnaires were translated and available in Dutch, English and Papiamentu. A sample of the questionnaire in English can be found in appendix 1.

## 2.5 - Data analysis

Information from the interviews was summarized per question and all data from the questionnaires were processed in Excel. Data were analyzed using frequencies functions and calculation of Odd's ratios.

## 3.0 - Results

### 3.1 - Literature study

The goal of this research was to study zoonoses that are of public health significance on the island of Curaçao. Not all possible parasitic zoonoses can be discussed because of limited time, therefore a selection has been made of zoonoses, that were thought of to be of high risk on Curaçao. The selection of zoonotic diseases, that are either parasitic or transmitted by parasites, were based on what was found during the literature study. In this chapter the 7 selected parasitic diseases will be discussed, and the reasons why they were selected.

#### 3.1.1 - *Anaplasma* spp.

Anaplasmosis is a bacterial infection that is caused by *Anaplasma* spp.. The genus *Anaplasma* consists of six species; *A.central*, *A.marginale*, *A.bovis*, *A.ovis*, *A.phagocytophilum* and *A.platys*.(12)

*Anaplasma* spp. is a gram negative obligate, intra-cellular bacterium and infection causes thrombocytopenia.(13) Dogs and humans become infected with *Anaplasma* spp. through the bite of an infected tick. Ticks play a role as a vector and get infected by feeding on a reservoir host infected with *Anaplasma* spp.. Human anaplasmosis is caused by the species *A.phagocytophilum*, whereas canine anaplasmosis is caused by both *A.platys* and *A.phagocytophilum*.(13,14)

Dogs and humans are susceptible to infection by many of the same tick-borne-bacterial-pathogens in the order Rickettsiales, such as *Anaplasma* spp. and *Ehrlichia canis*. In February 2010 research has been done on *Ehrlichia* infections on the island Curaçao. In this study 60 dogs were examined and 50 dogs were infected with *Ehrlichia canis*. Ehrlichiose is an infection that is transmitted by ticks. In this study, 89% of the dogs presented to the clinic carried ticks. All the ticks collected from these dogs were *Rhipicephalus sanguineus*.(15)

Although it is not proven that *R.sanguineus* is a vector for *A.platys*, research from Yabsley et al. in Grenada, where there was a high prevalence found of *A.platys* but a lack of other tick vectors than *R.sanguineus*, it may provide additional evidence that it does play an important part as a vector. If *R.sanguineus* is a vector for *A.platys*, it is likely to be found in the same areas where *Ehrlichia canis* is found. Although the *R.sanguineus* tick is not a common human biting tick, it will feed on humans.(16) Therefore, *Anaplasma* spp. has been chosen as one of the zoonoses of interest on Curaçao. We expect that the prevalence of the infection in dogs and possibly humans with *Anaplasma* spp. to be high.

#### 3.1.2 - *Ancylostoma* spp.

*Ancylostoma* spp., also known as hookworms, is a nematode that is commonly found in carnivores in tropical climates, where the abiotic conditions are conducive to the nematode life cycle.(5) Dog hookworm infections, which include *Ancylostoma caninum*, *Ancylostoma braziliense*, *Ancylostoma ceylanicum* and *Uncinaria stenocephala*, are a public health hazard because of its potential zoonotic transmission.(17) *A.ceylanicum* and *A.caninum* are known to use humans as definitive hosts. Mainly *A.braziliense*, but also *A.caninum*, are responsible for the cutaneous larva migrans in man, caused by percutaneous infection of L3 larvae from the environment. *A.ceylanicum* can develop in humans to adult worms, which causes patent enteric hookworm infections.(18) Occasionally, enteric infections with *A.caninum* can lead to eosinophilic enteritis in humans.(6)

Hookworm eggs are excreted in the faeces of infected dogs. L1 larvae develop and moult, and infectious L3 larvae can be ingested after licking or eating contaminated soil or grass or by skin



penetrations.(18)

Bundy and Steele (11) described in their review that the beaches of the Caribbean Island are ideal transmission sites for *Ancylostoma* species; there is a relatively unconstrained dog population, the warm moist sandy conditions optimize larval development and the fact that there is a lot of direct contact between unprotected skin and infectious substrate. Robertson(6) confirmed that soil or sand contaminated by infected dog faeces can lead to the development of cutaneous larva migrans in man, especially in areas of higher humidity. Due to vague clinical symptoms and lack of eggs in human faeces, human *A.caninum* infection is often difficult to diagnose, but a positive association between eosinophilia and/or IgE antibodies for hookworm antigens in human and dog ownership suggest occurrence of zoonotic disease transmission.(19)

Recent research in Brazil and Venezuela showed that *Ancylostoma spp.* was the most prevalent parasite in dogs, significantly more frequent in stray dogs and multi-dog household dogs.(8,10) The combined results from neighbouring and main import countries and the findings of Bundy and Steele earlier on Curaçao concludes that Curaçao is expected to have a high prevalence of *Ancylostoma*.

### 3.1.3 - *Dipylidium Caninum*

*Dipylidium caninum* is a cestode that needs an intermediate host to complete its lifecycle. The intermediate host is the dog flea, the cat flea, the human flea and the dog chewing lice. *D.caninum* mainly infects dogs and cats but can occasionally be found in humans. Adult worms of *D.caninum* develop in the intestines, where they release proglottides which contain egg packets that are passed via the faeces. Humans can get infected by ingesting an infected intermediate host which carries the larvae of *D.caninum*. The cestode cannot multiply in humans because they are not the definite host. This causes a low parasite count in humans.

The zoonose caused by *D.caninum* is called dipylidiasis and is associated with close contact with pets. Infections are worldwide distributed and have been reported on all continents. Depending on the geographic area, the frequency of infections in dogs ranges from 1% to 60%. Symptoms of dipylidiasis in young children are mainly vague and non-specific manifestations, such as diarrhea, alterations in appetite, restlessness, agitation and constipation. Because of these vague symptoms they are often not recognized as *D.caninum* infections.(20)

Rep(2) showed that *D.caninum* was the most frequent of the combined helminthic parasites isolated on the three islands Curaçao, Bonaire and Aruba. Blood and faecal samples showed that out of the 54 examined dogs 25 dogs were infected with *D.caninum*. With a prevalence of 46 % of *D.caninum* infections in the three Antillean islands and because of its worldwide spread it is included in this research to examine if the status of *D.caninum* has changed over the last 25 years on Curaçao.

### 3.1.4 - *Dirofilaria Immitis*

*Dirofilaria immitis*, also known as heartworm, are mosquito-borne-filarial nematodes. Infection occurs when an infected mosquito deposits a L3 of *D.immitis* onto the skin of a host. Dogs, humans, and a very wide range of other mammals, can act as hosts. The larvae enter the bite wound and undergo two moults in the host to become adults, which usually reside in pulmonary arteries and the right ventricle of the heart. Microfilaria can be found in peripheral blood, and can be ingested by mosquitoes. In these newly infected mosquitoes they can develop into infective L3 and so the cycle starts over again. In humans, *D.immitis* larvae follow the same pathway, ending in the lungs where they form typical 'coin lesions'. These lesions are an end-stage result of dead parasites that have stimulated a pneumonitis followed by granuloma formation in the vascular bed of the lungs.(21,22) In dogs, exercise intolerance, coughing, dyspnoea and cachexia are the most typical clinical signs. In

humans, the infection is asymptomatic in 54-80% of the reported cases. If symptoms are present, they include coughing, chest pain, fever, hemoptysis, and pleural effusion. Human dirofilariasis is found worldwide, but most cases are reported in areas with high canine prevalence.(21) For over 50 years *D. immitis* is endemic in the USA, and has spread southward towards the Caribbean. Hesselink(23) tested blood samples of 631 dogs on Curaçao, of which 10% were found to be infected with *Dirofilaria*. Of this positive group 39% were asymptomatic carriers. The total group showed an increase in prevalence with age. It seems probable that latent infections in man in the Caribbean exist, given the high regional prevalence of canine infection and the high numbers of vectors present.(11)

### 3.1.5 - *Giardia lamblia*

*Giardia* is an intestinal protozoan parasite that is frequently detected in humans and animals. It colonizes the small intestine of susceptible hosts, where it replicates. Cysts can be formed as the parasites transit toward the colon.

The morphological group of importance for humans and domestic animals is *G.lamblia*. There are 7 different genotypes of *G.lamblia*: humans are infected with type A and B, dogs primarily with C and D. Occasionally, dogs carry type A, and, less frequently, type B.(24) For many years, the role of animals in the transmission of giardiasis is debated. The vast majority of human infections are expected to be man-to-man transmission. However, now that it is clear that dogs can carry the same genotypes of *G.lamblia* as humans, dogs are potentially infective to humans and therefore a zoonotic hazard. An infection with *G.lamblia* in dogs is rarely associated with clinical illness, and if so, most cases are associated with kennel situations.(6) Infection with *Giardia* can occur by the faecal-oral-transmission of cysts, through poor hygiene, or by ingestion of cysts in contaminated water or food. Katagiri & Oliveira-Sequeira(8) examined faeces of both stray and domesticated dogs in Brazil, and showed an association between *Ancylostoma spp.* and *Giardia spp.*, and a higher prevalence of both in stray dogs. This combination of infection was the most common in dogs harbouring two or more parasitic species

Giardiasis is a worldwide spread common infection; the association with *Ancylostoma spp.*, the relatively high number of stray dogs and dogs from kennels and the transmission from dog to human makes it worth investigating the prevalence on Curaçao.(6,24)

### 3.1.6 - Scabies

Scabies is a worldwide spread common parasitic infection caused by the mite *Sarcoptes scabiei* and a major health problem in many indigenous and third world communities. Scabies is endemic in many tropical en subtropical areas such as Central and South America, Africa, India, South-east Asia and the Caribbean islands.(25) Little reliable information is available on the incidence, distribution and occurrence of scabies worldwide, though Henge et al. suggested that there would be 300 million cases around the world of humans infected with *S.scabiei*.(26)

The *S.scabiei* mite causes sarcoptic mange in different kinds of domestic and wild mammals. *Sarcoptes* comes in many related, but different strains that are compatible with the requirements of various hosts. *Sarcoptes scabieis hominis* is the main cause of mange in humans and *Sarcoptes scabiei canis* is most seen on dogs. Nevertheless, human infection with canine scabies is a frequent seen zoönose, due to prolonged skin to skin contact between man and dog. Diagnosing sarcoptes is found to be difficult, therefore human cases of canine sarcoptes are probably under-diagnosed in the daily practice.(27)

Scabies mostly occurs in stray and weakened dogs, but it can occur on all animals. On Curaçao the average of dogs per square kilometres are estimated at around 200, so close contact with dogs is inevitable and scabies might be a hazard for the inhabitants and the many tourists visiting the island.

### 3.1.7 - *Toxocara canis*

Toxocariasis is a zoonotic disease caused by *Toxocara canis*. Human toxocarosis is one of the most common parasitic infections around the world, which affects mainly developing countries and poor communities. It is caused by ingesting the eggs which originate from the faeces of the definite dog host.(28) Human toxocarosis is mostly asymptomatic. Larvae hatch from the eggs in the intestines, penetrating the mucosa, entering the portal circulation and could possibly become encysted in various organs. The life cycle of the parasite cannot be completed in humans because they are prevented from coming back to the intestines where they normally go to in dogs, to lay eggs. Therefore neither eggs nor larvae are passed in the faeces of humans. As a consequence only non-specific symptoms or clinical criteria are available for presumptive diagnosis. Even the relatively rare cases of ocular larva migrans can be mistaken for retinoblastoma and therefore wrongly diagnosed.(29)

The transmission dynamics of infections caused by *T.canis* are influenced, by the following epidemiological factors; the prevalence of infection in the local dog population; the size of the local dog population; the degree of dissemination in the human population; and its exposure-related behaviour. Any combinations of these factors contribute to the observed high prevalence of toxocarosis in Caribbean children.(30)

In 1975 an investigation has been done by B. Rep into the prevalence, size and identity of populations of intestinal helminthes on the Dutch Antillean islands. This research showed that of the 54 dogs that were examined only 3 were infected with *T.canis*, which compared to Aruba, where 10 out of 27 dogs were infected with *T.canis*, is not much. This study was done by checking for worms in the bodies of dogs. No ELISA or faecal samples were used for diagnostics.(2) A study in 1986, analyzing blood and faecal samples of 133 dogs, showed a prevalence of *T.canis* infection of 10,3 % in domestic dogs and 3,4 % in feral dogs.(31) The results of this second research implicate that diagnostic methods used in 1975, might not have been accurate.

The higher prevalence of *Toxocara* in domesticated dogs than in feral dogs makes it easier for people to come in contact with toxocara. Also, in both researches, no distinction was made between the ages of the dogs. Younger dogs and puppies have a higher prevalence of intestinal parasitic infection than older dogs. This is mainly due to the fact that young dogs have not yet acquired immunity to parasites and that certain modes of transmission are exclusive to neonates. Ramirez et al.(10) showed that *T.canis* infections were significantly more prevalent in younger dogs between the ages of 0-6 months than in older dogs. The transmission *T.canis* to humans is by oral ingestion of soil contaminated with eggs, either from unwashed hands or raw vegetables.(18) Especially children are more prone to get infected through more contact with contaminated soil.

## 3.2 – Interviews with Veterinarians

### 3.2.1 - Demographic factors

10 Different veterinarians were interviewed during this study. All of the veterinary clinics were in principle small animal practices. The practices were widely distributed over the island and the economic statuses of the clinics were ranged from low to high economic standard. 25% of the clinics were in high socio-economic areas and the rest was evenly divided between low and middle socio-economic standard. The clinics differed in size, number veterinarians working there and number of dogs they have visiting every week. Some of the clinics had up to 4 veterinarians working at the clinic or at dependences, while others were running the clinic by themselves. One of the veterinarians worked at the clinic of the animal shelter and therefore had no or little contact with the owners; the clinic treats animals that are brought in from the street or are neglected by their owners and these animals are being rehomed.

### 3.2.2 - Recommended deworming and vaccination protocols

The vaccination protocols differed slightly in each of the clinics, but in general an extra vaccination of parvo has been added to their protocol in comparison with the common Dutch protocol, this was due to the high prevalence of parvo infections on the island. Most people come to the clinics to get their puppies vaccinated but don't come back afterwards for their yearly vaccination, or even stop halfway during the puppy vaccination. The vaccination status on the island is low. In case of an outbreak, mostly of canine distemper, people will visit their veterinarian for a single vaccination. A difference is seen in the loyalty of owners getting their dogs vaccinated and the economical status of the neighbourhood the clinics are stationed at. In clinics with lower socio-economic standards the number of owners who come back for their yearly vaccination is lower than in neighbourhoods with medium to higher standards. In neighbourhoods with low to middle socio-economic standards, 50-60 % of the owners come back for their yearly vaccination and in the high socio-economic neighbourhood this was 80-90 % of all owners. Most of the clinics send a reminder by mail and email or make a phone call to the owners informing them about the yearly vaccination.

The deworming protocols are more or less the same in each clinic. They advise owners to deworm their dogs at least 2 times a year and start with puppies from the age of 2 weeks. Heartworm medication is advised to be given once a month. On average, 50% of the owners were loyal with deworming their dogs and coming to the clinic to get anti-helminthics. Some owners only came when they suspected the dog of having worms.

The problems these veterinarians were having were that not all owners are loyal or have enough money to get their dogs vaccinated and dewormed even though they emphasise the importance of vaccinations and deworming. Also some veterinarians said it is hard to keep track of which owners vaccinate their dogs, because pet stores on the island sell vaccinations and anti-helminthics.

### 3.2.3 - Perceived prevalence of zoonotic diseases

The veterinarians were asked if they have seen or diagnosed any of the selected zoonoses. Results are shown in figure 1.

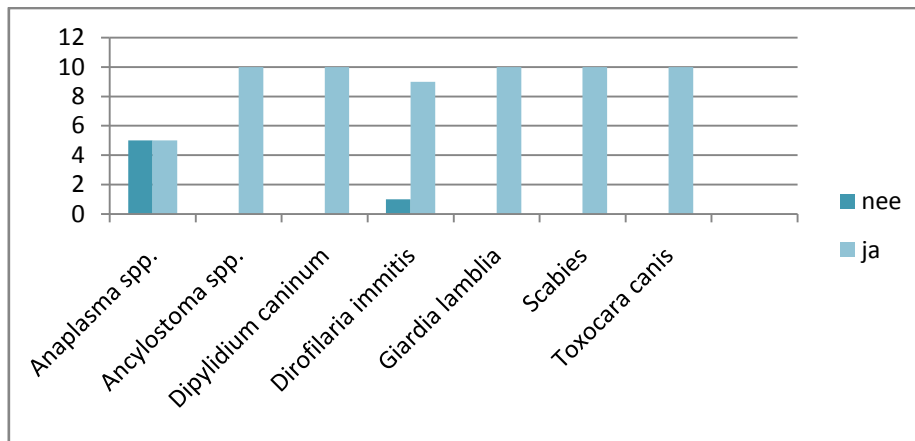


Figure 1: Prevalence of selected zoonoses according to the interviewed veterinarians

All the veterinarians knew the selected zoonotic infections and all infections were diagnosed on Curaçao.

Some of the clinics were not able to perform diagnostic test on *D.immitis* and *Anaplasma spp.*. 5 out of 10 veterinarians have diagnosed anaplasmosis with an average of 4 times a year. These diagnoses are mostly coincidental due to the test that is used; these clinics used the 4Dx snapstest for Ehrlichia, one of the most common infections on Curaçao, which also shows *A.platys*. The other clinics that did not diagnose anaplasmosis used the 3Dx snapstest that does not show *A.platys* or did not test for Anaplasma at all. Ancylostoma had a wide range of how often it was diagnosed; some of the veterinarians hardly ever diagnosed it, while others saw it in all the young puppies that came in to the clinic. A lot of variation was also seen in the frequency of *D.caninum* infections, most veterinarians saw a periodical change in prevalence during June, July and August, these months are slightly warmer and more humid, which causes an increased numbers of fleas. During the last two years, after hurricane Tomas, the veterinarians registered an increase in *D.immitis* infections. This increase was related to the large numbers of mosquitoes on the island after Tomas. In dogs with typical symptoms and from the age of 4, about 50% tested positive for *D.immitis*. In dogs with no clinical symptoms 10-20% tested positive. *G.lamblia* is most seen in puppies and often as a secondary infection and remarkably is that some veterinarians noted that coccidiosis is a bigger problem than *G.lamblia*. Scabies is often seen in the clinics, about twice a month, and it mostly infects stray dogs. Most veterinarians diagnose *T.canis* in puppies, an average of 60% of the puppies being infected. Other zoonotic infections that were not on the list and noticed by the veterinarians in the clinics were ringworm, coccidiose and Ehrlichia. 6 out of 10 veterinarians have seen ringworm and 4 of them have seen coccidiose at their clinic, although specific species of coccidiose have not been identified.

### 3.2.4 - Client education

All veterinarians informed the owners of dogs about the importance of vaccination and deworming. Some would especially emphasize this to the owners of puppies as they tend to be more attentive and tend to receive the information better. The risk of owners getting a zoonotic infection from their dog is not mentioned as a preventive measure. When a dog is presented with a disease that might be of zoonotic potential hazard or when owners ask about the infections, the veterinarians will inform the owner to be careful and take extra hygienic precautions. With most of the zoonoses that were selected, the owners are told of the risk of getting the infection themselves after it is being diagnosed in their dog. Concerning scabies it is told that the infection might be transmittable but that chances are low of catching it themselves. Some veterinarians ask if the owner themselves suffer

from any symptoms possibly related to scabies. After their dog has been diagnosed positively with *A.caninum*, *D.caninum*, *T.canis* or *G.lambliia*, they ask the owners specifically if they have children and if so to take extra care. The zoonotic potential of *D.immitis* was not known by any of the veterinarians and therefore owners were not informed.

### 3.3 – Interviews with GPs

#### 3.3.1 - Demographic factors

10 Different GPs were represented in this study. They differ in years in practice, the number of patients they see weekly, clinic size, how they are distributed on the island and the socio-economic status of the practice. 50% of the practices were located in areas of low socio-economic standard. The rest were evenly distributed over middle and high socio-economic areas.

#### 3.3.2 - Perceived prevalence of zoonotic disease

Before being given the list and being asked about ever diagnosing any of the selected zoonotic infections, 7 out of the 10 GPs knew what zoonoses were gave an example of one of the zoonoses as seen in their daily practice. Results are shown in figure 2.

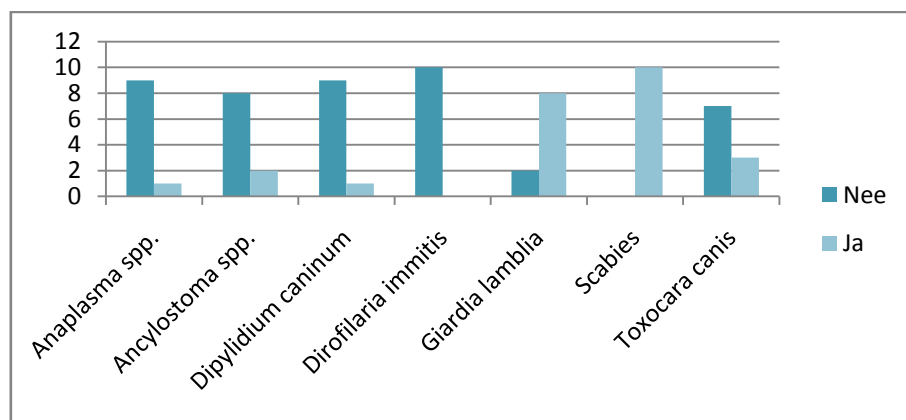


Figure 2: Prevalence of selected zoonoses according to the interviewed GPs.

9 out of the 10 GPs never diagnosed *Anaplasma spp.* or did not know about it. 1 GP suspected an infection of *Anaplasma*, however the diagnosis was never confirmed. Most of the GPs knew *D.immitis* as a canine disease, but none of them knew it has zoonotic potential, therefore it was not included in their differential diagnosis. Scabies was by far the best known and most diagnosed zoonosis. On average scabies is seen 7 times a year. Most GPs have seen a decline in the number of scabies patients over the last years. After scabies, *G.lambliia* is the most frequently seen by the GPs, with an average number of 5 cases a year. Most giardiasis patients were children and people with low hygienic standards. Some of the GPs have seen *Ancylostoma spp.*, *D.caninum* and *T.canis*, although most patients with worm infections were treated without a definitive diagnosis. Another zoonotic infection that was not selected but was seen by 9 of the 10 GPs was ringworm. About 30% had hardly seen it, 70 % diagnosed it on regular basis.

### 3.3.3 - Client education

Half of the GPs included the question “do you own a dog?” in the anamnesis; Some of the GPs always asked this, others only asked when scabies and ringworm were a possible diagnose or when patients were having vague gastro-intestinal symptoms that might be related to giarda or worm infections. The other half never thought to include dog ownership in the anamnesis.

When one of the selected zoonotic infections was diagnosed, some of the GPs would ask if the dog showed symptoms, especially with scabies and ringworm and they would advise to go see a veterinarian. Most of the GPs would not inform the patient that the disease might have been transmitted by their dogs. Advice given to the patients was that they should be careful with their surroundings, for example not to let children play in the sandpit, instead of cautioning them about the risks of having a dog. Patients are given advice on hygiene regarding them, but not regarding their dog.

### 3.4 - Questionnaire

300 Random inhabitants of Curaçao were asked to fill in a questionnaire. The first question was if they had a dog or previously had a dog, and, if yes, how many dogs they had. Results are shown in table 1.

No	107
Yes, one dog	89
Yes, two or more dogs	104

**Table 1:** Answers to the question “Do you had a dog of have you previously had a dog?”

Given this is a representative random sample, 63% of the inhabitants of Curaçao have, or previously had, dogs.

The total of 193 dog owners or former dog owners answered 6 questions that non dog owners did not have to answer, these question were about the circumstances of how the dogs were kept. The outcomes on these questions (2-7) are summarized in figure 3. These were asked because all of these factors can possibly contribute as a risk in getting a parasitic zoonotic disease. To test if these risk factors were of influence on the number of dogs infected with one of the selected disease, odds ratios and frequencies were calculated. No significant differences were found between the groups in the questions 2, 4, 5 and 6. Question 3 showed a difference between keeping dogs loose or on the chain (figure 4).

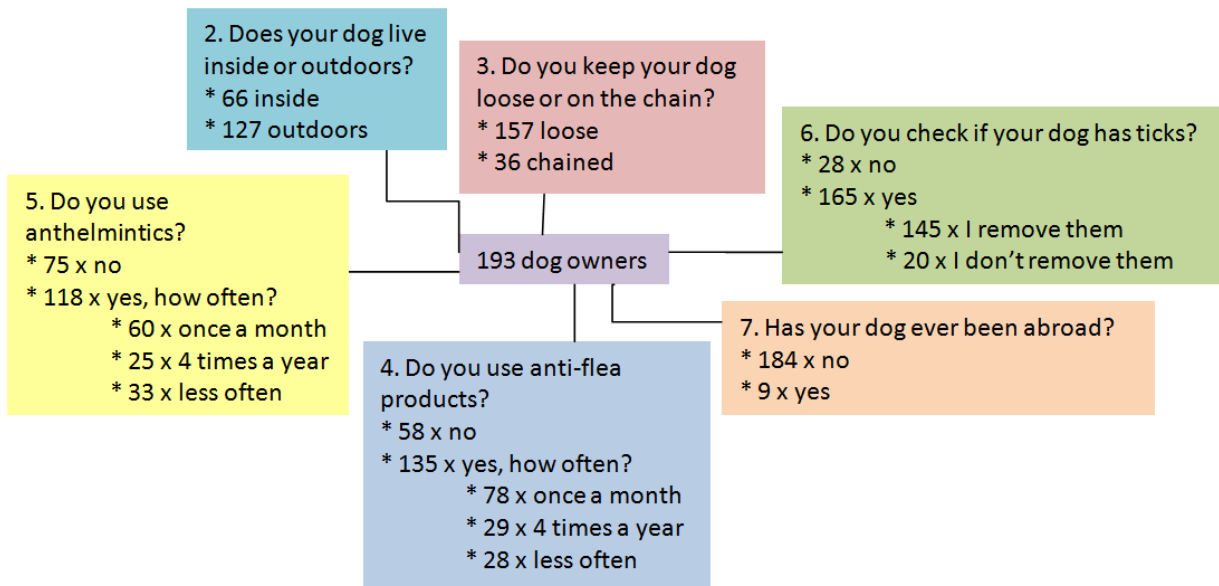


Figure 3: Summarized answers of dog owners on how the dogs were kept.

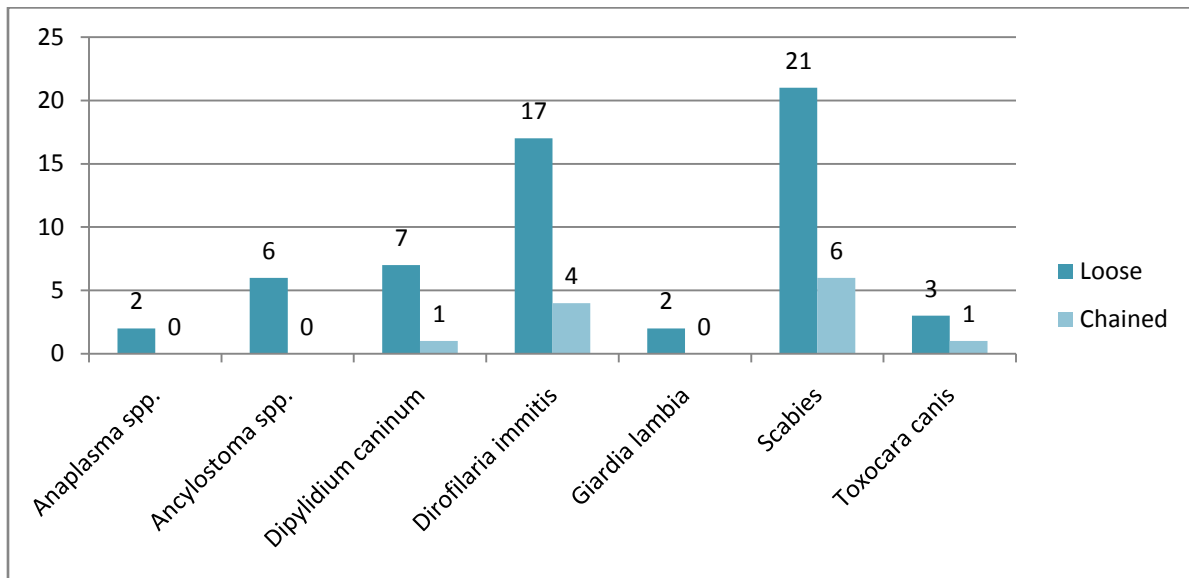


Figure 4: Number of loose and chained dogs, divided over the selected zoonoses.

All 7 selected zoonoses were found more often in the group of loose dogs, than in the group of chained dogs. It must be mentioned that the loose-dogs-group was bigger than the chained-dogs-group, but if this is corrected, most diseases still are seen more in the loose group than in the chained group.

9 Out of the 193 dog owners either imported their dog from another country or travelled with their dog abroad. When taking a dog abroad or importing a dog from another country, precautions have to be taken. The dog has to be vaccinated according to what the restrictions for that country are. In all countries a rabies vaccine is mandatory and in some countries deworming is also mandatory. Therefore the assumption is made that owners who travel with their dog abroad or have imported their dog should have heard about these zoonoses and that they might know of other zoonotic diseases. 6 out of the 9 owners, 67%, knew about there are diseases that can be transmitted from



humans to dogs. Of all 300 respondents, 53% knew that there were diseases that are transmittable from dogs to humans.

Question 8 was for all the respondents; do you think there are diseases that humans can get from their dog. A total of 142 (47%) answered no, the other 158 (53%) answered yes. The answer to this question was linked to dog ownership (question 1). Results from these combined answers are in figure 5. 62% of the non dogs owners knew what a zoonose was compared to 52% of the dog owners.

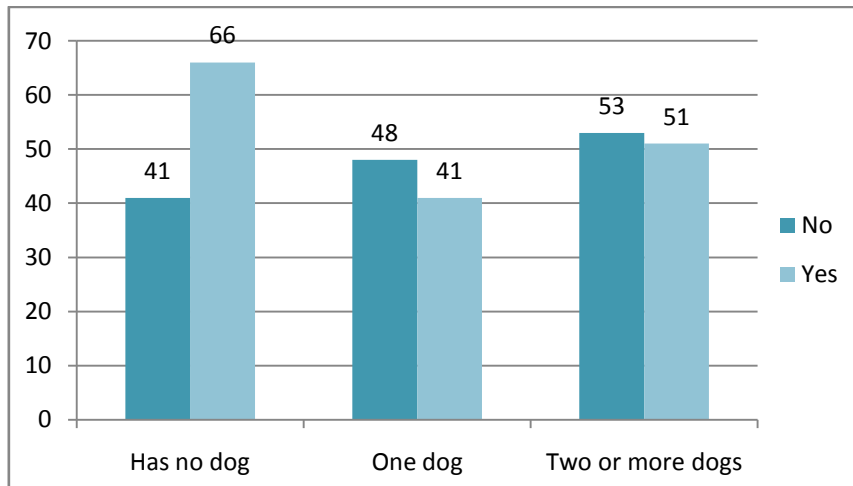


Figure 5: Combined answers on dog ownership en (knowledge) of zoonoses.

After this, the questionnaire continued on a new page, starting by explaining what a zoonosis is, to be sure it was clear to all respondents what the questionnaire was about.

Respondents were given 7 names of parasitic zoonoses and they were asked if they knew these diseases, if they had it themselves or if the dog had had it. Results are in shown in figure 6; numbers on top of the bar are times that people answered yes to these questions.

Only 4 people (1.3%) have had one of the selected zoonoses themselves; 1 case of dipylidiasis, 1 case of giadiasis and 2 respondents have had scabies. These 4 cases of human illness were in all the different groups, 1 had no dog, 2 had dogs that lived inside and 1 had a dog living outside.

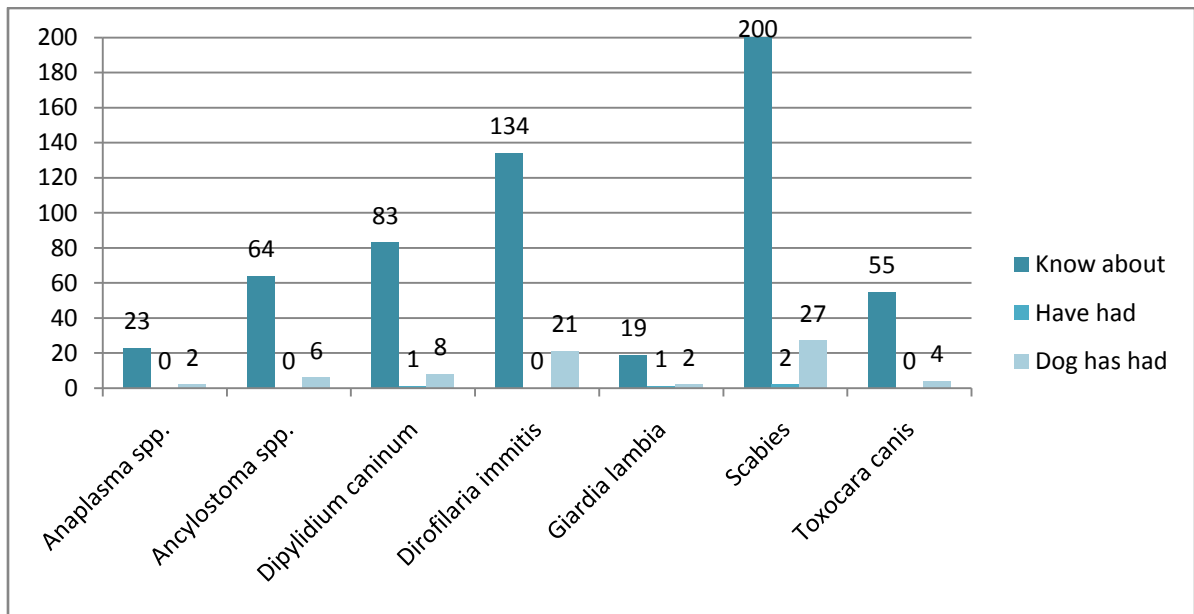


Figure 6: Number of people that knew the selected zoonoses, have had the diseases themselves and number of dogs that had the diseases.

The respondents were asked if they had dogs and if they knew that there are diseases that can be transmitted from dogs to humans. Participants were divided into three groups; Non dog owners, dog owners with one dog and dog owners with 2 or more dogs. Non dog owners more often answered that they knew of diseases which can be transmitted from dogs to humans, but they knew less different diseases. On average they knew 1,9 of the selected zoonoses, whereas owners with one dog knew 1,3 zoonoses and dog owners with two or more dogs knew 2,5 diseases. Figure 7 shows the distribution of the respondents over the number of the selected zoonoses that they had heard of.

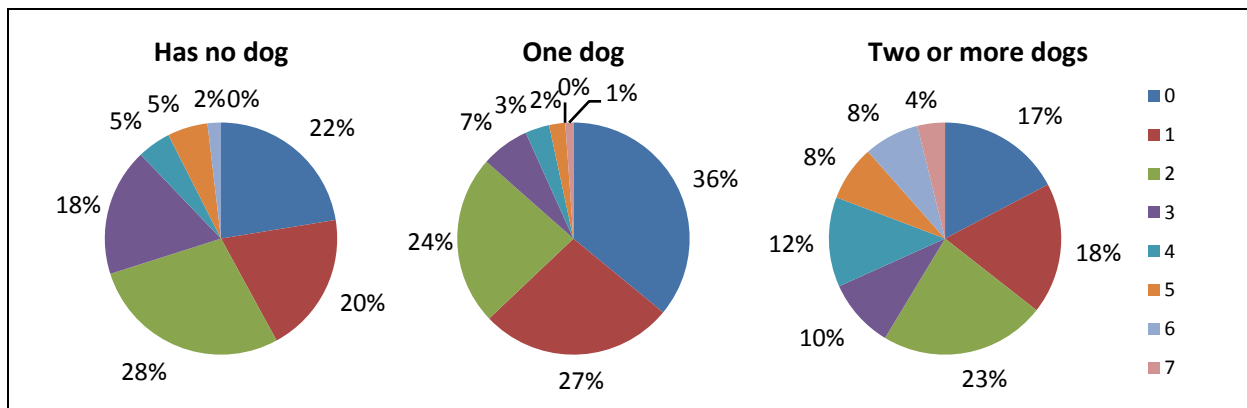


Figure 7: Piechart of the respondents that owned a dog, have 1 dog or have 2 or more dogs combined with percentages of how many of the selected parasitic zoonoses they had heard of.

For all 7 zoonoses the answers if people knew it, were combined with dog ownership, results are shown in figure 8. Scabies was known by most people, 200 out of 300, followed by *D. immitis*.

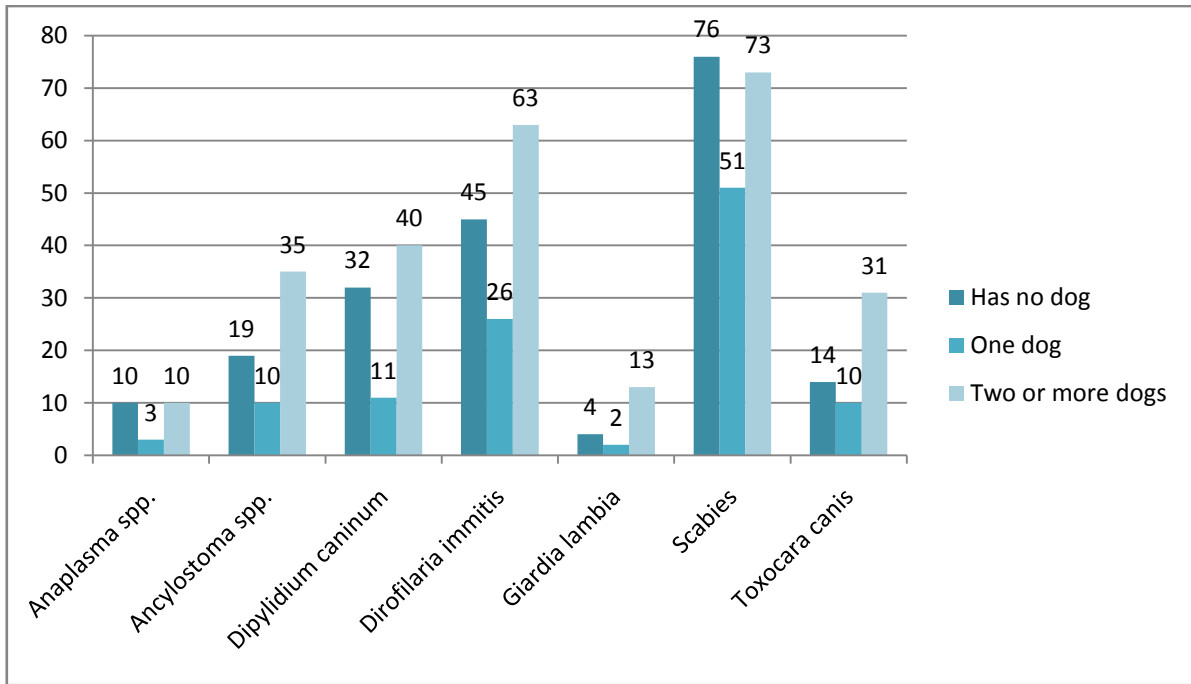


Figure 8: Combined results of knowing the zoonoses and owning a dog.

In the last question we asked the respondents now they know what zoonoses are, what extra precaution they would take to lower the risk of infection, a list of options was given: (more use of anti-flea products, (more) use of anthelmintics, check the dogs for ticks and remove them, remove the dog poop, better hygiene, inform children about proper handling dogs and if they would like more information about the diseases. In figure 9 results are shown. Better hygienic precautions were chosen by most respondents, 195 out of 300, followed by getting more information.

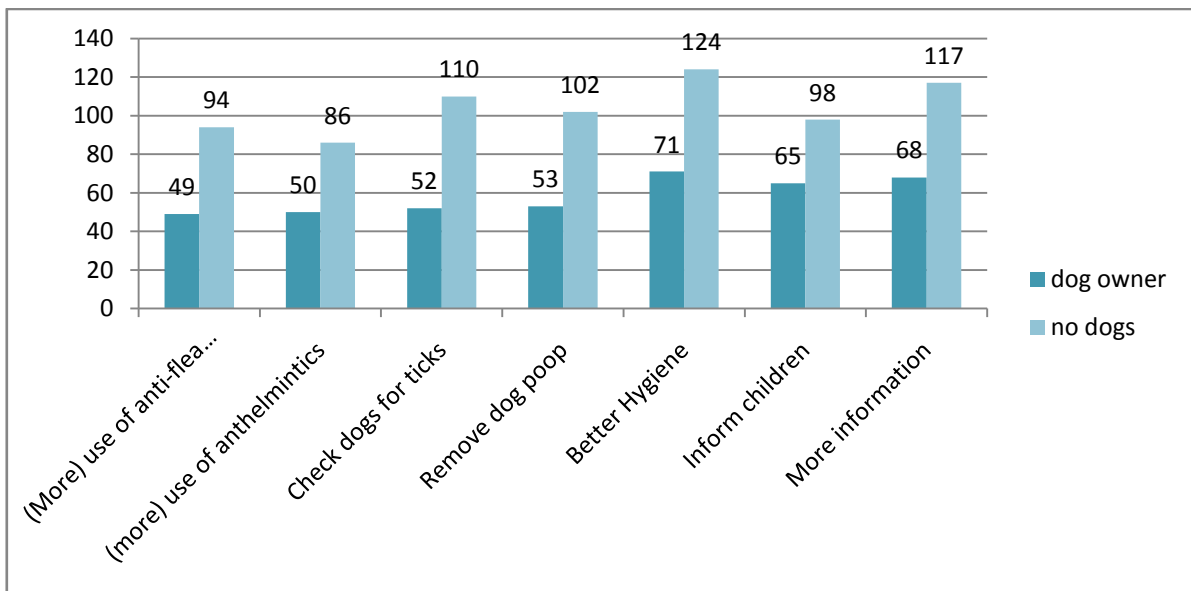


Figure 9: Number of respondents who would take extra precautions divided into dog owners and non dog owners.

## 4.0 - Discussion

The goal of this research was to see if this literature is still valid on the recent status of the zoonotic parasites of the dog and to get a general view of the recent clinical situation, knowledge and awareness concerning these on Curaçao. During the literature study it became clear that the definition of a zoonosis is widely interpreted. The definition used in this study describes zoonosis as a disease that can be transmitted from dogs to man, either direct or indirect via the environment or vector.(18) According to this definition, all of the selected diseases are zoonoses

All the veterinarians knew or had heard of the selected zoonoses and all infections were diagnosed on Curaçao. GPs diagnosed *G.Lambliia* and scabies in humans on a regular basis, whereas the other zoonoses were never thought of or never seen by most of the GPs. When comparing these findings with the results of the questionnaire, a resemblance is seen; only 4 of the respondents had had one of these zoonoses, 64 dog infections were counted. The dog infections were distributed over all 7 diseases while the human cases were cases of giardiasis, scabies and dipylidiasis. Results showed with both veterinarians (6 out of 10) and GPs (9 out of 10) that ringworm infection, a zoonosis that was not included in the selection of zoonoses, was very commonly diagnosed. Especially the GPs have seen ringworm often, and to confirm the diagnoses samples from patients were sent to the laboratory. Most GPs send their samples to 'Analytisch Diagnostisch Centrum'(ADC), who was willing to share the results of the samples that were sent in with us. In 2011 there were 48 cases of Trichophyton infections; 13 *T.mentagrophytes*, 8 *T.rubrum* and 27 *T.tonsurans*. In 2012 so far there was one case of *Microsporium canis* and 36 cases of Trichophyton infections; 7 *T.mentagrophytes*, 1 *T.rubrum* and 28 *T.tonsurans*. *T.rubrum* and *T.tonsurans* are anthropophilic, which makes that they are mainly found in humans and very seldom transmitted to animals. *T.mentagrophytes* is zoöphilic and therefore mainly found in animals, but can be transmitted to humans. *M.canis* is the most common fungus in dogs and cats, *T.mentagrophytes* are found occasionally on these animals.(32) The numbers of ADC can explain why GPs see ringworm more often than veterinarians, but it must be noted that ADC is not the only laboratory for diagnostics on Curaçao. Furthermore, ADC could provide us the number of cases of *G.lambliia* infections; there were 54 cases in 2011 and in 2012 so far 31 cases. The interviewed GPs diagnosed *G.lambliia* with an average of 5 times a year.

Nowadays, international travel and trade gives diseases more potential to spread over the world.(19) Worldwide the prevalence of intestinal helminths has declined over the last 20 years, probably due to the ready availability of safe and effective drugs to eliminate these infections by pets. Nevertheless, differences in detected number of parasites between studies may be due to factors such as environment and climate.(6) A tropical climate with high humidity and temperature causes higher diversity in parasites and a longer survival time of the developmental stages.(10) The likelihood of transmission of zoonoses to humans also depends upon the genus and species of the involved parasite. Because of alterations in habits of humans and their pets, new pathways of transmission develop, leading to emerging and re-emerging of parasitic disease.(6)

With the occurrence of emerging zoonoses, pet ownership is an important risk factor. Results showed that *T.canis* and *G.lambliia* are most often seen in puppies. This is in line with result from Robertson(6), who reported that Toxocarosis occurs more frequently in households with puppies rather than adult dogs. The risk increases in households with children that have a habit of geophagia. Also, when households adopt an animal, most of the time it is a young pet rather than an older animal, and puppies have a potentially higher prevalence of parasitism. Puppies are frequently acquired by young families whose members have a greater chance of getting infected through close contact with their pet. In shelters, dogs live in close proximity to each other with higher rates of infection. These dogs do not constitute a direct risk to the general public, but once they are rehomed

they might pose a risk to the new owners. It is important that shelter dogs receive proper treatment before being rehomed.

In a multi-dog household, the chances of dogs being infected with giardia are increased.(6) Results from this study could not confirm this statement. Only 2 out of the 64 dogs were infected with *G.lambliia*. Although both were found in a multi-dog household, this number is too low to draw conclusions from.

On the one hand, the owners who pay little or no attention to their animals have an increased risk of getting infected, because of lack of attention and medical care for their dog.(33) On the other hand, people who have close associations with pets, such as breeders, groomers, veterinarians and veterinary nurses are at increased risk.

Results from the survey showed that 60% of the respondents use deworming products for their dogs, of whom, more than 30% stated to use these every month. More than 40% of the respondents use anti-flea products monthly, 30% less often. Although it was not part of the questionnaire, most of the respondents mentioned which product they were using. Part of the products was acquired via the veterinarian, but some were home made products, such as motor oil or vitamin water. In future research the question 'what kind of products do you use' should be added to the questionnaire. That way a differentiation can be made between the correct way of deworming and anti-flea treatment and products which effectiveness are unknown and not proven. Although 60% of the respondents claimed to use deworming products, information obtained from inhabitants is probably not always reliable, as the questions might have been misunderstood. To prevent this, survey questions were word clearly and surveys were available in Dutch, English and Papiamentu. Apart from misinterpretation of the questions, some dog owners feel ashamed admitting they did not give deworming or anti-flea products to their dog and give the desired response, rendering the question, in part, unreliable.

The importance of client education is crucial to the control of zoonotic parasitic infections. Both GPs and veterinarians play a vital role in educating their clients. Stull(9) stated that GPs are less involved and comfortable with this than veterinarians. During the interviews it was noted that most veterinarians informed their clients when their dogs were infected with a zoonosis, GPs however failed to inform their clients about the source and transmission routes of most zoonoses. This might be due to lack of knowledge of zoonoses, not thinking of the dog as a possible source of infection, and not asking about pet ownership in the anamnesis. 3 out of the 10 GPs did not know what zoonoses were and could not name an example, and 50% never asked about the ownership of a dog during anamnesis. After diagnosing scabies, 3 out of 10 GPs warned clients about the possibility that they might have caught it from their dog and advised to visit a veterinarian. 9 out of the 10 GPs did not know or had heard about Anaplasma. None of the GPs and veterinarians were aware of the zoonotic potential of *D.immitis*, considering heartworm infections in dogs are of major concern on Curaçao.

The veterinarians explained more often about the zoonotic potential of the selected infections. With scabies they asked the owners if they had complaints or symptoms that might be related to scabies and with *G.lambliia* and *T. canis* infections they warned owners to watch their children, because of the higher risk of children getting infected. Nevertheless, veterinarians and GPs never informed clients about zoonoses as a preventive measure. It is important to educate clients preventatively, making them aware of the potential hazards, and more willing to take preventive measures against zoonotic infections. Robertson(6) described a study in Australia; most pet owners were aware of zoonotic parasites and therefore used anthelmintics on a regular basis. Some of the interviewed veterinarians said they were apprehensive in telling the owners about diseases they could get from

their dogs, because they were afraid it might scare people off and they would abandon their dog. People on Curaçao are not as close with their dogs and often do not have a lot of money to spend on veterinary care, dogs are primarily used as guard dogs and kept outside. For this reason the GPs do not take dogs into consideration during anamnesis. However, results from the survey showed 34% of dog owners kept their dog inside the house.

Informing people is about creating awareness and thereby hopefully limiting the risks of getting infected with a zoonosis. Owners have to learn not to be scared but to be careful. Often, human actions cause infections in humans and dogs. To break this cycle of transmission and to control zoonotic infections, it is important to educate. The cycle of transmission can be broken by simple measures such as washing hands and cleaning the environment of the dog, deworming dogs, supervising small children and dog interaction, disposal of faeces from the garden and telling children how to properly handle the dog, thus preventing faecal-oral transmission.

When asked what extra precaution the respondents would take to lower the risk of zoonoses, most people answered to clean better, better hygiene, and 185 respondents stated that they would like more information. Most of these preventive measures must be done by the owners, outside the veterinary practice; to stimulate people to do this at home, awareness must be created by the veterinarians. Results from this study show that most owners do not go to the veterinarian often, therefore correct instructions about deworming should be available, to be carried out at home. Only one of the veterinarians gave advice about deworming more often when it concerned families with small children. As most new clients do not visit the veterinary clinic until the puppy is 6 weeks of age, advice must be given to clients who have pregnant or newborn animals at home.(9)

This research has given an indication about the zoonoses of importance on the island by doing a literature study and interviewing GPs, veterinarians and inhabitants. Further research into the prevalence of these zoonoses should be done by collecting faecal and blood samples of both humans and dogs. The collected data should give a better indication of the actual numbers of infected humans and dogs and whether they carry the same parasites. Without these actual numbers it cannot be concluded that there is a public health problem. After the literature study it was expected that all of the selected parasitic zoonoses were of concern on Curaçao, but observed prevalence by GPs could not confirm this. Only *G.lambli*a and scabies were diagnosed in both humans and dogs on a regular basis. There is a possibility that the numbers of cases of the other selected zoonoses are under-diagnosed due to lack of knowledge. If the knowledge towards zoonoses increases, GPs are more likely to take these in consideration during the anamnesis and the differential diagnosis. GPs and veterinarians have to communicate about zoonoses of importance on Curaçao, by sharing information on zoonoses concerning dogs and the corresponding correct treatments. General knowledge should be kept up to date, especially concerning *D.immitis*. Results from the interview showed that *D.immitis* is an upcoming infection in dogs on Curaçao and knowledge concerning its zoonotic potential was absent. Studies about *D.immitis* infections in humans and how to diagnose these are trending. Veterinarians and GPs should keep a close eye on the developments of these studies.

Education and awareness are some of the most powerful tools in reducing the prevalence and incidence of zoonotic parasitic infection in both dogs and their owners. Veterinarians, who are up to date with recent developments on zoonotic diseases, can be the main source of information for pet owners. The government can help improving public health by alerting people about emerging zoonoses on the island and taking measures against pet shops and other shops where incorrect information and medication are given. By working together the prevalence of zoonotic parasitic infections can be decreased.

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## 7.0 - Appendix 1

### Questionnaire

1. Do you have a dog or have you previously had a dog?
  - No → Go to question 8
  - Yes → How many dogs do you have? .....
  
2. Does your dog lives inside or outdoors?
  - Indoors
  - Outdoors
  - Both
  
3. Do you keep your dog loose or on the chain?
  - Loose
  - Chained
  
4. Do you use anti-flea products?
  - No
  - Yes → How often?
    - Once a month
    - 4 times a year
    - Less often, i.e.: .....
  
5. Do you use anthelmintics (deworming medication, also includes heartworm medication)?
  - No
  - Yes → How often?
    - Once a month
    - 4 times a year
    - Less often, i.e.: .....
  
6. Do you check if your dog has ticks?
  - No
  - Yes → Do you remove these?
    - No
    - Yes
  
7. Has your dog ever been abroad?
  - No
  - Yes → What country? .....
  
8. Do you think there are diseases that humans can get from dogs?
  - No
  - Yes

**Continue on the back of this sheet.**

*There are diseases transmittable from animals to humans, they are called zoonoses. A well known example is rabies. Rabies is transmitted from dogs to humans via saliva, for example by being bitten.*

9. Which of the following diseases do you know? And did you, or your dog ever had any of these diseases? Cross off the diseases you know about, you might have had, and/or your dog might have had.

<b>Disease</b>	<b>Know about</b>	<b>You have had</b>	<b>Dog has had</b>
Ancylostoma canis Hookworm			
Toxocara canis Dog roundworm			
Dipylidium caninum Dog tapeworm			
Dirofilaria Immitis Heartworm/Lungworm			
Anaplasma Anaplasmosis			
Scabies Mange			
Giardia Giardiasis			

10. Now that you know (or already knew) what zoonoses are, would you take extra precaution to lower the risk of getting these diseases (because it is also a risk to human)? What would you do?

- (More often) use of anti-flea products
- (More often) use of anthelmintics (deworming medicine)
- Check the dog for ticks and remove these
- Remove dog poop
- Clean better (washing hands, better hygiene, etc.)
- Inform children about proper handling of dogs
- Get more information

**Thank you for completing the questionnaire!**