KNOWLEDGE, ATTITUDE AND PRACTISE TOWARDS HEARTWORM DISEASE AMONG DOG OWNERS IN KLANG VALLEY

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Knowledge, Attitude And Practise Towards Heartworm Disease Among Dog Owners in Klang Valley

By

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KNOWLEDGE, ATTITUDE AND PRACTISE TOWARDS HEARTWORM DISEASE AMONG DOG OWNERS IN KLANG VALLEY

ABSTRACT

Canine heartworm disease is a relatively common vector-borne disease in Malaysia. Administration of heartworm preventative products works in reducing the risk of infection. Therefore, this study investigated the knowledge, attitude and practice of dog owners in Klang Valley towards heartworm disease that in a way assesses the beliefs and behaviours of the dog owners. 144 dog owners living in Klang Valley had participated in this cross-sectional questionnaire study. The majority of respondents (70.1%) were aware of the presence of heartworm disease in dogs where most of them have good knowledge (54.5%), attitude (68.3%) and practice (80.2%) towards heartworm disease. It was found that the education level of respondents has significant association with the attitude towards heartworm disease. Cost (40.9%) was the main barrier to respondents towards heartworm disease prevention. Unsurprisingly, price (25.1%) is the major factor influencing the respondents in choosing the heartworm prevention products. Veterinarians are the major source of information regarding heartworm disease (42.3%) and heartworm prevention products (50.6%), it is evident that the veterinarians played a significant role in the awareness of heartworm disease in dogs. All in all, most of the respondents are aware and have good knowledge, attitude and practice regarding heartworm disease in dogs but there are still a minor portion of respondents who have not heard about heartworm disease before. Hence, this indicates that further promotion of heartworm disease awareness should be done.

Keywords: Canine, Heartworm, Vector-borne disease, Prevention, Awareness

PENGETAHUAN, SIKAP DAN AMALAN TERHADAP PENYAKIT CACING JANTUNG DALAM KALANGAN PEMILIK ANJING DI LEMBAH KLANG

ABSTRAK

Penyakit cacing jantung anjing adalah penyakit bawaan vektor yang lazim di Malaysia. Pentadbiran produk pencegahan cacing jantung berfungsi dalam mengurangkan risiko jangkitan. Oleh itu, kajian ini menyiasat pengetahuan, sikap dan amalan pemilik anjing di Lembah Klang terhadap penyakit cacing jantung yang menilai kepercayaan dan tingkah laku pemilik anjing. 144 pemilik anjing yang tinggal di Lembah Klang telah mengambil bahagian dalam kajian soal selidik keratan rentas ini. Majoriti responden (70.1%) menyedari kehadiran penyakit cacing jantung pada anjing di mana kebanyakan mereka mempunyai pengetahuan yang baik (54.5%), sikap (68.3%) dan amalan (80.2%) terhadap penyakit cacing jantung. Didapati tahap pendidikan responden mempunyai perkaitan yang signifikan dengan sikap terhadap penyakit cacing jantung. Kos (40.9%) merupakan penghalang utama kepada responden terhadap pencegahan penyakit cacing jantung. Tidak mengejutkan, harga (25.1%) adalah faktor utama yang mempengaruhi responden dalam memilih produk pencegahan cacing jantung. Doktor haiwan adalah sumber utama maklumat mengenai penyakit cacing jantung (42.3%) dan produk pencegahan cacing jantung (50.6%), terbukti bahawa doktor haiwan memainkan peranan penting dalam kesedaran tentang penyakit cacing jantung pada anjing. Secara keseluruhannya, kebanyakan responden sedar dan mempunyai pengetahuan, sikap dan amalan yang baik mengenai penyakit cacing jantung pada anjing tetapi masih terdapat sebahagian kecil daripada responden yang tidak pernah mendengar tentang penyakit cacing jantung sebelum ini. Oleh itu, ini menunjukkan bahawa promosi kesedaran penyakit cacing jantung perlu dilakukan.

Kata kunci: Anjing, Cacing jantung, Penyakit bawaan vektor, Pencegahan, Kesedaran

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LIST OF ABBREVIATIONS

L1	1st larval stage
L2	2nd larval stage
L3	3rd larval stage
L4	4th larval stage
S5	immature adult
EDTA	Ethylenediaminetetraacetic acid
ELISA	Enzyme-linked immunosorbent assay
ICT	Immunochromatographic test
PCR	Polymerase chain reaction
URL	Uniform Resource Locator
QR	Quick response
SPSS	Statistical Package for the Social Sciences
RM	Ringgit Malaysia

LIST OF SYMBOLS

%	Percentage
≤	Less than or equal to
≥	More than or equal to
n	Number
<	Less than
>	More than
=	Equal
p	Significance level
r	Correlation coefficient

CHAPTER 1

INTRODUCTION

1.1 Research Background

Heartworm disease is an endoparasitic infection caused by filarial nematode *Dirofilaria immitis* (*D. immitis*). *D. immitis* causes vascular disease that can progress to an impaired blood flow, which will eventually affect the pulmonary system, and in severe cases the right heart chambers, resulting in right sided congestive heart failure (Noack et al, 2021).

Malaysia is a country with high temperature and humidity with abundant rainfall, which are ideal conditions for vector-borne disease transmission (Chelliah & Šlapeta, 2019). Hence vector control and periodical preventions are vital for dogs in Malaysia because it is important to note that vector control alone is not reckoned as an effective means of preventing infection or disease in dogs (Bowman, 2013). When the numbers of dogs protected against heartworm increases, there will be reduction in host for heartworm disease transmission, which will in turn reduce the cases of heartworm disease in dogs. Thus, it is important for dog owners to comply with heartworm prevention as a dog can become infected just by missing a single preventive dose especially in highly endemic areas (American Heartworm Society, 2020).

1.2 Problem Statement

There are no studies done in investigating the level of knowledge, attitude and practice among dog owners regarding heartworm disease in Klang Valley. Besides, no studies have been done to determine the association of sociodemographic factors with

the level of knowledge, attitude and practice among dog owners regarding heartworm disease in Klang Valley.

1.3 Research Questions

- What is the level of knowledge among dog owners regarding heartworm disease?
- What is the level of attitude among dog owners regarding heartworm disease?
- What is the level of practice among dog owners towards heartworm disease prevention?
- Is there association between sociodemographic factors with the level of knowledge, attitude and practice among dog owners regarding heartworm disease?

1.4 Research Objectives

- To investigate the level of knowledge, attitude and practice regarding heartworm disease among dog owners.
- To determine the sociodemographic factors associated with the level of knowledge, attitude and practice of dog owners regarding heartworm disease.

1.5 Research Hypothesis

Null Hypothesis

- The level of knowledge among dog owners regarding heartworm disease is low.
- The level of attitude among dog owners regarding heartworm disease is low.
- Dog owners have poor practice towards heartworm prevention.

- There is no association between sociodemographic factors with the level of knowledge, attitude and practice among dog owners regarding heartworm disease.

Alternative hypothesis

- The level of knowledge among dog owners regarding heartworm disease is high.
- The level of attitude among dog owners regarding heartworm disease is high.
- Dog owners have good practice towards heartworm prevention.
- There is association between sociodemographic factors with the level of knowledge, attitude and practice among dog owners regarding heartworm disease.

1.6 Significance of the Study

This research is important in determining the knowledge, attitude and practice towards heartworm disease among dog owners in Klang Valley. With this, the appropriate approaches to advise dog owners on the correct approaches in preventing heartworm infection in their dogs could be done. Besides, this study could also act as a medium for owners to be aware about heartworm disease in dogs.

CHAPTER 2

LITERATURE REVIEW

2.1 Life cycle of heartworm

Adult heartworms reside in the pulmonary arteries of the canine host. In heavy infestations, heartworms can be regurgitated back into the heart of the host due to the lack of space or blood pressure changes, especially in small dogs (Bowman & Atkins, 2009). After sexual reproduction of the adults in the pulmonary arteries, the microfilariae will be released into the circulation where they will be ingested by female mosquitoes in a blood meal. The microfilariae will undergo two moults from L1 to L2 and subsequently L3 over a period of eight to seventeen days (Ettinger et al., 2017). The infective L3 in the infected mosquito's mouthpart will be transmitted once the mosquito takes a blood meal. The infective L3 will then enter the animal's body via the puncture wound made by the mosquito and moult into L4 that ranges from three to twelve days in the subcutaneous tissue and muscle fibres (American Heartworm Society, 2020). The final moult to S5 occurs two to three months post-infection, where these immature adults will enter the vascular system before migrating to the heart and lungs of the host for the final maturation (Ettinger et al., 2017). The infected dogs will develop patent infections, where circulating microfilariae can be detected about six to nine months post-infection after the heartworms have reached sexual maturity about 3 months post-infection (American Heartworm Society, 2020). The completion of the life cycle of *D. immitis* can take up to six to seven months under optimum conditions. It is known that adult heartworms in the canine host can live up to five to seven years (Ettinger et al., 2017).

2.2 Clinical signs of heartworm disease

The clinical signs of heartworm disease depend on the severity and duration of infection (Ettinger et al., 2017). Clinical signs of the disease include weight loss, mild persistent cough, exercise reluctance, decreased appetite and exercise intolerant (Noack et al., 2021). Although the majority of affected dogs are asymptomatic, chronic cases reflect the impacts of the parasite on the pulmonary arteries and lungs, followed by the heart (Ettinger et al., 2017). As the disease progresses, reduction of cardiac output will eventually occur due to damage to the pulmonary endothelium and vascular occlusion from worm death. As a result, pulmonary hypertension that follows can lead to compensatory right-sided heart enlargement and subsequently right-sided heart failure (Noack et al., 2021).

2.3 Methods of detection of heartworm disease

Various methods are available for the diagnosis of heartworm disease in dogs. Presence of microfilariae can be determined by performing direct blood smears where blood should be collected in an ethylenediaminetetraacetic acid (EDTA) tube before placing drops of blood on a clean slide as wet fresh blood slide. The presence of microfilariae can be detected under microscope through erythrocyte movement caused by the characteristic serpentine movements of these microfilariae (Trancoso et al., 2020). Serological tests to detect *D. immitis* antigens that are based on enzyme-linked immunosorbent assay (ELISA) or immunochromatographic test (ICT) are also available. Due to their sensitivity and specificity, antigen-based detection methods such as ELISA and ICT are considered the gold standard diagnostic tests for heartworm detection. PCR on the other hand are significantly more sensitive and specific than the antigen-based test but are not commonly practised in clinical settings due to its availability (Smith et al., 2022). PCR are often done only for dogs that are suspected of

being infected but with microfilariae-negative results (Noack et al., 2021). However, PCR is not commonly used in commercial settings despite its high accuracy (Zhang, 2022). Instead, commercial antigen tests are more broadly used in veterinary clinics and hospitals as the current commercial antigen tests were found to be able to reliably detect infections (Genchi et al., 2017). This could be due to the requirement of costly instruments and requirement of trained personnels, which results in PCR being a high-priced test that not all people can afford (Rahman et al., 2013).

Additional tests such as radiography and echocardiography could be done to assess and stage the severity of the disease (Ettinger et al., 2017). The prognosis of a heartworm infected patient can be evaluated by assessing the cardiopulmonary status through radiography. Enlarged, tortuous and truncated branches of pulmonary arteries are typical signs of heartworm caused vascular lung pattern, which are accompanied by variable degrees of pulmonary parenchymal changes (American Heartworm Society, 2020). Echocardiography is quite sensitive in detecting the enlargement of the right heart chamber, where the septal and right ventricular free wall thickness will all increase (Ettinger et al., 2017). Besides, the body wall of adult heartworms is highly echogenic, hence producing definitive evidence of heartworm infection (American Heartworm Society, 2020).

2.4 Treatment for heartworm disease

The American Heartworm Society and the European Society of Dirofilariasis and Angiostrongylosis propose protocols with two to three months pre-treatment with macrocyclic lactones combined with antibiotics (doxycycline) to achieve complete elimination of adult heartworm infections (American Heartworm Society, 2020). Macrocyclic lactones can be divided into two groups, the avermectins (abamectin, ivermectin, eprinomectin, and selamectin) and the milbemycins (milbemycin oxime and

moxidectin). The administration of macrocyclic lactones eliminate susceptible larvae and prevent new infections, while allowing older worms to develop further and become susceptible to melarsomine dihydrochloride (William, 2012). In cases of severe infection however, adulticidal therapy should not be opted due to the severe immune response from the rapid killing of heartworms. Thus, either mechanical removal using retrieval devices or surgical heartworm removal is suggested (Lee et al., 2008).

2.5 Prevalence of heartworm disease

Due to Malaysia's favourable climate with high temperature and humidity ideal for vector-borne disease transmission, Malaysia is considered a hyperendemic area for canine heartworm (Lau et al., 2017). There is a significant decline in the prevalence of *D. immitis* antigen in Malaysia before and after the year 2000, which were 25.5% and 4.0% respectively. From December 2017 to June 2018, the prevalence of *D. immitis* in dogs in Kuala Lumpur was 3.85% (Chelliah & Šlapeta, 2019). This could be due to the implementation of mosquito vector control in the National Dengue Strategic Plan by the Ministry of Health (Hii et al., 2016). Stray dog populations serve as reservoirs for the survival of *D. immitis* in Malaysia (Lau et al., 2017). Presumably due to indoor keeping and preventive efforts, prevalence of *D. immitis* antigen in owned dogs was significantly lower than the prevalence in stray dogs, which are 18.4% and 24.1% respectively (Chelliah & Šlapeta, 2019).

2.6 Awareness of heartworm disease

In first world countries such as Europe and North America, the awareness concerning canine vector-borne disease is continuously growing but less in Southeast Asia (SEA) regions, which are still developing (Nguyen et al., 2020). Additionally, due to limited access to veterinary services and preventive measures in suburban or rural

areas of those developing regions, there is increased risk for dogs to be affected with vector-borne disease (Dantas-Torres et al., 2020; Otranto et al., 2017). Based on a survey done on dog owners in Klang Valley, the respondents who were aware about preventive medicine about parasitic diseases including heartworm prevention is only 33% (Ahmad, 2020). Besides, a study done in Penang to assess the knowledge of dog owners regarding *D. immitis* showed that only a small percentage (14% at Animal Aid Veterinary Clinic and 3% at Cuddles Veterinary Hospital, Cuddles Veterinary Clinic, and Ark Veterinary Centre) of dog owners have excellent knowledge on *D. immitis* (Leong et al., 2022).

CHAPTER 3

RESEARCH METHODOLOGY

3.1 Respondents

Cross-sectional study via convenience sampling of respondents was used for this study. The inclusion criteria of targeted respondents were: (i) Malaysians living in Klang Valley, (ii) Aged 18 years old or older, (iii) Currently own one or more dogs, and (iv) Owners who are involved in taking care of the dog/ dogs. The exclusion criteria for respondents include: (i) Malaysians who do not live in Klang Valley, (ii) Aged less than 18 years old, (iii) Currently not owning any dogs, and (iv) Not the rightful owner of the dog, i.e. sitting or taking care of the dog/ dogs on behalf of someone else.

3.2 Questionnaire

The self-administered questionnaire was constructed in both English and Mandarin in Google Forms, in which the respondents gained access via an URL link shared through Whatsapp, Facebook and Instagram. Besides, a QR code was displayed for the clients in a veterinary clinic to access the Google Forms. A pilot study was conducted (n=20) and improvements in terms of language were made to enhance clarity.

The questionnaire consists of three sections, where the first page includes consent for the respondents, the demographics of the respondents (age, gender, household monthly income, and education level), years of taking care of the dog/ dogs, and whether the owners have heard about heartworm disease.

The second section includes whether the dog/ dogs had been infected by heartworm disease, the ways of knowing heartworm disease as well as heartworm prevention products, the type of heartworm prevention products (Heartgard, Nexgard, Advocate, Revolution, Comfortis Plus, and no heartworm prevention product

administered) purchased by the owners, the barriers (cost, time, and my dog/ dogs live indoor) to heartworm prevention, the factors influencing the owner's selection of heartworm prevention product, and the ranking of the basic care for dogs (vaccination, deflea and deticking, heartworm prevention, annual general checkup, and grooming) based on their importance using a five point Likert scale, which ranges from 1 being the least important to 5 being the most important.

The knowledge, attitude and practice of owners regarding heartworm disease in dogs are in the third section of the questionnaire. Eight questions were listed to assess the knowledge of dog owners towards heartworm disease where 'Yes' indicates the correct answer while 'No' indicates the wrong answer. Respondents who scored '1 to 3' is an indication that they have poor knowledge regarding heartworm disease whereas those who scored '4 to 6' and '7 to 8' indicate respondents have fair and good knowledge towards heartworm disease respectively. Five questions were listed where owners were required to answer the five points Likert scale to evaluate the attitude of dog owners towards heartworm disease. The choices were as follows: 1: strongly disagree, 2: disagree, 3: not sure, 4: agree and 5: strongly agree. The scoring system is as follows: mean score of 1 to 2 indicates respondent has a poor attitude towards heartworm disease while mean scores of 3 to 4 showed that respondents has a fair attitude towards heartworm disease. Those who have a good attitude regarding heartworm disease will have a mean score of 5 points. Eight questions were set to determine the practice of dog owners towards heartworm disease using five point Likert scale where the options are as follows: 1: never, 2: seldom, 3: frequent, 4: always, 5: everytime. The second question under the attitude part is not necessary to be answered by respondents if they only have a dog. A mean score of 1 to 2 suggests that respondents have poor attitude towards heartworm disease whereas a mean score of 3 to

5 and 6 to 7 show that respondents have a fair and good attitude respectively towards heartworm disease.

3.3 Statistical Analysis

Cronbach alpha was used as a measure of internal consistency and value of ≥ 0.7 is accepted (Hair et al., 2010). The collected data was keyed into Microsoft Excel and analysed using IBM® SPSS® Version 27. Continuous variables were tested for normality with the numerical data analysed and presented in the form of mean and standard deviation while categorical data were analysed and presented in frequency and percentage. The association between gender with knowledge, attitude, and practice respectively were determined using Mann-Whitney U test whereas the association between knowledge, attitude and practice respectively with age, household monthly income, and education level were determined through Kruskal-Wallis test. Spearman's rank order correlation were done to measure the correlation between knowledge, attitude, and practice. The statistical significance was determined at a *p*-value of ≤ 0.05.

CHAPTER 4

FINDINGS AND DISCUSSION

4.1 Findings

A total of 144 dog owners participated in this study. Three (2.1%) respondents access the questionnaire through QR code while the remaining 141 (97.9%) respondents filled in the Google Forms via the URL link given.

Table 4.1 shows the sociodemographics of the respondents where most of the respondents were from the age group of 20 to 29 (49.3%). Females were the predominant gender that participated in this study (65.3%) and half of the respondents have a household monthly income of < RM 4850 (50.7%).

Table 4.1: Sociodemographics of the respondents (*n* =144)

Sociodemographics	Number of respondents (*n*)	Percentage (%)
Age (years)		
18 - 19	8	5.6
20 - 29	71	49.3
30 - 39	21	14.6
40 - 49	21	14.6
50 - 59	13	9.0
60 and above	10	6.9
Gender		
Male	50	34.7
Female	94	65.3
Household monthly income		
< RM 4850	73	50.7
RM 4850 - RM 7099	28	19.4
RM 7110 - RM 10960	13	9.0
> RM 10960	30	20.8
Education level		
No formal education	3	2.1
Primary	4	2.8
Secondary	25	17.4
Tertiary (University)	112	77.8

Table 4.2 showed that the majority of the respondents (55.6%) had taken care of dogs for less than five years. Surprisingly, 29.9% of the respondents were unaware of heartworm disease in dogs (Table 4.3). Among those who were aware, 22.8% had dogs infected with heartworm disease previously (Table 4.4).

Table 4.2: Experience of dog owners (*n* =144) in taking care of dog/ dogs

Duration of owners taking care of dog/ dogs (years)	**Number of respondents (*n*)**	**Percentage (%)**
≤ 5	80	55.6
6 - 10	33	22.9
11 - 19	18	12.5
≥ 20	13	9.0

Table 4.3: Awareness of respondents towards heartworm disease in dogs (*n* =144)

Awareness	**Number of respondents (*n*)**	**Percentage (%)**
Yes	101	70.1
No	43	29.9

Table 4.4: Respondents (*n* =101) with dog/ dogs that have had or had not have heartworm disease

Dogs infected by heartworm disease before	**Number of respondents (*n*)**	**Percentage (%)**
Yes	23	22.8
No	78	77.2

Table 4.5 displays the source of information of the dog owners regarding heartworm disease. Majority of the respondents were familiar with heartworm disease through their veterinarians (42.3%). Similarly, when it comes to heartworm prevention products, veterinarians remained the main source of information (50.6%).

Table 4.5: Source of information of dog owners (n =101) in knowing about heartworm disease and heartworm prevention products

Source of information regarding heartworm disease and heartworm prevention products	Frequency of selection (n)	Percentage (%)
Heartworm disease		
Veterinarians	82	42.3
Social media	57	29.4
Websites	28	14.4
Books/ journals/ newspapers	15	7.7
Pet exhibition	11	5.7
Others	1	0.5
Heartworm prevention products		
Veterinarians	87	50.6
Social media	38	22.1
Websites	26	15.1
Books/ journals/ newspapers	5	2.9
Pet exhibition	16	9.3

As shown in Table 4.6, cost (40.9%) and dog/dogs living indoors (39.4%) were the major barriers of respondents to heartworm disease prevention. Table 4.7 presents the factors that influence respondents in choosing heartworm prevention products where most respondents choose the products based on their price (25.1%). When ranking the services in dog care based on the order of their importance, heartworm prevention falls third to vaccination and ectoparasite control (Figure 4.1).

Table 4.6: Barriers to respondents (n = 101) towards heartworm disease prevention

Barriers	Frequency of selection (n)	Percentage (%)
Cost	54	40.9
Time	26	19.7
My dog(s) live indoor	52	39.4

Table 4.7: Factors influencing respondents (n = 101) in choosing heartworm prevention products

Factors	Frequency of selection (n)	Percentage (%)
Price	51	25.1
Method of administration	26	12.8
Wide range of protection across different parasites	45	22.2
Easy to procure (wide availability)	30	14.8
Advertisements	12	5.9
Condition of dog/ dogs (chronic disease, old age)	39	19.2

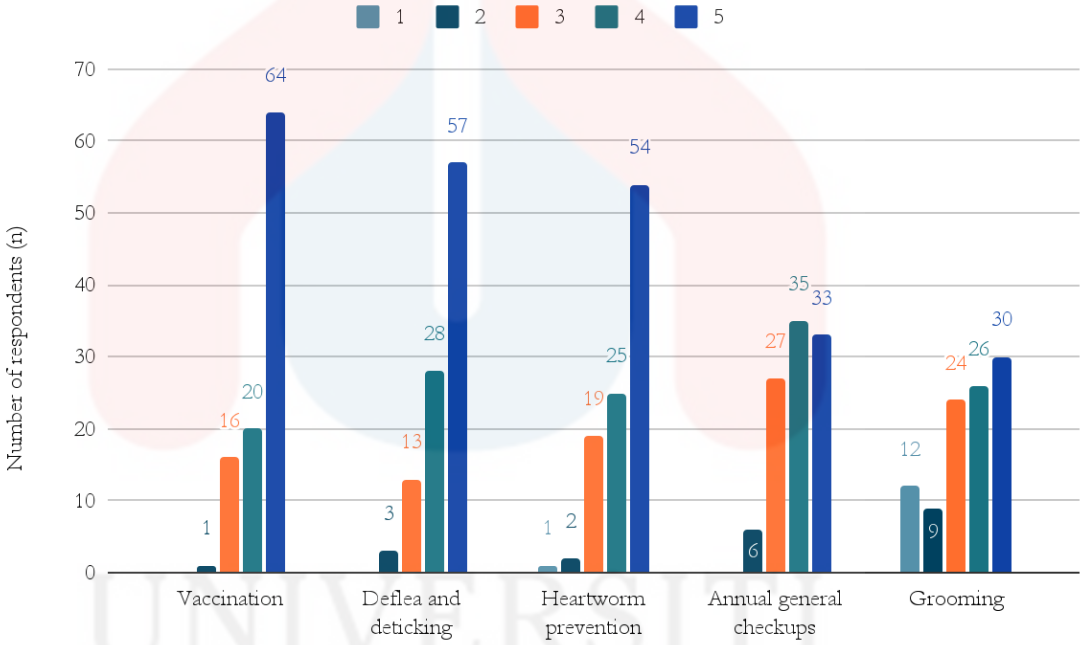

Figure 4.1: Ranking of the importance of services available for dogs

Table 4.8 displays the total scores for knowledge, attitude and practice of the respondents towards heartworm disease. More than half of the respondents scored good (54.5%) while only a minute respondents had poor scores (6.9%) in the knowledge part. There were no respondents who had a poor score under the attitude part with a majority of them scoring good (68.3%). Most of the respondents scored good (80.2%) in practice. For the second statement under the practice part which stated that the

heartworm prevention tablets were split between dogs, out of the 36 respondents who have more than one dog had a good score (61.1%).

Table 4.8: Total scores for knowledge, attitude and practice attitude of respondents (n = 101) towards heartworm disease

Variable	Level	Score	Frequency	
			n	**%**
Knowledge	Poor	1 - 3	7	6.9
	Fair	4 - 6	39	38.6
	Good	7 - 8	55	54.5
Attitude	Poor	5 - 11	-	-
	Fair	12 - 18	32	31.7
	Good	19 - 25	69	68.3
Practice	Poor	7 - 15	3	3.0
	Fair	16 - 24	17	16.8
	Good	25 - 35	81	80.2
Practice (n = 36)	Poor	1 - 2	11	30.6
	Fair	3 - 4	3	8.3
	Good	5	22	61.1

As shown in Table 4.9, there is significant association of the educational level of respondents with their attitudes towards heartworm disease. However, the other socio demographic variables did not have significant association with knowledge, attitude nor practice towards heartworm disease. As depicted in Table 4.10, there is significant correlation between the total scores of practice and attitude as well as total scores between knowledge and attitude. However, there is no significant correlation between knowledge and practice of the respondents.

Table 4.9: Association between knowledge, attitude and practice of dog owners towards heartworm disease with the variables of socio demographics

Socio demographic variables	Kruskal-Wallis								
	Knowledge			Attitude			Practice		
	H	df	*p*	H	df	*p*	H	df	*p*
Age	8.151	5	0.148	10.353	5	0.066	5.684	5	0.338
Household monthly income	4.220	3	0.239	4.456	3	0.216	3.505	3	0.320
Education level	3.298	2	0.192	6.896	2	0.032*	2.845	2	0.241

Socio demographic variables	Mann-Whitney U					
	Knowledge		Attitude		Practice	
	U	*p*	U	*p*	U	*p*
Gender	850.500	0.148	765.500	0.066	963.500	0.338

*$p \leq 0.05$

Table 4.10: Spearman's rank order correlation between total scores of knowledge, attitude and practice of respondents (n = 101) towards heartworm disease

Correlation	*r*	*p*-value
Knowledge - Practice	0.169	0.091
Practice - Attitude	0.324	<0.001*
Knowledge - Attitude	0.260	0.009*

r, Spearman's rho
*$p \leq 0.05$

4.2 Discussion

A study stated that females, young people, and people without children have a positive dog-human companionship (Dotson & Hyatt, 2008). This could be the reason the majority of respondents who participated in this study are young females. Since the majority of the respondents are young adults with tertiary education, they could be students or fresh graduates with low income. As indicated in a case study, the starting salary for fresh graduates in Malaysia ranges from RM 2169 to RM 2635 (Nora et al.,

2022). There has been a change in the learning process due to the hit of the COVID-19 pandemic, where teachers use several applications in giving assignments or learning assessments as part of the implementation of online learning, with one of them being Google Forms (Zakwandi et al., 2022). Hence, young adults are more accepting and versatile towards the questionnaire distributed through a virtual platform.

The COVID-19 pandemic that emerged in 2019 had caused social isolation in multiple countries, where the stricter the social isolation, the greater the interest in dog adoption (Morgan et al., 2020). This could explain the majority of the owners participating in this study having only five or less than five years of experience in taking care of their dog/ dogs.

There are several possible reasons for a dog to contract heartworm disease. Heartworm preventives that are applied inconsistently will not provide adequate protection against heartworm infection, resulting in dogs getting infected with heartworms (Chelliah & Šlapeta, 2019). Besides, the housing of a dog also played an important factor as shown by a study in Taiwan which revealed that dogs spending more than 50% of their time outdoors were 5.5 times more likely to be infected with heartworm as compared to dogs that stayed completely indoors (Lu et al., 2017). Although most respondents indicated that their dogs have not been infected with heartworm disease, it is important to note that the dogs might not really be heartworm negative. False negative results can occur if the heartworms are still immature, having low worm burden, in all male infections, or with the formation of immune complexes (Lu et al., 2017). This is because the earliest that female heartworm antigen and microfilariae can be detected is about five to six months post-infection respectively, where there will be a false negative result if a heartworm positive dog is tested early (American Heartworm Society, 2020). A hypergammaglobulinemic state induced by the reaction of dead or dying worms that results in the formation of antigen-antibody

complexes masking the antigen of heartworms was suspected to be preventing accurate detection in heartworm infected patients (Drake et al., 2015). On the other hand, Klang valley being an urban area could also contribute to less dogs being infected by heartworms. Field areas had significantly higher prevalence and risk of mosquitoes carrying heartworms than did more developed areas (Beaulieu et al., 2020).

In this modern world, more people are keeping pets as companions for emotional support due to the stress at work. There is also an increasing number of pet owners treating their pets as part of their family members (Wu et al., 2021). Hence, the respondents are conscious of the importance of vaccinations, deflea and deticking, heartworm prevention as well as annual general checkups. In spite of that, there was an ambiguous response towards the importance of grooming. A study showed that owners with more frequent engagement and close contact with their dogs are associated with frequent grooming of their dogs (Vaness et al., 2012).

Among the 144 respondents, around two thirds of them are aware of heartworm disease in dogs, which indicates the pet owners are getting gradually more conversant with pet care. Correspondingly, the dog owners are more interested in inquiring about heartworm disease and its preventive products from the veterinarians (Sakshi et al., 2017). Besides, the evolution of social media has brought about a new means for consumers to search and acquire information on the products in the market (Gupta & Chopra, 2020). The increasing number of people using social media have provided an opportunity for marketers to increase their use of digital marketing (Stephen, 2016). Hence, respondents opt for sourcing information regarding heartworm disease and its prevention products through social media and websites apart from relying on their veterinarians. Curiosity and the desire for further details from the information given by their veterinarians also bring about dog owners to explore pet-related health information online (Kogan et al., 2009).

The preferences of dog owners in selecting specific brands of heartworm prevention products might be due to the availability and accessibility of the products in the market (Wu et al., 2021). Generally, the price of the products are the major factor influencing the respondents of this study in choosing their heartworm prevention products. Dog owners would compare the price in regards to the spectrum of action of the products. For example, the products give protection against multiple parasites or only for certain types of parasites. In addition, respondents prefer to select heartworm prevention products with a broad spectrum of action for the purpose of convenience besides feeling more at ease with their dogs being protected across different types of parasites (Bebrysz, 2021). However, there are also respondents who did not administer any heartworm products for their dogs, which indicates in spite of veterinarians being an important source of information regarding heartworm disease, some dog owners did not seek veterinary advice (Gates et al., 2019). Due to an increased labour costs as well as the rising costs of medical equipment and supplies, veterinary expenditure has become more costly (Williams et al., 2020). Unsurprisingly, cost was selected most frequently as an obstacle towards heartworm disease prevention by the respondents. The frequency of respondents choosing their dogs being indoor as a barrier to heartworm disease prevention is just slightly lesser than cost. This could be due to the respondents' perception of indoor dogs having a lower risk of infection, and hence the unworthiness of spending on the prevention products (Fischels, 2022). However, it is important to note that although indoor dogs' risk of heartworm disease infection is relatively lower than an outdoor dog, the possibility of infection is still there. Although most respondents' dogs have not been infected by heartworm disease, because of the ineffective control of infected stray dogs acting as reservoirs and the impossible complete eradication of mosquitoes, *D. immitis* in the dog and mosquito population will be continuously circulating (Lai et al., 2000).

The majority of the respondents have good and fair knowledge regarding heartworm disease in dogs. This shows that pet owners have been becoming progressively well versed in pet care and a greater personal involvement in treatment of their pets, which results in an increased query towards veterinarians (Sakshi et al., 2017). Evidently, veterinarians play an important role in assisting pet owners to have a better understanding of animal health (Bir et al., 2020). Moreover, pet owners nowadays frequently use the internet due to the abundance of information available regarding pet care and health (Kuhl et al., 2022). However, it is important for the owners to validate the information that they have come across online with their veterinarians because the information available on the internet is not always accurate (Hofmeister et al., 2008). Generally, the respondents have good attitudes and practices towards heartworm disease. That could be due to the increasing human-animal bond as shown by the strong attachment of owners to their pets similar to those to human beings in a study (Freiwald et al., 2014). The owners with close bonds with their dogs are more likely to seek preventive care and act in accordance with the veterinarian's recommendations (Lue et al., 2008).

Despite the fact that most of the respondents were able to correctly identify most of the statements regarding knowledge towards heartworm disease, nearly half of the respondents were unaware of the vector that transmits heartworm disease. A study conducted on pet owners regarding the possible sources of endoparasitic infection showed that about one third of the respondents had no knowledge on the possible infectious causes, with the majority of them mentioning food, animal faeces, sand/ soil/ plants, arthropods and maternal-foetal transmission (Matos et al., 2015). This showed that the information regarding the source of heartworm infection in dog owners is still lacking. Most of the respondents were not sure regarding the statement that heartworm preventives are costly. Dog owners with higher socioeconomic status might be more

probable to expend heartworm prevention products since they are more financially able (Wisnieski et al., 2023).

The significant association between the education level of respondents and their attitudes towards heartworm disease could indicate that people with higher education levels have greater dog ownership engagement and interest. The quality of human-animal bond seems to be influenced by the levels of education where tertiary educated pet owners are more likely to develop a strong emotional connection with their dogs (Calvo et al., 2016).

The significant correlation of attitude with practice and knowledge respectively indicates that the attitude of an individual plays a significant role between knowledge and practice (Lakshmi et al,. 2022). This is further supported by a study that speculated that pet owners that have different perceptions and ideas regarding companion animal care provide a higher level of care as compared to those who do not take their animals to the veterinarians (Ramón et al., 2010). On the other hand, no significant correlation was found between the knowledge and practice of respondents, indicating dog owners with good knowledge do not necessarily engage in good practice. This could be due to normative beliefs where the management practices of dog owners were greatly influenced by the endorsement by friends and family (Rohlf et al., 2015). This was supported by a survey done on pet owners in Klang Valley showing the general pet health care by the owners was only at a moderate level (Ahmad & Abdul Rani, 2016). However, attitudes towards dogs and other companion animals are changing with the rising attention to animal welfare (Lohmann et al., 2015).

CHAPTER 5

CONCLUSION

This study showed that a great portion of dog owners in Klang Valley were aware of heartworm disease in dogs. Overall, the respondents who were aware of heartworm disease had good scores for knowledge, attitude, and practice of respondents towards heartworm disease. Veterinarians played an important part as a source of information regarding heartworm disease and its prevention products. Cost was the dominant barrier to respondents in heartworm disease prevention. Therefore, it is important for veterinarians to educate owners on the consequences of heartworm infection and its greater cost and commitment required for treatment. The price was the major force that drove respondents in the selection of heartworm preventives. To the respondents, vaccination, deflea and deticking of their dogs were more important to the respondents in comparison to heartworm prevention. As per this study, the educational level has significant association with the attitudes of respondents towards heartworm disease with significant correlation between practice and attitude as well as knowledge and attitude of the respondents. For future research and studies, a greater sample size should be included to better represent the Klang Valley population for stronger and more reliable results.

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APPENDIX A

Heartworm prevention products purchased by dog owners (n = 101)

Heartworm prevention products	Frequency of selection (n)	Percentage (%)
Heartgard	52	39.1
NexGard	29	21.8
Advocate	8	6.0
Revolution	5	3.8
Comfortis Plus	6	4.5
I do not administer heartworm prevention products	25	18.8
Others	8	6.0

APPENDIX B

Frequency (*n*) and percentage (%) of responses from respondents (*n* = 101) in the knowledge towards heartworm disease

Items	Correct		Incorrect	
	n	**%**	***n***	**%**
Heartworm disease is not transmitted through ticks and fleas.	55	54.5	46	45.5
Heartworm disease is transmitted through mosquitoes.	66	65.3	35	34.7
Dogs in Malaysia have a high risk of contracting heartworm disease.	86	85.1	15	14.9
Heartworm disease cannot be prevented 100% by prevention products.	73	72.3	28	27.7
Deworming pills do not always cover heartworm.	81	80.2	20	19.8
Heartworm disease treatment required long term medication and management.	87	86.1	14	13.9
Presence of heartworm disease can be detected through blood samples.	94	93.1	7	6.9
Indoor dogs can also have heartworm disease.	91	90.1	10	9.9

APPENDIX C

Frequency (*n*) and percentage (%) of responses from respondents (*n* = 101) in the attitude towards heartworm disease

Items	Strongly disagree		Disagree		Not sure		Agree		Strongly agree	
	n	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
Heartworm prevention will allow my dogs to have a better quality of life.	1	1.0	-	-	5	5.0	23	22.7	72	71.3
Without prevention, I believe my dog is likely to get heartworm disease.	-	-	3	3.0	26	25.7	19	18.8	53	52.5
Every dog owner must ensure that their dog(s) is (are) adequately protected from preventable diseases.	-	-	1	1.0	4	4.0	15	14.9	81	80.1
Heartworm prevention products are hard to acquire in the market.	11	10.9	10	9.9	28	27.7	21	20.8	31	30.7
Heartworm prevention products are costly.	21	20.8	22	21.8	41	40.6	7	6.9	10	9.9

APPENDIX D

Frequency (*n*) and percentage (%) of responses from respondents (*n* = 101) in the practice towards heartworm disease

Items	Never		Seldom		Frequent		Always		Everytime	
	n	**%**	***n***	**%**	***n***	**%**	***n***	**%**	***n***	**%**
I give my dog(s) heartworm prevention products regularly according to the product instructions.	6	5.9	3	3.0	21	20.8	18	17.8	53	52.5
I split the heartworm prevention tablet between my dogs. (*n* = 36)	22	61.1	1	2.8	2	5.5	5	13.9	6	16.7
I split the heartworm prevention tablet between each administration.	51	50.5	8	7.9	8	7.9	12	11.9	22	21.8
I exercise mosquito control within my house.	7	6.9	3	3.0	22	21.8	37	36.6	32	31.7
I kept the record on when to administer heartworm prevention products to my dogs (e.g. calendars, journals).	12	11.9	5	4.9	17	16.8	23	22.8	44	43.6
I ask my veterinarian's advice on the best heartworm prevention products for my dogs.	4	4.0	1	1.0	16	15.8	28	27.2	52	51.5
I choose heartworm prevention products that are easy and hassle-free to be administered.	4	4.0	4	4.0	9	8.9	31	30.7	53	52.4
I have my dogs tested for heartworm annually.	11	10.9	18	17.8	27	26.7	12	11.9	33	32.7