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Research Article

Etiological Factors Associated with Disease Morbidity and Mortality of Adult Dogs among Kennels in Nairobi, Kenya

Sharon Nthenya Mbindyo*, George Karuoya Gitau, Charles Matiku Mulei and Susan Wanjiru Mbugua

Department of Clinical Studies, University of Nairobi (P.O Box 29053-00625, Kangemi, Kenya)
***Corresponding author:** snmbindyo@gmail.com

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ABSTRACT

Records of all adult dogs that were sick or had died during the period from 2008 to 2012 were evaluated by review of clinical treatment sheets and necropsy reports. The primary etiological factors of morbidity and mortality were determined. Blood smears were made and fecal samples were collected from 643 adult dogs and analyzed for blood parasites and helminthes respectively. The prevalence and incidence rates of tick borne infectious agents and helminthes were determined. Data analysis included descriptive statistics and simple associations between variables (sex, age and breed) and outcome using chi-square at P<0.05 significance level. Tick fever 29% (219/756) was reported as the most common etiology of morbidity of adult dogs followed by flea allergy dermatitis 16% (121/756), helminthosis 12.3% (93/756), mange 6.7% (51/756) and eye and ear conditions 5.2% (39/756). The conditions causing significant mortality included old age 24.6% (98/398), aflatoxicosis 18.8% (75/398), cancer 15.3% (61/398), tick fever 9.3% (37/398) and abdominal conditions 6.5% (26/398). Of the adult dogs sampled, 43.1% (277/643) were positive for blood parasites. The prevalence of *Ehrlichia, Babesia* and *Haemabartonella* was 19.4% (125/643), 4.5% (29/643) and 5% (32/643) respectively. Of the dogs sampled, 49% (315/643) were positive for helminthes. The prevalence of *Ancylostomum caninum*, *Toxocara canis and Coccidial* cysts was 28.5% (183/643), 5.1% (33/643) and 0.2% (1/643) respectively. The significant factors associated with morbidity and mortality were age (P<0.01) and breed (P<0.01). Breed and age of the adult dogs were significantly associated (P<0.01) with tick borne infections whereas all the factors (sex, breed and age) were significantly associated (P<0.01) with helminth infections. It can be concluded that there is a relatively high adult dog morbidity and mortality and that tick borne and helminth infections are prevalent among adult kenneled dogs in the study area. Awareness of the diseases and conditions common to kenneled adult dog population will help reduce morbidity and mortality, improve quality of life, and extend the lifespan of the dogs.

Key words: Adult dogs, Kennels, Etiological factors, Morbidity, Mortality

INTRODUCTION

Dogs play an important role in the service industry as police, security and guard dogs and in contraband (explosive and narcotic) detection (Moore, 2001; Sonntag and Overall, 2014) and they also assist the disabled, hunt and herd livestock (Derr, 2004). The dog population size of Kenya is estimated to be 3 million (Batson, 2008) with the highest percentage in Nairobi due to the increasing need for security and companion animals (Weru, 2009).

Numerous studies have revealed that the longevity and utility of dogs are affected by a wide range of diseases that can be caused by gastrointestinal parasites (intestinal parasites, both helminthes and protozoa (Palmer *et al*. 2008; Chee *et al*. 2008); tick borne disease agents, including several *Ehrlichia, Babesia* and *Haemabartonella* species (Dantas-Torres, 2008; Otranto *et al*. 2010) and ectoparasites (mites and fleas) that cause severe dermatitis (Dan, 2007; Bindari *et al*. 2012). Conditions such as conjunctivitis and ear infections can be caused by parasites and allergies (Herrera *et al*. 2007; Cole, 2011). A prevalence of cancer, renal disease, degenerative joint disease, cardiac disease, endocrine disorders, periodontal disease, cognitive dysfunction and obesity occur as dogs age (Carpenter *et al*. 2005; Vermote *et al*. 2010; Dobson, 2013; Kerrigan, 2013).

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Determination of the diseases that shorten a working dog's life would ideally allow the implementation of preventive medicine and management practices to improve longevity. The purpose of the study was to determine the etiological factors associated with morbidity and mortality of adult dogs among kennels in Nairobi, Kenya.

MATERIALS AND METHODS

Study area

The study was conducted in 35 kennels located in the urban and periurban areas in Nairobi, Kenya (1° 17' 0" S, 36° 49' 0" E). The locations were randomly selected and included Embakasi (1° 19' 57.7" S, 36° 54' 1.3" E), Hurlingham (1° 17' 27'' S, 36° 47' 29" E), Nairobi Industrial Area (1° 18' 22.1" S, 36° 51' 45.7" E), Ngara (1° 16' 28.8" S, 36° 49' 44.6" E), Parklands (1° 15' 44.1" S, 36° 49' 1" E), Karen (1° 18' 42.3" S, 36° 41' 55" E), Kikuyu (1° 15' 15.6" S, 36° 40' 54" E), Kilimani (1° 17' 2.1" S, 36° 47' 53.2" E), Upper Hill (1° 18' 3.9" S, 36° 49' 1" E), Uthiru (1° 16' 18.8" S, 36° 42' 13.7" E) and Westlands (1° 16' 5.8" S, 36° 48' 40" E), Kinoo (1° 15' 9.5" S, 36° 41' 34.9" E), Langata (1° 22' 0.7" S, 36° 43' 41" E), Lavington (1° 16' 28.3" S, 36° 46' 45.3" E), Limuru (1° 6' 24.9" S, 36° 38' 35.3" E), Mbagathi Way (1° 18' 31.7" S, 36° 48' 16.8" E), and Thika (1° 2' 19.5" S, 37° 5' 0.2" E).

Data collection and sampling

Records of all the adult dog morbidity and mortality cases (infections, euthanasia, accidental, natural death) in the kennels within a period of 5 years (2008-2012) were reviewed. Information collected from the medical records included: breed, sex, dates of birth and death, sick, died or euthanatized, reason for euthanasia or cause of natural death, primary gross pathologic findings reported on necropsy report. The primary etiological factors of morbidity and mortality were determined after evaluation of the recorded clinical treatment sheets and the necropsy reports. The etiology of morbidity and mortality was categorized by the affected anatomic structure except for the specific disease processes and all the cases of neoplasia that were grouped together. In the cases where a dog had more than 1 disease process, the etiology was categorized as multiple diseases. The etiology of morbidity and mortality in dogs in which there was insufficient information to conclusively determine a cause for sickness or death was categorized as unspecified or undetermined.

Blood smears were made and fecal samples were rectally collected for laboratory analysis from 643 adult dogs that were randomly selected. The blood smears were examined under the microscope for hemoparasites as described by Irwin, (2009). The fecal flotation test as described by Dryden *et al*. (2006) was used to identify common helminthes and protozoal cysts found in the fecal samples.

Data analysis

Results are reported as percentage and the simple associations between the outcome and variables (age, breed and sex) were determined with X^2analysis. All analyses were performed with standard software (SPSS, version 11.5, SPSS Inc, Chicago, IL, USA); values of $P< 0.05$ were considered significant.

RESULTS

A retrospective study was used to determine the etiological factors of morbidity and mortality in kenneled adult dogs in Nairobi, Kenya from 2008 to 2012. A total of 9 types of diseases and conditions were recorded in 756 sick adult dogs and a total of 12 types of diseases and conditions were recorded in 398 dead adult dogs. The variation of the diseases in prevalence was analyzed on the basis of sex, breed and age of the dogs. Tick fever 29% (219/756) was reported as the most common etiology of morbidity of adult dogs followed by flea allergy dermatitis 16% (121/756), helminthosis 12.3% (93/756), mange 6.7% (51/756), eye and ear conditions 5.2% (39/756), respiratory conditions 4.5% (34/756), reproductive conditions 2% (15/756), multiple diseases 20.5% (155/756) and other unspecified causes 3.8% (29/756) (Table 1). The reported etiology of mortality of the adult dogs included old age 24.6% (98/398), aflatoxicosis 18.8% (75/398), cancer 15.3% (61/398), tick fever 9.3% (37/398), abdominal conditions 6.5% (26/398), cardiac conditions 4.3% (17/398), urologic conditions 3.5% (14/398), respiratory conditions 2% (8/398), reproductive conditions 2% (8/398), helminthosis 1.3% (5/398), multiple diseases 5.8% (23/398) and undetermined causes 6.5% (26/398) (Table 2).

Laboratory analysis of blood smears and fecal samples was done to determine the prevalence and incidence rates of tick borne infectious agents and helminthes and are illustrated in Tables 3 and 4 respectively. The significant factors associated with morbidity and mortality were age ($P<0.01$) and breed ($P<0.01$). Breed and age of the adult dogs were significantly associated ($P<0.01$) with tick borne infections whereas all the factors (sex, breed and age) were significantly associated ($P<0.01$) with helminth infections.

DISCUSSION

Tick fever was reported as the most common etiology of morbidity of dogs. This was in agreement with studies by Watanabe *et al*. 2004; Stich, 2008; Rahman *et al*. (2010), Little, (2010), Chomel, (2011). Flea allergy dermatitis, which was the second most reported common etiology of dog morbidity, is one of the most pruritic dermatoses of dogs (Hill *et al*. 2006; Yaacov, 2012; Craig, 2012). As both tick fever and flea allergy dermatitis are associated with ectoparasites, this indicates that the ectoparasite control protocol in some of the kennels may have been ineffective.

Old age was reported as the most common etiology of mortality of the adult dogs. These findings were similar to studies by Egenvall *et al*. 2000, Proschowsky *et al*. (2003). Aflatoxicosis was the second most common etiology of mortality of the adult dogs. The dogs were reported to have been euthanized or to have died. This observation was also reported earlier by Arnot *et al*. (2012) and Ural *et al*. (2013). This may have occurred

Table 1: Etiology of disease morbidity in kenneled adult dogs

Disease (n)	Sex		Breed					Age				
	Male n (%)	Female n (%)	GSD n (%)	Crosses n (%)	Rottweilers n (%)	Labrador retrievers n (%)	Others n (%)	1-2 n (%)	3-4 n (%)	5-6 n (%)	7-8 n (%)	>9 n (%)
Tick fever (219)	113 (51.6)	106 (48.4)	89 (40.6)	67 (30.6)	24 (11)	14 (6.4)	25 (11.4)	32 (14.6)	59 (26.9)	68 (31.1)	36 (16.4)	24 (11)
Flea allergy dermatitis (121)	56 (46.3)	65 (53.7)	43 (35.5)	31 (25.6)	22 (18.2)	9 (7.4)	16 (13.2)	31 (25.6)	36 (29.8)	24 (19.8)	19 (15.7)	11 (9.1)
Helminthosis (93)	40 (43)	53 (57)	29 (31.2)	24 (25.8)	18 (19.4)	9.7 (9)	13 (14)	21 (22.6)	27 (29)	19 (20.4)	11 (11.8)	15 (16.1)
Mange (51)	24 (47.1)	27 (52.9)	17 (33.3)	13 (25.5)	6 (11.8)	10 (19.6)	5 (9.8)	9 (17.6)	16 ((31.4)	11 (21.6)	8 (15.7)	7 (13.7)
Eye and ear conditions (39)	17 (43.6)	22 (56.4)	15 (38.5)	9 (23.1)	5 (12.8)	4 (10.3)	6 (15.4)	5 (12.8)	9 ((23.1)	12 (30.8)	7 (17.9)	6 (17.6)
Respiratory conditions (34)	15 (44.1)	19 (55.9)	11 (32.4)	8 (23.5)	5 (14.7)	4 (11.8)	6 (17.6)	4 (11.8)	11 ((32.4)	9 (26.5)	6 (17.6)	4 (11.8)
Reproductive conditions (15)	3 (20)	12 (80)	6 (40)	4 (26.7)	2 (13.3)	1 (6.7)	2 (13.3)	2 (13.3)	3 (20)	5 (33.3)	3 (20)	2 (13.3)
Multiple diseases (155)	75 (48.4)	80 (51.6)	47 (30.3)	39 (25.2)	35 (22.6)	13 (8.4)	21 (13.5)	29 (18.7)	48 (31)	31 (20)	25 (16.1)	22 (14.2)
Unspecified (29)	11 (37.9)	18 (62.1)	9 (31)	7 (24.1)	4 (13.8)	4 (13.8)	5 (17.2)	6 (20.7)	8 ((27.6)	6 (20.7)	5 (17.2)	4 (13.8)

Table 2: Etiology of mortality in kenneled adult dogs

Disease (n)	Sex		Breed					Age				
	Male n (%)	Female n (%)	GSD n (%)	Crosses n (%)	Rottweilers n (%)	Labrador retrievers n (%)	Others n (%)	1-2 n (%)	3-4 n (%)	5-6 n (%)	7-8 n (%)	>9 n (%)
Old age (98)	48 (49)	50 (51)	29 (29.6)	24 (24.5)	16 (16.3)	13 (13.3)	16 (16.3)	0 (0)	0 (0)	0 (0)	6 (6.1)	92 (93.9)
Aflatoxicosis (75)	34 (45.3)	41 (54.7)	30 (40)	19 (25.3)	16 (21.3)	2 (2.7)	8 (10.7)	0 (0)	19 (25.3)	32 (42.7)	17 (22.7)	7 (9.3)
Cancer (61)	27 (44.3)	34 (55.7)	28 (45.9)	13 (21.3)	7 (11.5)	5 (8.2)	8 (13.1)	0 (0)	0 (0)	0 (0)	11 (18)	50 (82)
Tick fever (37)	16 (43.2)	21 (56.8)	14 (37.8)	8 (21.6)	7 (18.9)	2 (5.4)	6 (16.2)	1 (2.7)	5 (13.5)	10 (27)	8 (21.6)	13 (35.1)
Abdominal conditions (26)	11 (42.3)	15 (57.7)	7 (26.9)	7 (26.9)	5 (19.2)	3 (11.5)	4 (15.4)	0 (0)	0 (0)	11 (42.3)	9 (34.6)	6 (23.1)
Cardiac conditions (17)	8 (47)	9 (53)	5 (29.4)	3 (17.6)	3 (17.6)	3 (17.6)	3 (17.6)	0 (0)	0 (0)	2 (11.8)	10 (58.8)	5 (29.4)
Urologic conditions (14)	6 (42.9)	8 (57.1)	4 (28.6)	3 (21.4)	3 (21.4)	2 (14.3)	2 (14.3)	0 (0)	1 (7.14)	6 (42.9)	2 (14.3)	5 (35.7)
Respiratory conditions (8)	3 (37.5)	5 (62.5)	3 (37.5)	2 (25)	1 (12.5)	1 (12.5)	1 (12.5)	0 (0)	1 (12.5)	3 (37.5)	2 (25)	2 (25)
Reproductive conditions (8)	0 (0)	8 (100)	3 (37.5)	2 (25)	1 (12.5)	1 (12.5)	1 (12.5)	0 (0)	2 (25)	3 (37.5)	1 (12.5)	2 (25)
Helminthosis (5)	2 (40)	3 (60)	2 (40)	2 (40)	1 (20)	0 (0)	0 (0)	0 (0)	2 (40)	3 (60)	0 (60)	0 (60)
Multiple diseases (23)	9 (39.1)	14 (60.9)	9 (39.1)	5 (21.7)	3 (13)	2 (8.7)	4 (17.4)	0 (0)	1 (4.3)	5 (21.7)	6 (26.1)	11 (47.8)
Undetermined (26)	11 (42.3)	15 (57.7)	11 (42.3)	5 (19.2)	3 (11.5)	2 (7.7)	5 (19.2)	3 (11.5)	3 (11.5)	11 (42.3)	5 (19.2)	4 (15.4)

after exposure to and ingestion of contaminated feed (Newman *et al*. 2007; Dereszynski *et al*. 2008). In this study, cancer was the third etiology of death at 15.3% in the adult dogs. Other studies by Proschowsky *et al*. 2003 and Michell, 1999 reported a prevalence of 14.5% and 15.7% respectively. Cancer has been reported to be a frequent etiology of death in dogs from larger breeds and is a disease of older age (Fleming *et al*. 2011; Bonnett and Egenvall, 2010). In the absence of reliable histological tumor registries, it was difficult to know the prevalence of specific types of cancer in dogs.

The findings of this study showed that there was no association between sex of the dogs and adult dog morbidity and mortality. This was in agreement with studies by Bronson, (1982) and Moore *et al*. (2001). A study by Michell, (1999) noted that neutered females lived significantly longer than males or sexually intact females. This could not be reported in this study, as the neuter status of the dogs was not determined. The study showed that there was significant association between breed and adult dog morbidity and mortality. This was in agreement with studies by Proschowsky *et al*. (2003), Giger *et al*. (2005), Lindbald- Toh *et al*. (2005), Egenvall *et al*. (2005), Bonnett *et al*. (2005) and Dobson, (2013). Studies have also shown that dogs from larger breeds have shorter lifespans than dogs from smaller breeds (Fleming *et al*. 2011) and that many purebreds have a significantly lower life expectancy than crossbreed dogs (Egenvall *et al*. 2000).

Table 3: Prevalence and incidence rates of tick borne infections

Variables		Number sampled	Number positive	(%)
Blood parasites	*Ehrlichia*	643	125	19.4
	Babesia	643	29	4.5
	Haemabartonella	643	32	5
	Mixed infections	643	91	14.2
Sex	Male	308	132	42.9
	Female	335	145	43.3
Breed	German Shepherd dogs	413	240	58.1
	Crosses	129	27	20.9
	Rottweilers	61	6	9.8
	Labrador retrievers	12	2	16.7
	Others	28	2	7.1
Age (in years)	1-2	230	74	32.2
	3-4	227	90	39.6
	5-6	114	80	70.1
	7-8	38	22	57.9
	Above 9	34	11	32.4

Table 4: Prevalence and incidence rates of helminth infections

Variables		Number sampled	Number positive	(%)
Helminths	*Ancylostomum caninum*	643	183	28.5
	Toxocara canis	643	33	5.1
	Coccidial cysts	643	1	0.2
	Mixed infections	643	98	15.2
Sex	Male	308	175	56.8
	Female	335	140	41.8
Breed	German Shepherd dogs	413	225	54.5
	Crosses	129	68	52.7
	Rottweilers	61	13	21.3
	Labrador retrievers	12	3	25
	Others	28	9	32.1
Age (in years)	1-2	230	99	43
	3-4	227	113	49.8
	5-6	114	71	62.3
	7-8	38	17	44.7
	Above 9	34	15	44.1

The study also showed that age had a significant association to adult dog morbidity and mortality. This was in agreement with studies that have shown that older dogs have an increased rate of mortality due to neoplasia, cardiovascular, or urologic diseases (Craig, 2001; Egenvall *et al*. 2005; Bonnett *et al*. 2005; Tarafder and Samad, 2010; Fleming *et al*. 2011). Conclusions regarding cause-specific mortality could not be drawn because of the small sample size.

The prevalence of canine ehrlichiosis was relatively high at 19.4%. Studies by Trapp *et al*. (2006) and Santos *et al*. (2009) reported that the prevalence of canine ehrlichiosis ranged from 14 to 44.7%. The prevalence of *Babesia* was at 4.5%. A study by Chaudhuri, (2006) reported a prevalence of 9% but the species of piroplasm infecting the dogs was not reported. *Haemabartonella* had a prevalence of 5%. Studies by Biondo *et al*. (2009) and Novacco *et al*. (2010) reported a prevalence of infection varying from 0.5 to 40%. The variations in the prevalence rates can be attributed to the diversity of diagnostic protocols used by the authors, and environmental factors involved in the epidemiology of the tick borne infections in the regions studied.

The results of this study showed that there was no significant association between sex of dogs and tick borne infections. This was similar to the findings of Samradhni *et al*. (2005), Yabsley *et al*. (2008) and Rahman *et al*. (2010) but was different from the findings by Kordick *et al*. (1999) which showed males had a higher risk for tick borne infections. Males and females were exposed to identical parasite control measures and the probability of tick infestation between female and male dogs were similar, thus they had an equal chance to be infected.

In this study, there was significant ($P<0.01$) association between dog breeds and tick borne infections. However, this was different from the studies by M'Ghirbi *et al*. (2009) and Rahman *et al*. (2010) but was similar to the findings of Miller and Zawistowski, (2004) and Harrus and Waner, (2011) and who noted that German shepherd dogs had the highest mortality rate as they were more susceptible to tick borne infections compared to the other breeds. Among the different age groups, older dogs (ages 5-6 and 7-8 years) had the highest incidence rates (70.1% and 57.9% respectively) of tick borne infections. Previous studies showed that the older the dogs, the higher the probability of being exposed to *Ehrlichia canis* (Watanabe *et al.* 2004; Rembeck *et al*. 2007; Rahman *et al*. 2010).

Concurrent infections of canine ehrlichiosis, canine babesiosis and haemabartonellosis were observed in this study. This was in agreement with studies done by Assarasakorn and Niwetpathomwat, (2007) and Rani *et al.* 2011). *Rhipicephalus sanguineus* is the predominant tick vector that transmits the *Ehrlichia, Babesia* and *Haemabartonella spp*. (Dantas-Torres, 2008; Kledmanee *et al*. 2012; Hii, 2012). Environmental infestation can perpetuate the tick's life cycle, causing recurrent or persistent infection in a kennel (Rani *et al*. 2011).

In this study, *Ancylostomum caninum* was the greatest contributor as a parasitic disease of the gastrointestinal tract that had the highest frequency of occurrence. *Toxocara canis* had a lower prevalence rate. This was in agreement with studies done by Kagira and Kanyari, (2000), Martinez-Carrasco *et al.* (2007), Inpankaew, (2007), Traub *et al*. (2008), Enes *et al*. (2010) and Ngui *et al*. (2012). These findings confirm the hypothesis that infection pressure from canine intestinal parasites is higher in kennels than in individual domestic situations. The improper use of effective dewormers and inappropriate deworming schemes may influence the prevalence of helminths (Swai *et al*. 2010).

The results of this study showed that there was a significant ($P<0.01$) association between sex of the dogs and helminth infections. This was also observed earlier by Kutdang *et al*. (2010), however, was not in agreement with a study by Swai *et al*. (2010). The male dogs had a higher infection rate than their female counterparts. This was not in agreement with a study by Wakelin, (1984) who reported that female dogs were more infected with helminth parasites than the male dogs due to the physiological peculiarities of the female dogs, which usually constitute stress factors thus reducing their immunity to infections.

In this study, there was significant ($P<0.01$) association between dog breeds and helminth infections. This was similar to the findings of Akeredolu and Sowemimo, (2014) who observed that crosses were more susceptible to helminth infections compared to the other breeds. The findings of higher incidence rates in the German Shepherd dogs may be attributed to the larger

sample size. The results of this study showed that there was a significant (P<0.01) association between different age groups and helminth infections. This was in agreement with Kutdang *et al*. (2010) and Swai *et al*. (2010) who reported that younger dogs less than 4 years of age had the highest incidence rates, while the least incidence rate was among older dogs.

Dogs in some of the kennels had concurrent infections with *Ancylostomum caninum* and *Toxocara canis* and *Ancylostomum caninum* and *Coccidial* cysts. This is possible as the dogs may contract infections due to poor nutrition and poor sanitary conditions (Kutdang *et al*. 2010).

Conclusion

The results of this study emphasize the importance of a variety of diseases and conditions in causing morbidity and mortality of the kenneled adult dog population. Diseases such as tick borne infections, skin conditions and helminthosis can be attributed to errors in management practices. Awareness of the diseases and conditions will help reduce morbidity and mortality, improve quality of life, and extend the lifespan of the dogs through implementation of preventive medicine and proper management practices.

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