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COLLEGE OF BASIC AND APPLIED SCIENCES

PET OWNERSHIP AND PARASITIC INFECTIONS IN COMPANION ANIMALS IN SELECTED COMMUNITIES IN SOUTHERN GHANA

EMMANUEL OKORIE BAAH

(10388298)

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DECLARATION

I hereby declare that the research work in this thesis is authentic and was conducted by the author. Works from other authors, where appropriate, have been duly cited. This work has not been submitted to any institution for the award of any degree.

CANDIDATE

EMMANUEL OKORIE BAAH

SIGNATURE...

DATE……………………………..……..

SUPERVISORS

DR. FRED ABOAGYE-ANTWI

SIGNATURE………………………………

DATE……………………………...........

DR. ISAAC FRIMPONG ABOAGYE

SIGNATURE…………………..……......

DATE……………………....……..........

DR. DANIEL ODURO

SIGNATURE...

DATE..

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ABSTRACT

In Ghana, companion animals such as dogs are rarely given medical treatment and thus serve as reservoirs of zoonotic diseases. The close relationship of dogs and horses with humans poses risk of zoonoses. Identifying the factors that affect dog ownership and infections in dogs and horses is useful for provision of veterinary services and reducing risk of human infections. A cross sectional study was conducted to identify factors that affect dog ownership and to evaluate the factors that affect helminth infections in dogs and horses in Ghana. Using coprological, haematological and interviewing techniques, 428 dogs, 78 horses and their owners or handlers were studied. It was found out that gender, reason for keeping dogs, occupation and religion influenced dog ownership ($p < 0.001$). The prevalence of helminth infections in dogs was 66.6%. *Ancylostoma caninum* (39.5%), *Toxocara* (40%), *Dipylidium caninum* (26.2%) were the zoonotic helminths identified in the study. *Spirocerca lupi* (3.0%) was the only helminth that was not known to be zoonotic. A chi-square analysis suggested that deworming status was significantly associated with helminth infection in dogs ($p < 0.001$). The prevalence of *Babesia* spp. in dogs was 7.7%. It was found that 69.4% of dog owners never dewormed their dogs and 89.7% of respondents knew rabies as a canine zoonosis. However, none of the respondents were aware of any helminthozoonoses or protozoonoses. The prevalence of helminth infections in horses was 39.7%. The helminths identified in horses were *Parascaris* (32.9%), Strongyle-type eggs (26.0%) and *Trichostrongylus* (8.2%). Inherent factors such as age, sex and breed were not statistically associated with helminth infection in horses ($p > 0.05$). The prevalence of *Babesia* spp. in horses was 11.0%. None of the stable keepers were aware of any equine-related zoonoses. It is concluded that gender, religion, occupation and reasons for keeping dog were significant factors that may influence dog ownership. Deworming status was also a significant factor

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associated with helminth infection in dogs. The difference in proportion of dog owners based on factors such as gender, religion could be influenced by the high number of male heads in Ghanaian households and religious or socio-cultural beliefs. Variations in parasite prevalence could possibly reflect differences in pet management practices, parasite and host species, anthelminthic treatment, local climatic conditions and possibly, diagnostic techniques. Based on the limited knowledge of respondents on zoonoses, integrative approaches on creating public awareness on zoonoses, and management of companion animals is recommended to protect the health of dogs and humans.

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DEDICATION

This thesis is dedicated to my beloved mother Lydia Baah Agyakwa.

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LIST OF ABBREVIATIONS

ELISA	Enzyme-linked immunosorbent assay
PCR	Polymerase chain reaction
CAT	Computed axial tomography
PCR-RFLP	Polymerase chain reaction- Restriction fragment length polymorphism
EPG	Egg per gram
MAFF	Ministry of Agriculture, Food and Fisheries
DABCS	Department of Animal Biology and Conservation Science
SPSS	Statistical Package for Social Scientist
DNA	Deoxyribonucleic acid
WHO	World Health Organization
P	Prevalence
MI	Mean intensity
SEM	Standard error of mean
EDTA	Ethylenediaminetetraacetic acid

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CHAPTER ONE

1.0 INTRODUCTION

1.1 General Introduction

Generally, pets are kept for companionship, recreational purposes, hunting and security (Serpell, 1986). However, the reasons for keeping pets may vary across cultural societies (Hart, 1995). The importance of pets in human life have been established by many studies (Akiyama *et al*., 1987; Bolin, 1987; Garrity *et al*., 1989). The relationship between pet ownership and human health is questionable due to difficulties in assigning a direct connection (Headey, 2003). According to Tower & Nokota (2006), pet owners are less depressed, suffer less from mental stress and have higher self-esteem compared to individuals who do not own pets. However, despite the many benefits derived from association with pets, these animals including dogs, serve as reservoir hosts for several zoonotic diseases (Damborg *et al*., 2016) and pose significant risk to human health and welfare (Talan *et al*., 1999; Weiss, 1998).

Among the many pets are dogs and horses with dogs probably being the most common household pets around the world (Ugbomoiko *et al*., 2008). In Ghana, the number of owned household dogs is about one million, not including the many wandering dogs that stray from street to street in some communities (Veterinary Service Directorate, 2009). Pet ownership is rarely associated with companionship or recreational purposes in Ghana. Dogs in most Ghanaian households are kept for hunting in rural communities and security in most urban and semi urban households (Johnson *et al*., 2015).

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Studies have shown that companion animals such as dogs are a potential source of several zoonotic diseases, most of which can be threats to human health and well-being (MacPherson, 2005). According to McCarthy & Moore (2000), possession of a pet is a risk factor for the incidence of pet related zoonotic diseases, especially for most dog owners in Ghana (Johnson *et al*., 2015). In Johnson's report, dog owners who kept dogs for hunting reasons constituted the highest proportion of dog owners. Hunting dogs had the highest prevalence of zoonotic helminths such as *Dipylidium*, *Toxocara* and *Ancylostoma*.

Helminths are the commonly encountered enteric disease-causing organisms in dogs worldwide (Ramirez-Barrios *et al*., 2004). Epidemiologically, helminths are also regarded as the most important parasites. In Africa, prevalence of worm infections in dogs ranges from 62.6% in Ghana (Johnson *et al*., 2015), 67.2% in Tanzania (Muhairwa *et al*., 2008), 72.5% in Nigeria (Mahmuda *et al*., 2012), 89.3% in Ethiopia (Mekbib *et al*., 2013) to 91.4% in Gabon (Davoust *et al*., 2008). Some of these helminths that infect dogs are known to be zoonotic and cause diseases like Hydatidosis., Toxocariasis (Overgaauw & Knapen, 2013; Sowemimo & Ayanniya, 2017), cutaneous larva migrans (Brooker *et al*., 2004; Khalafalla, 2011) in humans. Some studies have reported the presence of blood-borne parasites such as *Piroplasma* spp., *Ehrlichia* spp., *Hepatozoon canis* and *Trypanosoma* spp. in domestic dogs (Ahmed *et al*., 1994; Useh *et al*., 2003; Adamu *et al*., 2012; Nonyelu, 2013). Pregnant women, children under five years and the elderly are at risk of contracting pet related zoonotic diseases (Kourtis *et al*., 2014)

Horses unlike dogs are less common in most Ghanaian communities and homes. They are considered as livestock pets. They are mostly used for activities such as horse riding, entertainment and agriculture (Useh *et al*., 2005). Horses, like many other pets are known to suffer from parasitic infections, some of which are zoonotic. Studies on the prevalence of

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helminths of horses have shown different prevalence under varying management systems (Boxell *et al*., 2004). Parasitism has been identified as the most important hinderance to the successful rearing of horses worldwide (Capewell *et al*., 2005). Inherent factors such as age and sex have been found to influence parasitic infections (Bucknell *et al*., 1995), with young horses carrying several parasites accompanied by serious manifestations.

This study therefore aimed at investigating the factors that are associated with pet ownership, parasitic infections in companion animals, and risk factors that are associated with parasitic infection in companion animals.

1.2 Rationale of study

Pets are an integral part of households in most countries where they share human lifestyles, bedrooms and beds (Chomel & Sun, 2011). As modern society becomes more urbanized, the presence of traditional and exotic companion animals increases in popularity (Chomel & Sun, 2011). This is evidently true in Ghana since there has been an increase in the number of exotic dog breed sellers in the Greater Accra Region over the past few years (Daily Guide, 2011). According to Daily Guide (2011), there are over 150 unconfirmed dog breeders in Accra alone. There has also been a reported increase in the number of free roaming dogs (The Mirror, 2008). Hence, one of the aims of this study was to shed light on factors influencing dog ownership.

In most Ghanaian communities, the rearing of domestic animals and keeping of pets in homes are common practices. However, despite the many benefits of pets such as psychological support, improved health and companionship (Akiyama *et al*., 1987; Ownby *et al*., 2002; Parslow, 2005; Staats *et al*., 2008), very little attention is invested in the health of these animals, considering the

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fact that diseases of these animals could be zoonotic and could have serious health implications on the owners, the immediate family and the communities as a whole (Amissah-Reynolds *et al*., 2016). Several studies attest to the fact that some infections of companion animals could be transmitted to humans and vice versa (Katagiri & Oliveira-Sequeira, 2007; Khante *et al*., 2009; Damborg *et al*., 2016), particularly in some rural areas where dogs are kept together with other livestocks (Chrieki, 2002). Between 2002 and 2010, numerous outbreaks of reported zoonotic diseases were identified and found to be associated with household pets (Smith & Whitfield, 2012). In developing countries such as Ghana, the greater number pet owners live under poor conditions and pet management as well as disease control strategies are non-existent. Zoonotic infections should therefore be of great concern since majority of emerging infectious diseases are zoonotic (Andersen, 1997; Oliveira-Sequeira *et al*., 2002; Chomel *et al*., 2007). A human case of *Toxocara* infection with prevalence of 53.5% was reported in children in the Central Region of Ghana (Kyei *et al*., 2015).

The continuous growth of the dog breeding industry in Ghana has necessitated the need for veterinary interventions to mitigate the impact of zoonoses on public health. Epidemiological reports suggest that free roaming dogs have highest prevalence of parasites (Aberes *et al*., 2013; Bhattacharjee & Sarmah, 2013). Prevalence of helminth infections is high in dogs of owners who rear them for hunting purposes (86.4%) and security purposes (59.2%) (Johnson *et al*., 2015). A study by Johnson *et al*., 2015 showed that dog owners who bought their dogs from street dog sellers in Ghana had dogs that were significantly infected with helminths.

An understanding of the demographics and factors that are associated with dog ownership may be of public health and veterinary importance (Robinson & Pugh, 2002), social psychology

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(Akiyama *et al.*, 1987; Bolin, 1987; Garrity *et al.*, 1989; Raina *et al.*, 1999), or marketing of veterinary services or products.

Generally, infections in pets are mostly due to the fact that pets are seldomly treated for parasitic diseases and laws on pet management and control are non-existent (Ugbomoiko *et al.*, 2008) or poorly implemented. As such this study also sought to ascertain management practices and their effect on parasite prevalence. The prevalence of helminth parasites varies substantially from one region to another based on the helminth species involved, the host species, and climatic conditions and even management practices (Robertson *et al.*, 2000; Oliveira-Sequeira *et al.*, 2002). It is therefore imperative for timely investigations of the prevalence of these parasites to be conducted within a given area so that effective parasite control strategies in pets could be achieved.

Horses, including most domestic animals are vulnerable to parasites and may be infected with different species (Wannas & Dawood, 2012). Due to the economic importance of enteric parasites, huge amounts of money are invested in the control of these parasites worldwide (Bliss, 2018). Yet, enteric parasites are still a constant menace affecting the health and well-being of horses and other domestic pets in different parts of the world (Mbafor *et al.*, 2012). Horse riders, horse keepers and stable cleaners or caretakers are the population at risk of contracting horse zoonoses.

Very little data exists on pet ownership in Ghana. This study therefore addresses factors that are associated with dog ownership in Ghana, management practices and their association with helminth prevalence.

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1.3 Objectives

1.3.1 General Objective

1. To investigate the factors that affect dog ownership and, parasitic infections in dogs and horses.

1.3.2 Specific Objectives

1. To determine the prevalence of helminths in dogs and horses.
2. To determine the prevalence of haemoparasites in dogs and horses.
3. To determine the association between pet keeping/management practices and helminth prevalence in dogs and horses.
4. To assess the knowledge, attitudes and practices of dog and horse owners in their management.

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CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Pet ownership

Humans have been keeping pets for many years (Serpell, 1986). Pet ownership is a common practice in many households in many countries (AVMA, 1993; Butler & Bingham, 2000; Murray *et al*., 2010). Although companion animals (pets) may be defined in many ways (Eddy, 2003), cats and dogs are conventional paradigms of pets. In Canada, it was estimated that 56% of homes owned a dog or cat (Perrin, 2009). In the USA, about 56% of houses constituting 53 million have companion animals (APPMA, 1994). In South Africa, it has been reported that 37% of homes that keep companion animals kept dogs and cats, horses and birds (Odendal, 1994). An estimated 2% of the households in USA own an average of 2.54 horses (AVMA, 1993). Pet ownership in European homes include Germany (37%), Ireland (70%), Britain (55%) and France (63%) (Reader's Digest Association Inc, 1991). Pet ownership is associated with spending of time and financial resources. An estimated 40.8 billion dollars is spent yearly on pet industry in United States (APPMA, 2007). Pet ownership is also generally related to demographics and there are various definitions of pet and pet ownership (Salman *et al*., 1998; Hart, 2003), yet there is little data regarding the reasons for having pets.

In Ghana, pets are kept for several reasons. Some Ghanaians keep pets such as dogs for hunting. Others keep dogs for security reasons and few keep dogs for recreational and companionship purposes. A study conducted by Johnson *et al*., 2015 reported 27.1% and 56.8% of dogs were kept for hunting and security respectively whilst 8.4% and 7.6% were kept for companionship and breeding purposes respectively in the Greater Accra region of Ghana.

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Many studies have been conducted on the factors associated with dog ownership some in developed countries (Franti & Kraus, 1974; Westgarth *et al*., 2007). However, only a few studies have been conducted in developing countries (Knobel *et al*., 2008). In Tanzania, pet ownership is largely observed among better educated, large and wealthier households (Knobel *et al*., 2008). In this same report, it was observed that households with Muslim occupants were less likely to own dogs than households with Christian occupants. It was also reported that households that had male heads were more likely to own a dog. Several reports in Sub-Saharan Africa indicate that the number of unowned dogs is low (Knobel *et al*., 2008). The number of the dogs owned varies significantly worldwide. In Africa, many dogs are not restricted and hence, stray freely (Beck, 2000). In Chad, 10.9% of the total dog population is not owned and are considered stray dogs. In Sri Lanka, 19% of the dog population is not owned (Kayali *et al*., 2003). In Tunisia, about 5-15% of the dog population was considered “stray”.

The breeding of companion animals such as exotic dog breeds has become very common in Ghana. Unconfirmed reports indicate that there are over 150 dog breeders in Accra alone. The dog trade industry in Ghana is a diverse mix of small scale and large-scale systems which comprises a range of street side pet sellers to well organized breeder houses in large cities. The interest and demand of many Ghanaians to pet exotic dog breeds has made the dog trade industry lucrative. This has attracted many others to join the dog trade industry. Dog breeders in Ghana sell puppies at price of 500 to 2,000 GHC depending on the breed of dog. However, local dog breeds are very cheap, hence are common in many Ghanaian homes, resulting in growing population of owned and stray dogs.

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Horses are not common household pets in Ghana. In Ghana, horses are kept for games in polo clubs, rides on beaches and parade in the military and police force. In some communities, especially the Northern part of Ghana, horses are a vital part of festivals where chiefs ride on beautifully adorned horses. According to a stable keeper at the Accra Polo grounds, horses are owned by several stakeholders who enrol their horses in polo games for profit and sometimes offer them for sale.

2.2 Companion animals

A companion animal or pet is a tamed animal that is kept for pleasure rather than utility (Eddy, 2003). This description of a pet focuses on an animal that is kept for pleasure and companionship, while specifically excluding utilitarian contribution to labour, health and perhaps security. Large animals such as horses, camels, donkeys and elephants that are used for transportation and for carrying loads may fill a role as companions and may be strongly attached to their human handlers. Fishes, gerbils, birds, rabbits or hamsters, frogs, lizards, snakes, guinea pigs and turtles have been reported in some homes as pets (Perrin, 2009). A survey conducted in 1992 on companion animals in South Africa reported that there were about 393 million dogs, 1 million horses, 98 million birds, 97 million cats and 22 million other companion animals (Odendal, 1994). Dogs are the commonest household companion animals with horses being the least common (Odendal, 1994).

In Ghana, little information exists on the demographics of companion animals except that an annual census is taken by the Veterinary Service Directorate of Ghana. However, this census only reflects the number of reported cases at the various veterinary clinics, and not all pet owners are veterinary clients. According to the Veterinary Service Directorate (2009), Ghana has a

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population of about one million owned dogs. No reliable information currently exists on the demographics of other companion animals in Ghana since a comprehensive study on the demographics and census of companion animals has not been conducted. Pfukenyi *et al*. (2010) reported that 82% of respondents owned dog in Zimbabwe in a survey of pet ownership. The global dog population is estimated to be more than 500 million (Hsu *et al*., 2003).

2.3 Classification of dog populations

The different relationships between cultures and the dogs associated with them has varied the structures of canine population. The classifications of dog population are based on the degree of dependence and supervision by humans. According to Matter & Daniels (2000), three types of dog populations have been classified: dogs that do not roam without human supervision; dogs that stray or roam without human supervision; and dogs that are not owned and freely roam. WHO (1990) classifies dog population as: restricted dogs that are supervised and are dependent on humans for resources; family dogs that semi-restricted, stray partly and are dependent on humans for food; neighbouring dogs that are semi-restricted, roam freely and are semi-dependent on humans for food; feral dogs that are unrestricted and are not dependent on humans for resources.

2.4 Importance of dog and horses

Pets such as dogs are kept in households for security and companionship (Serpell, 1986). In Ghana, Johnson *et al*. (2015) reported that dogs were kept in homes for hunting, security and companionship reasons. In Zimbabwe and Kenya, dogs are appreciated for the security they offer both humans and livestock against invaders (Butler & Bingham, 2000). According to Serpell (1986), Marvin (1998), and Podberscek (2009), dogs are a delicacy in some cultures. In some

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parts of West Africa and Southeast Asia, dogs are important source of protein in diet. In Nigeria, dogs serve as meat in some local communities (Opara *et al*., 2004; Ayinmode *et al*., 2016). However, in a report by Gadegbeku *et al*. (2013), 64% of respondents in Ashongman-Accra in Ghana considered dog meat as a food taboo for religious, ethical, superstitious and compassionate reasons. In the Islamic religion however, dogs are considered to be spiritually impure (Beck, 2000). The relationship between dogs (stray or communal) and humans is not always postive. In South Africa, dogs cause problems such road accidents, barking, biting children and livestock, and faecal contamination (Beck, 2000). In some developed counties, dogs are important in forensic investigation, being able to locate people or illegal drugs (Stejskal, 2012; Alexander *et al*., 2015). Sniffer dogs have been used by law enforcement agencies in legal investigations for detection of drugs, explosives, arson, cadaver, search and rescue, tracking, training and fieldwork for decades (Stejskal, 2012).

Horses are utilized through activities such as horse riding and police service (Patterson, 2002), transportation (Greene, 2008), agriculture (Thompson, 1976) and historically in warfare (Stanek *et al*., 2004). Curative horse-riding programs have shown positive effects on the well-being of people with disabilities (Yorke *et al*., 2008). Many products such as meat, milk, hide, hair, bones are derived from horses (MaCGregor, 1985; Chong-Eon *et al*., 2007). Drugs such as Premarin, a menopausal oestrogen replacement therapy is extracted from the urine of pregnant horses (Tempelman-Kluit, 1999). Horse meat is eaten in many parts of the world (Ambriz, 2004; Chong-Eon *et al*., 2007). The bone of horse is used to make implements (MaCGregor, 1985), the hooves are used for making animal glue (Bartlett, 1994) and skin as the leather for making jackets and baseball gloves (Ockerman & Hansen, 2000). The tail hair of horses can be used for making string musical instruments such as violin and viola (McCutcheon, 2000; Matsutani, 2002).

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2.5 Impact of pet ownership on owner's health and behaviour

Evidence suggests that pet ownership is beneficial to human health and behaviour (Serpell, 1991). Friedman *et al*. (1980) reported significant statistical association between pet ownership and survival of patients. However, the approaches used in Friedman's work have been criticised (Wright & Moore, 1982), and the results have not been reproduced (Serpell, 1991). Other reports indicate that if a person is strongly attached to animal companion, it may help lessen the impact of negative life events, such as grief, and have positive effect on anxiety and depression (Akiyama *et al*., 1987; Bolin, 1987; Garrity *et al*., 1989). A decline in risk of asthma, allergic rhinitis and cardiovascular diseases has been reported in people exposed to pets (Anderson *et al*., 1992; Nafsted *et al*., 2001; Ownby *et al*., 2002). Reduced symptoms and risk of depression have been observed in the aged with strong pet attachments (Garrity *et al*., 1989). Siegel (1990) also reported that people who own pets have less stressful life. However, other studies have failed to detect a relationship between pet ownership and improved health status (Ory & Goldberg, 1983; Robb & Stegman, 1983). Parslow *et al*. (2005) reported depression and poorer physical health among pet owners. Researchers have also demonstrated that pet ownership among the elderly provides no health benefits (Tucker *et al*., 1995; Simons *et al*., 2000) or emotional distress (Stallones *et al*., 1991). Boredom and loneliness have also been reported among pet owners (Wells & Rodi, 2000). Other researchers also failed to prove that pet ownership is linked with a reduced risk of cardiovascular diseases (Parslow & Jorm, 2003) or any psychological or physical health improvement of the elderly (Parslow *et al*., 2005).

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2.6 Parasite prevalence in free roaming pets

Free-roaming cat and dog populations have been identified as risk to public health (Traub *et al*., 2005; Garde *et al*., 2013; Gerhold & Jessup, 2013). Free-roaming dogs and cats lack the veterinary care to control zoonotic diseases and hence, pose a potential health hazard to humans and other animals (Gerhold & Jessup, 2013; Garde *et al*., 2013). Responsible pet owners are able to significantly control pet related zoonotic diseases through proper routine veterinary care and vaccinations (Gerhold & Jessup, 2013). However, in a study conducted by Amissah-Reynolds *et al*., 2016 in Ghana, 46% of 100 respondents never dewormed their dogs. This suggests that only a few pet owners exercise dog veterinary care. Amissah-Reynolds and colleagues, however did not report the prevalence of helminth infection in dogs that were not dewormed. Johnson *et al*. (2015) in their report on management practices of dogs reported helminth prevalence in dogs that received anthelminthic treatment. The result was however statistically insignificant. Effective dog management is seldomly achieved because fewer resources are assigned towards dog health and control (Dalla *et al*., 2010).

A study of helminths in stray dogs reported a prevalence of 2%-43% in in Iran (Emamapour *et al*., 2013), 84.78% in stray dogs in Ethiopia (Aberes *et al*., 2013) and 66.7% in Ghana (Amissah-Reynolds *et al*., 2016). Johnson *et al*. (2012) reported significant helminth infection in free range dogs as compared with dogs restricted within walled houses. Dogs and cats act as reservoirs of various zoonotic infections (Labarthe *et al*., 2004; Traub *et al*., 2005). These animals live freely in the community and contaminate the environment with helminths and other protozoans discharged in their faeces (Traub *et al*., 2005; Zibaei *et al*., 2007; Arbabi *et al*., 2009).

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2.7 Helminthozoonoses

Gastrointestinal parasites in pets are common in developing countries (Perera *et al*., 2013). Enteric parasites are the main cause of diseases in dogs (Hendrix & Blagburn, 1983). In Ghana and other countries, gastrointestinal parasites cause significant public health problems (Perera *et al*., 2013; Amissah-Reynolds *et al*., 2016). The association of pet owners with their pets presents a great risk of zoonoses (Aberes *et al*., 2013; Dhaliwal & Prayag, 2013; Amissah-Reynolds *et al*., 2016), despite their beneficial importance such as mental health and even physical well-being (Akiyama *et al*., 1987). Zoonotic diseases are cosmopolitan and are spread through contact of humans with companion animals or livestock.

2.7.1 Echinococcosis

Echinococcosis is a zoonotic disease that is caused consuming the hydatid cyst of *Echinococcus granulosus* and *Echinococcus multicularis* (Schmidt *et al*., 2009). In many developing countries, dogs serve as means of disposing offal and hence, they may get infected when they consume the viscera of an infected animal (Schmidt *et al*., 2009). In the life cycle of the worm, ingested cysts attach to the small intestines and develop. Eggs are produced and are passed in the dog's faeces where they contaminate the environment and are ingested by other animals including humans. Human infection results when eggs of *Echinococcus* spp. are unintentionally ingested usually as a result of caressing dogs. In human infection, cysts develop commonly in the liver, lungs or brain. Some tribes of Kenya have the highest rate of Echinococcosis since they relish roasted dog intestines (Nelson & Rausch, 1963). In Lebanon, leather tanners use dog faeces to tan leather and risk contamination (Schwabe & Daoud, 1961).

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2.7.1.1 Diagnosis, treatment and control of Echinococcosis

Hydatids can be seen using X-radiography, ultrasonography or CAT scans. Immunodiagnostic methods are less sensitive than imagery (Babba *et al*., 1994). Molecular diagnostic techniques such as ELISAs and PCR test for *Echinococcus* spp. are considerably effective (Craig & Larrieu, 2006; Conraths & Deplazes, 2015). Surgery is the only method of treatment when the cyst is found in an unrestricted location (Moro *et al*., 2000). Albendazole is the drug of choice for treatment of Echinococcosis. Elimination can be achieved by refusing dogs access to offal, culling stray and free roaming dogs, and by education of the general public by veterinary services (McManus & Smyth, 1986; Gemmell *et al*., 1987).

2.7.2 Dipylidiasis

Dipylidiasis is a zoonotic disease caused by *Dipylidium caninum*, a cosmopolitan tapeworm found in dogs and cats. The oval gravid segment of the worm is elongate and is shaped somewhat like a cucumber seed. It contains egg capsules or packets, each containing as many as 20 eggs (Griffiths, 1978). The life cycle involves an intermediate host that may be the dog or cat flea (Chen, 1934) or louse and human flea (Bartsocas *et al*., 1966; Craig & Ito, 2007). Gravid tapeworm segments are released in host's faeces. Eggs are ingested by the adult louse or flea larvae. *Thiodectes canis* and *Pulex irritans* also act as intermediate hosts (Neira *et al*., 2008; Ramana *et al*., 2011). The active oncosphere develops to the infective cysticercoid stage in the arthropod host (Robertson & Thompson, 2002). The definitive host becomes infected by consuming the infected arthropod. Chronic enteritis is common in heavy infections. Nervous disturbance and tension are attributed to the tapeworm infections and may be associated with such

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clinical signs as abdominal discomfort, vomiting, convulsions and severe epileptic fits (Bradley, 1971). Gravid segments around the anus may cause anal irritation (Dantas-Torres, 2008).

A human case of zoonoses caused by *Dipylidium caninum* has been reported in China (Peng *et al*., 2017) and in the United States (Turner, 1962; Hunter, 1962). Infants and young children are at risk of contracting Dipylidiasis due to their playing habits with pets (Bartsocas *et al*., 1966; Casasbuenas, 2005; Peng *et al*., 2017). A report from Chile indicates that children between the ages of 2 months to 4 years old are the population at risk of contracting Dipylidiasis (Neira *et al*., 2008). Accidental infection occurs when the flea vector is swallowed or when people kiss or are licked by their pet (Schmidt *et al.*, 2009). Dipylidiasis has a worldwide distribution (García-Agudo *et al*., 2014). Cases have been reported in children and adults in Europe, Japan, China, United States, India, Sudan and Latin America (Neafie & Marty, 1993; Brandstetter & Auer, 1994; Vargas *et al*., 2000; Molina *et al*., 2003; Casasbuenas, 2005; Tsumura *et al*., 2007; Samkari *et al*., 2008; Zhao *et al*., 2008; Li *et al*., 2010; Cabello *et al*., 2011). Another case of human dipylidiasis has also been reported in girl from Spain (García-Agudo *et al*., 2014). In the report it was found out that the girl's family owned a dog with no flea collar and poor veterinary care. Another case of dipylidiasis was reported in Sinaloa, Mexico (Cabello *et al*., 2011).

2.7.2.1 Diagnosis, treatment and control of Dypilidiasis

Diagnosis of *D. caninum* is done by observing rice grain-like proglottids and egg packets in the parasite (Molina *et al*., 2003; Neira *et al*., 2008). Identification of tapeworm segments crawling on stool or on the perianal hairs of dogs is indicative of infection. Tapeworm eggs can be found on faecal examination if segments have been crushed on passage through the anal sphincter or mechanically broken as the faeces are stirred (Griffiths, 1978). Children expel proglottids in

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faeces and they may be found on the anus or diapers (Reis *et al*., 1992; Bowmann, 1995). García-Agudo *et al*. (2014) reported that the incidence of human dipylidiasis is unknown, due to misdiagnosis. Treatment of dipylidiasis has been done with various drugs such as paromomycin, and niclosamide (Jones , 1979) and praziquantel (Wijesundera, 1989; García-Agudo *et al*., 2014).

2.7.3 Toxocariasis

Toxocariasis is a globally distributed zoonosis caused by *Toxocara canis* and *Toxocara cati*. *T. canis* infects dogs and is rare in cats (Anderson, 2000). Birds and livestock (e.g. sheep, pigs and poultry) serve as paratenic hosts (Taira *et al*., 2004). Adult worms inhabit small intestines and somatic tissues of their host. Adult *T. canis* may be 18 cm long, the sub globular egg, about 85µm in diameter, is finely pitted (Anderson, 2000). Surveys have shown that virtually all puppies born are infected with *T. canis* (Barriga, 1988). A survey in Nigeria reported a prevalence of 30.5% *T. canis* infection with 39.5% of the dogs between the ages of 0-6 months (Sowemimo & Ayanniya, 2017). In the United States, more than 30% of dogs less than 6 months were found to be shedding *T. canis* eggs (Blagburn, 2001). Infection is less common in adult dogs but it still occurs (Blagburn, 2001). In the cycle, adult parasite sheds eggs in the faeces of the host. The eggs develop and become infective to the third stage larvae. The larvae invade the host through ingestion of the third stage larvae. The larvae hatch in the digestive system and migrate towards the liver and then move to other organs (Mok, 1968; Woodruff, 1970). Migration in the lungs results in larvae breaking across the alveoli, travelling up the respiratory tract, and then being swallowed to begin egg production in the small intestines (Schmidt *et al*., 2009; Anderson, 2000).

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Foetal puppies acquire *T. canis in utero* when larvae from the dam's somatic tissue are activated late in pregnancy to migrate across the placenta (Burke & Robertson, 1985; Urquhart *et al.*, 1996). The dam appears resistant to parasite and development of larvae to the adult stage is suppressed (Scothorn *et al*., 1965). Puppies are then born with developing ascarids (Urquhart *et al*., 1996). A small number of larvae may also be transmitted to nursing puppies through transmammary route in the mother's milk (Burke & Robertson, 1985; Gillespie, 1988). Transplacental transmission results in more infections than the transmammary transmission (Burke and Roberson, 1985).

Infected dogs may show signs of mild to moderate cough accompanied by a mucopurulent discharge (Urquhart *et al*., 1996). Severe pulmonary oedema, haemorrhage and even death may result just a few days after birth (Urquhart *et al*., 1996). Adult ascarids in puppies can induce mucoid enteritis, which may be associated with mild diarrhoea (Griffiths, 1978; Urquhart *et al*., 1996), anorexia, vomiting, ill thrift, stunting and abdominal discomfort. A characteristic potbelly appearance may develop in heavily infected dogs (Griffiths, 1978). Intussusception and intestinal obstruction due to numerous worms in the small intestine of young puppies have been reported (Lyndell & Michael, 1992; Griffiths, 1978). Poor hair coat and reduced growth have been reported in infected dogs (Schneider *et al*., 2011).

Human Toxocariasis continues to plague humans despite the anthelminthic treatment and regimens given to dogs and cats in some parts of the world (Overgaauw & Knapen, 2013). Prevalence of *T. canis* and *T. cati* vary from 3.5- 34% for *T. canis* in dogs and from 8-76% for *T cati* in cats (Fok *et al*., 2001; Habluetzel *et al*., 2003; Le Nobel e*t al*., 2004; Dubná *et al*., 2007; Martínez-Moreno *et al*., 2007; Lee *et al*., 2010). Human infections usually occur when food products contaminated with the eggs *Toxocara* spp. are consumed (Glickman & Schofer, 1987;

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Nagakura *et al*., 1989; Stürchler *et al*., 1990; Baixench *et al*., 1992; Salem & Schantz, 1992; Taira *et al*., 2004). Dog contact may be an important source of transmission of *Toxocara* eggs to pet owners (Wolfe & Wright, 2003; Aydenizöz-Özkayhan *et al*., 2008; Roddie *et al*., 2008). Cases of human Toxocariasis have been reported in Africa (Lötsch *et al*., 2017), America (Lee *et al*., 2014; Woodhall *et al*., 2014), Nigeria (Okewole, 2016), Kenya and Tanzania (Wiseman & Woodruff, 1971) and Ghana (Kyei *et al*., 2015).

2.7.3.1 Diagnoses, treatment and control of Toxocariasis

Diagnosis is established on clinical manifestations, laboratory examinations, molecular and sero-diagnostic methods (Overgaauw & Knapen, 2013). Asymptomatic infections also commonly occur (Pawlowski, 2001). Laboratory diagnosis of *T. canis* infection involves the confirmation of characteristic globular eggs with thick, pitted shells. Whole worms in vomitus or faeces may be identified. ELISAs using specific secretory-excretory antigens and liver biopsies are also employed in clinical diagnosis (Schmidt *et al*., 2009). Computer tomography, sonography and MRI are used in diagnosis of *Toxocara* infection (Magnaval & Glickman, 2006; Lim, 2008).

Adult worms in dogs may be satisfactorily removed with piperazine and organic phosphorus compounds (Griffiths, 1978). Mebendazole as a drug for treatment is effective in human infections (Magnaval, 1995). Febendazole has also been used in the treatment of Toxocariasis in dogs (Overgaauw & Knapen, 2013). To reduce vertical transmission of *T. canis* from dam to puppies, topical selamectin is administered to pregnant bitches and lactating dams at 6 mg/kg (Payne-Johnson *et al*., 2000). Febendazole is also administered orally at 50 mg/kg daily (Burke &

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Roberson, 1983). Ivermectin is administered orally at 300 µg/kg body weight (Payne & Ridley, 1999).

Control programmes consist of routine deworming of household pets, and proper disposal of faeces (Schmidt *et al*., 2009). Preventing defecation of pets in public, hygiene, and public education are some control actions against *Toxocara* infection (Glickman & Shofer, 1987)

2.7.4 Ancylostomiasis (Hookworm disease)

Ancylostoma caninum is common cosmopolitan parasitic bloodsucking hookworm that causes a disease known as Ancylostomiasis in dogs (Meyers *et al*., 1976). The definitive host of this nematode parasite include dogs, foxes and humans for *A. caninum*; dogs, cats and foxes for *A. braziliense* (Griffiths, 1978). Eggs are usually laid in the 8-cell stage and are 60 × 40µm (Griffiths, 1978). *A. caninum* has been reported throughout the United States and Africa (Croese *et al*., 2013; Aberes *et al*., 2013; Johnson *et al*., 2015 Amissah-Reynolds *et al*., 2016).

In the life cycle, the host releases eggs in the faeces after entry of parasite into the host (Yoshida *et al*., 1974). The third-stage larvae *A. caninum* can be transmitted orally (Foster & Cross, 1934). Dogs can also become infected with *A. caninum* upon skin penetration (Loos, 1898). The larvae migrate in the bloodstream to the lungs, coughed up and are swallowed to develop into adults in the small intestine and lay eggs (Schmidt *et al*., 2009). Larvae that migrate to the lungs remain in circulations and develop into quiescent forms in the muscles of dogs (Lee *et al*., 1975; Little *et al*., 1983). If the dog is a female, the quiescent larvae will become active late in pregnancy, move to the mammary glands and be transmitted to the suckling puppies (Stone & Girdeau, 1966). Such transmammary infections can result in large numbers of larvae being passed directly into neonatal

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puppies. The quiescent larvae may also be reactivated in adult dogs in the absence of pregnancy or lactation, migrating to the small intestine to establish a patent infection even in the absence of exposure to infectious stages in a contaminated environment (Urquhart *et al*., 1996). Transplacental transmission occurs in pregnant bitches which are infected cutaneously or orally and worms do not mature in the puppies until they are born (Clapham, 1962; Foster, 1932; Foster, 1935).

Clinical manifestation in puppies and young dogs presents acute anaemia because of blood loss induced by the worms in the intestines (Urquhart *et al*., 1996). This anaemia is severe and may be fatal in neonatal puppies that acquire large numbers of larvae by transmammary transmission (Urquhart *et al*., 1996). In puppies as young as 10 days old, bloody diarrhoea, anaemia, hypoproteinaemia and death may ensue. In older dogs, non-regenerative iron deficiency anaemia may result. In a contaminated environment, larvae can penetrate the skin and may cause dermatitis (Schantz, 1994).

Human infection due to zoonotic ancylostomiasis is rare but have been reported in many parts of the world (Anten & Zuidema, 1964; Velasquez & Cabrera, 1968; Yoshida *et al*., 1968; Areekul *et al*., 1970; Chowdhury & Schad 1972; Croese *et al*., 1994a; Croese *et al*., 1994b; Khoshoo *et al*., 1995; Bahgat *et al*., 1999; Traub *et al*., 2008; Jiraanankul *et al*., 2011; Sato *et al*., 2011; Dhaliwal & Prayag, 2013; Inpankaew *et al*., 2014). Studies in Australia show that intestinal infection with *Ancylostoma caninum* is a major cause of human eosinophilic enteritis (Prociv & Croese, 1996). The infection is accompanied by abdominal pain and eosinophilia (Prociv & Croese, 1996). Studies in Asia, have demonstrated that hookworm of dogs and cats is the second most common hookworm species infecting humans (Traub, 2013).

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2.7.4.1 Diagnoses, treatment and control of Ancylostomiasis

Diagnosis can be done by finding parasite ova in standard faecal flotation using saturated salt or sodium nitrate solution. Concentration techniques can be used to estimate faecal egg counts (Cross, 2000). Finding hookworm ova or worms in faeces is the only conclusive diagnosis of hookworm disease (Schmidt *et al.*, 2009). Speciation hookworm can be accomplished by culturing larvae from faeces (Schmidt *et al.*, 2009). Diagnosis can also be done with the use of molecular techniques such ELISA and western blot techniques (Sato *et al.*, 2010). Speciation with PCR-RFLP has also yielded promising results (Hawdon, 1996).

To reduce the burden of transmammary transmission of *A caninum* from dam to puppies, anthelminthics such as 10% imidacloprid plus 2.5% moxidectin topical solution is administered at day 56 of gestation (Kramer *et al.*, 2006). Febendazole is administered at 50 mg/kg daily in dogs (Burke & Roberson, 1983). Ivermectin is administered intramuscularly at 300 µg/kg post conception (Stoye, Meyer, & Schneider, 1989). An irradiated larva vaccine that was extremely effective against *Ancylostoma caninum* in dogs was discontinued mainly because of its lack of acceptance by the American veterinary profession (Miller, 1978; Urquhart, 1980). Sanitory disposal of faeces is vital to the control of hookworm disease (Schmidt *et al.*, 2009).

2.8 Common haemoparasites of dogs

Canine haemoprotozoan parasites have been reported in dogs in Africa (Opara *et al.*, 2016; Nonyelu, 2013; Anise *et al.*, 2018) and other parts of the world (Bhattacharjee & Sarmah, 2013; Priyowidodo *et al.*, 2018). Haemoprotozoans are unicellular organisms under the sub-kingdom Protozoa (Molyneux & Ashford, 1983). Transmission to their host is usually by the bite of arthropod vectors such as ticks (Birkenheuer *et al.*, 1999) or by ingestion of an arthropod

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intermediate host. Haemoprotozoan infections are common in dogs in tropical countries (Radostis *et al*., 2000). According to Shirvastava (2014) and Tsegay (2016) canine *Babesia* spp., *Leishmania* and *Trypanosoma* are common haemoprotozoan parasites of dogs that result in considerable financial loss arising from treatment and high mortality rate.

2.8.1 *Leishmania* spp. (Haemoflagellate)

Leishmania spp. are a haemoprotozoan parasites that cause Leishmaniasis. The host of the parasite includes human beings, dogs, cats, horses and sheep, with dogs and rodents principally serving as reservoir hosts for spread of zoonotic visceral leishmaniasis (Canavate *et al*., 2004; Ahuja *et al*., 2006; Chappuis *et al*., 2007; Schmidt *et al*., 2009). The parasite is transmitted by a phlebotomine sand fly (Pearson & Sousa, 1996; Chappuis *et al*., 2007). The parasite is found in the reticulo-endothelial cells of capillaries, spleen and other organs of the host. Parasites may also be seen in monocytes, polymorphonuclear leucocytes, and macrophages (Schmidt *et al*., 2009). *L. donovani* affects visceral areas. Parasites are small intracellular, non-flagellated oval or circular bodies about 2 µm wide and 4 µm long. The parasite occurs as a leptomonad in the insect host (Griffiths, 1978). Leishmaniasis could occur due to more than twenty *Leishmania* species. 90% of visceral leishmaniasis cases have been reported from five countries: India, Bangladesh, Nepal, Sudan and Brazil (NCID, 2006). Visceral leishmaniasis occurs due to *L. donovani* complex in Indian, East Africa and *L. infantum* in Africa, Europe and Latin America (Chappuis *et al*., 2007; Lukes, 2007). *L. infantum* causes zoonotic fatal visceral leishmaniasis (Dhaliwal & Prayag, 2013). Visceral leishmaniasis has been reported in a girl in India (Dey *et al*., 2007). A case of advanced kala-azar has been reported in a boy of about 6 years old in Sudan (Hoogstraal &

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Heyneman, 1969). In dogs, infection is accompanied by lesions, alopecia, lymphadenopathy, inflammation, fever, anaemia and splenomegaly (Dhaliwal & Prayag, 2013).

2.8.1.1 Diagnoses, treatment and control of Leishmaniasis

Diagnosis of *Leishmania* spp. is based on identifying Leishman-Donovan bodies in tissues or secretions (Schmidt *et al*., 2009). Molecular and immunodiagnostic tests are sensitive and can detect *Leishmania* parasites (Schmidt *et al*., 2009). Molecular and biochemical methods that hybridizes mitochondrial kinetoplast DNA have yielded promising results in the identification of *Leishmania* (Schoone *et al*., 1991; De Brujin & Barker, 1992; Massamba & Mutinga, 1992).

Treatment is accompanied by inoculation of antimony compounds. The drug of choice used is miltefosine (Sundar *et al*., 2002). Antimonials such as meglumine antimoniate (Glucantime) and allupurinol can be administered to cure Leishmaniasis.

The most effective means of preventing Leishmania infection is through the utilization of topical insecticides, collars and spot-on formulations of pyrethroids on dogs. Vaccines can be used in combinations with repellants and ectoparasticides. Dogs can be housed indoors, ideally in a fine mesh netted environment to decrease sand fly bites.

2.8.2 *Babesia* spp.

Babesia spp. are haemoprotozoan parasites that reside in the red blood cells of mammalian hosts, *Babesia microti* (Kjemtrup & Conrad, 2000), *Babesia divergens* (Telford & Spielman, 1997; Beattie *et al*., 2002), *Babesia duncani* (Bloch *et al*., 2012) and *Babesia venatorum* (Jiang *et al*., 2015) cause zoonotic babesiosis. *Babesia divergens* was first reported in human in Croatia in

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1956 and epidemiological surveys have shown that *B. divergens* may extend beyond Europe into North Africa (Zintl *et al*., 2003). Canine babesiosis is caused by *Babesia vogeli* and *Babesia gibsoni*. Most human cases of Babesiosis are caused by *Babesia divergens* (Genchi, 2007). Canine *Babesia* parasites are distributed throughout tropical and sub-tropical regions.

Peracute babesiosis is accompanied by collapse due to hypotensive shock, pale mucous membranes (Christensson, 1989), tachycardia, weak pulse, lethargy, depression, vomiting and seizures (Rockey, 1961). Usual signs are fever, anaemia, icterus, prostration, and death (Griffiths, 1978). In chronic forms of the disease, signs are vague (Ewing & Buckner, 1935). The manifestations of the disease are quite variable. Clinical findings include splenomegaly, haemoglobinuria, vomiting and diarrhoea (Gorenflot *et al.*, 1998). Chronic babesiosis is characterised with signs such as anorexia, weight loss, lymphadenopathy, nasal discharge and bleeding tendencies.

2.8.3.1 Diagnoses, treatment and control of Babesiosis

Demonstration of parasite in the erythrocyte is best accomplished by taking capillary smears from the margin of the ear (Jacobson, 2006). Giemsa stained thin and thick blood film preparations are effective in diagnosing Babesia infection (Akel & Mobarakai, 2017). Serological and molecular tests such as PCR may detect several species of *Babesia* (Jacobson, 2006).

Acriflavine and trypaflavine have both given good results for the treatment of Babesiosis. Phenamidine is less toxic and quite effective treatment in dogs (Griffiths, 1978). Doxycycline, dexamethasone and prednisolone can be administered to lessen haemolysis but the benefit in

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treatment of babesiosis is uncertain. Other drugs such as imidocarb (dipropionate and dihydrochloride), parvaquone and clindamycin are used to treat babesiosis.

2.9 Gastrointestinal helminths of horses

In a study by Mbafor *et al*. (2012) in Cameroon, enteric nematodes such as *Parascaris equorum, Oxyuris equi., Strongyloides* spp., *Trichostrongylus axei* were identified in horses. These helminths are among the major causes of colic which causes mortality in horses (Reinemeyer & Nielson, 2009b).

2.9.1 *Parascaris equorum*

P. equorum is a large nematode found in horses and other equids (Griffiths, 1978; Anderson, 2000; Epe *et al*., 2004; Lyons & Tolliver, 2004). *Parascaris equorum* is a cosmopolitan species (Von Brand, 1952; Anderson, 2000). Adult *Parascaris* worms live in the small intestine of the horse (Griffiths, 1978; Reinemeyer, 2009a). The worm has three large lips, with each lip having a labial sinus on the lateral margins (Griffiths, 1978). Eggs are sub-globular and has thick, pitted, albuminous shell with brownish colour and contains a one-celled zygote between 90-100 microns in size (Griffiths, 1978).

In the life cycle of *P. equorum*, the female worm lays eggs which develop to the first and second larval stage. The first stage larva migrates from the small intestines into the blood vessels and from there travel to the liver, where they moult into second larval stage (Clayton & Duncan, 1977). The second larval stage migrates to the lungs and invade the alveoli. At this point they are coughed up and swallowed and the larva migrates and develops into adult roundworms in the

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small intestines. (Griffiths, 1978). Eggs are shed in faeces and are picked up by horses in pastures.

Resulting pathogenesis is especially important in young animals and may include pneumonia, bronchial haemorrhage, colic, and intestinal disturbances resulting in morbidity (Southwood *et al*., 1998; Schmidt *et al*., 2009). Intestinal perforation or obstruction is common (Cribb *et al*., 2006; Tatz *et al*., 2012). Colic results from intestinal obstructions caused by a large number of parasites (Tatz *et al*., 2012). Parascariasis is a common disease among horses less than one year (Austin *et al*., 1990). Older horses are usually immune to infection (Roberts & Janovy, 2000). Attempts to demonstrate transmammary or prenatal transmission have not been successful (Anderson, 2000).

2.9.1.1 Diagnosis, treatment and control Parascariasis

Diagnosis is accomplished by finding typical brown sub-globular eggs in faecal flotation. Effective treatments include drugs such as ivermectin or moxidectin which kills the early larval stages, febendazole, pyrantel pamoate, piperazine, dichlorvos and trichlorfon (Poynther & Hughes, 1958; Lyons *et al*., 1976; Lyons *et al*., 2008a; Cobb & Boeckh, 2009). However, impaired efficacy of ivermectin and pyrantel against *P. equorum* and other strongyles have been found in foals (Brazik *et al*., 2006; Lyons *et al*., 2008b; Nareaho *et al*., 2011). Occassional resistance to piperazine has also been reported (Drudge *et al*., 1983).

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2.9.2 *Strongylus* spp.

Strongylus species of horses include four main species; *Strongylus edentatus*, *Strongylus equinus*, *Strongylus vulgaris* and *Strongylus asini*. These species are worldwide except *Strongylus asini* (Melhorn, 2015). *Strongylus vulgaris* is the most pathogenic *Strongylus* species in equids (Griffiths, 1978). The adult worm inhabits the large intestine and caecum. *Strongylus vulgaris* is brownish or reddish if blood has been ingested recently. The egg of *S. vulgaris* is 74-95 × 36-58 µm, *S. edentatus* egg measures 64-99 × 40-57 µm, *S. equinus* measures 70-90 × 40-55 µm and *S. asini* measures 75 × 45 µm (Melhorn, 2015). In Canada, *S. vulgaris* have been found in more than 85% of horses (Slocombe & McGraw, 1973). In a study by Poynther (1969), the occurrence of infection in yearlings was greater than the incidence recorded in foals

The life cycle varies for the different species of *Strongylus***.** The life cycle of *S. vulgaris* will be emphasized since it is the most pathogenic species. Ingested infective third stage larvae penetrate the intestinal wall and mature into fourth stage larvae in about 10 days to two weeks (Ogbourne, 1973). These larvae migrate and penetrate the intima of the submucosal arterioles, and migrate in these vessels toward the anterior mesenteric artery. About 45 days after initial infection, the fourth stage larvae return via the arterial system to the submucosa of the caecum and colon where they become fifth stage larvae about 3 months after initial infection. The larva enters the lumen, mature and produce eggs about 180-200 days after initial infection. Some larvae remain as fourth stage or fifth stage larva in aneurysms in the cranial mesenteric artery. Transmission is through the ingestion of third stage larvae with food and water. Most infective larvae die after a few months' exposure on pasture, but some may survive as long as a year (Griffiths, 1978). There is no evidence of prenatal infection (Drudge *et al*., 1966)

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Diarrhoea is a more frequent sign of infection with strongyles (Dunn, 1969). Anaemia, emaciation, poor coat and poor performance are frequently attributed to large strongyles in the intestine. Following experimental infection in nine months old pony foals, an acute reaction characterised by a marked increase in temperature, loss of appetite, rapid loss of body weight, depression and recumbency, abdominal distress, constipation and occasionally, intermittent diarrhoea were observed (Drudge *et al*., 1966).

2.9.2.1 Diagnosis, treatment and control of Strongylosis

Diagnosis is by demonstrating eggs from faeces, but larvae are required for specific identification. Rectal palpation for aneurysms involving the cranial mesenteric artery may be helpful in diagnosis (Griffiths, 1978). Thiabendazole is widely used and several other anthelminthic drugs have been developed for use in adult horses, including benzimidazole compounds (Bello *et al*., 1973; Bradley & Radharkrishnan, 1973), tetrahydropyrimidines (Cornwell *et al*., 1973) and organic phosphorus compounds (Cook , 1973)

2.10. Equine haemoparasites

The most economically important haemoparasites of horses are *Trypanosoma vivax, T. brucei Babesia bigemina, B. bovis, B. equi, B. caballi, Anaplasma* and *Ehrlichia* (Leeflang & Ilemobade, 1977). Haemoparasites such as *Babesia* spp. and microfilariae have also be reported in horses in Nigeria (Pam *et al*., 2013; Oladipo *et al*., 2015). African animal Trypanosomiasis, Babesiosis and Cowdriosis caused by *Amblyomma* spp. are considered the most important constraints to horse rearing in sub Saharan Africa (Ajeyi & Fabiyi, 1983; Food and Agriculture Organization, 1992).

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Blood-borne parasites have severe and debilitating effects on the health and perhaps the reproductive success of horses.

Equine haemoparasites such as *Babesia* are intraerythrocytic or extraerythrocytic protozoan parasites that cause equine piroplasmosis. Piroplasmosis was first reported in South Africa and was originally called anthrax fever (Henning, 1956; Theiler, 1901). The parasite that causes the disease was later renamed as *Piroplasma equi* (Laveran, 1901). Two different species that infect horses have been identified (Koch, 1904). The species were named *Babesia caballi* and *Babesia equi* (Nuttal & Strickland, 1910; Laveran, 1901). *Babesia equi* has been renamed as *Theileria equi* due to similarities with each other (Mehlhorn & Schein, 1998). Equine piroplasmosis was originally endemic to the Asian continent (Friedhoff *et al*., 1990), however international transport of horses has made equine *Piroplasma* a cosmopolitan parasite (Bruning *et al*., 1997). The parasite is now endemic in Europe, Africa, and America (Friedhoff *et al.*, 1990; de Waal 1992; Yin *et al*., 1997; Camacho *et al*., 2005). Transmission of the parasite is facilitated by tick vectors such as *Dermacentor*, *Rhipicephalus* and *Hyalomma* (de Waal, 1992). Transplacental infection of foals *in utero* is a common cause of equine abortion (de Waal and van Heerden 2004; Phipps & Otter, 2004) Globally, piroplasmosis of horses serves as a significant threat in international horse trade and sport. (Sluyter, 2001; Irby, 2002).

2.10.1 Diagnoses, treatment and control of Piroplasmosis

Diagnosis is accomplished by several techniques such as identification of parasites in giemsa-stained thin and thick blood films, culture techniques, PCR and serological assays. Examination of blood film is the gold standard for detecting and identifying haemoparasites of horses (de Waal and van Heerden, 2004). When parasitaemia is low, thick blood film smears are suitable for

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examining blood (de Waal & van Heerden, 2004). *In vitro* culture procedures provide specific and sensitive alternate approaches for examining blood samples when microscopy and serology yield unconvincing negative results for *B. equi* and *B. caballi* (Holman *et al*., 1993; de Waal & van Heerden, 2004; Holman *et al*., 1994; Zweygarth *et al*., 1997. *In vitro* culture techniques are expensive and require expertise.

Diminazene is administered via intramuscular inoculation against *B. caballi* but is ineffective against *T. equi* infections (de Waal, 1992). Imidocarb is also a drug of choice and it is very effective against *B. caballi* and *T. equi* (Belloli *et al*., 2002). Euflavine and parvaquone are effective against both *B. caballi* and *T. equi infections* (Kuttler *et al*., 1987). Regular administration of acaricides can lead to a reduction in the incidence of piroplasmosis by eliminating tick vectors (de Waal, 1992).

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CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Study area and population

The study on dogs was conducted in one suburb (Madina) of the La-Nkwantanang Municipal Assembly of the Greater Accra Region and Nsawam of the Akwapim South Municipal District of the Eastern Region of Southern Ghana. The Greater Accra Region is second most populated region in Ghana (Ghana Statistical Service, 2012) and is reported to have the highest density of owned dogs (Veterinary Service Directorate, 2009).

The study was conducted in four communities: Zongo, Washington, Redco and Libya quarters in Madina. Madina has a population of about 111,926 people, representing 2.8% of the region's total population (Ghana Statistical Service, 2014) and has coordinates 5°41'0" N, 0°10'0" W. The La Nkwantanang municipality is situated within the dry climatic zone of Ghana. The municipality experiences rainfall of 700 mm in the first rainy season and 770 mm in the second rainy season (Dickson *et al*., 1988). The land area of the Municipality consists of plains scattered with rippling landscape. The vegetation is dominated by shrub lands and grassland. (Ghana Statistical Service, 2014). The main economic activities in the La Nkwantanang Madina Municipality are commerce and agriculture (Ghana Statistical Service, 2014).

Nsawam is the capital of the Akuapim South Municipal District in the Eastern Region of Ghana. It is located on the Accra-Kumasi highway and it is surrounded at the west by the Densu River. The study was conducted in five different communities namely: Adoagyiri, Achikorpe, Oparekrom, Akwamu and Ntoaso. The population of Nsawam Adoagyiri Municipal, according to the 2010 Population and Housing Census, is 86,000 representing 3.3% of the Eastern region's

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total population (Ghana Statistical Service, 2014). The Municipality is situated between latitude 5’.45 N and 5’.58 N and longitude 0.07’W and 0.27’ W. The Nsawam-Adoagyiri Municipal covers an area of about 175 km^2, out of the total area of the Eastern Region (Ghana Statistical Service, 2014). The majority (28.7%) of the employed population are engaged as service and sales workers followed by those who work as agricultural, forestry and fishery workers (22.4%). Average annual rainfall is between 125 cm and 200 cm (Ghana Statistical Service, 2014). The rainy season is usually between May to June (Ghana Statistical Service, 2014).

Horses were sampled from two stables in the Greater Accra Region of Ghana. One stable was located on the Abossey Okai - Korle bu mortuary road in a locality called Ayigbe town with coordinate N $5^{0}33'8.4132''$ W 0^{0} $13'49.44''$ The total number of horses at the stable during the time of study was twenty-two. The stable has several breeds of horses including horses from Chad, Nigeria, Argentina, and Nigeria. The other stable was the Accra Polo grounds (N $5^{0}37'$ $3.3528''$ W $0^{0}10'$ $22.2456''$) located in the vicinity of Shangri-la, airport area on the Spintex road, Accra. The geographical coordinates are. The Polo ground has stables for about 108 horses and has several exotic horse breeds. The Polo grounds has membership of varied nationalities. The club offers squash, a recreational facility, with fully equipped squash court and trainer. The polo ground has riding school for people who want to learn horse riding.

3.2 Study design

The study began with a reconnaissance survey of the study areas. In selecting the study area, two conveniently selected regions in Southern Ghana (Eastern and Greater Accra Regions) were clustered into municipalities. Two municipalities (La- Nkwantanag Municipal Assembly in the Greater Accra in Region and Akuapim South Municipal District in the Eastern Region) were

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randomly selected. Two suburbs, Madina and Nsawam in the Greater Accra Region and Eastern region respectively were then conveniently selected from the municipalities because they were thought to reflect the assumed differences in socio-cultural and socio-economic aspects and pattern of dog ownership and also because of their accessibility and proximity to the laboratory.

The selection of study area for horses was strictly based on convenience since horses were known to be available in two areas in the Greater Accra Region. The research involved field sample collection and laboratory sample processing and identification of parasites. The design was a cross sectional study which was conducted from December, 2018 to May 2019. Blood samples were collected mainly from veterinary clinics and faecal samples were collected during house-to-house visits. Dogs brought to selected veterinary clinics within the period of study in selected communities were sampled for haemoparasites. A comprehensive list of house addresses of dogs in the community was obtained from records at the district veterinary clinic and veterinary field workers in Madina and Nsawam to obtain a sampling frame. Dog owning households were purposively selected to target houses where dogs were present. Dogs and dog owners were randomly sampled from the sampling frame. In houses where there was more than one dog, only one dog selected by the owner was included in the study. Horses were conveniently sampled because a sampling frame was not obtained during the time of study. The inclusion of participants in the study was strictly voluntary and based on consent of their owners, after being informed of the objectives and goals of the study. A pre-structured questionnaire was administered to dog owners to ascertain individual factors such as level of education, occupation, age, sex and pet management/husbandry practices as well as owners' awareness of zoonoses. Samples collected were sent to the parasitology laboratory at the Department of Animal Biology and Conservation Science, University of Ghana for processing. Ethical approval for the study was obtained from

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the Research and Ethical Review Committee of the Institutional Animal Care and Use, University of Ghana.

3.3 Estimation of sample size

The sample size of dogs and horses was estimated using a formula described by (Pourhoseingholi *et al*., 2013; Dohoo *et al*., 2003). The formula used is:

$$n = \frac{Z^2 \times P \times Q}{L^2}$$

where n = required sample size, Z = Z value corresponding to the level of confidence (1.96), P = known or estimated prevalence, Q = (1-P), L = allowable error (0.05). Based on gastrointestinal helminths prevalence of 62.6% in dogs (Johnson *et al*., 2015) in the Greater Accra Region, P was estimated at 62.6% for dogs in this study to give maximum sample size. Hence n = $1.96^2 \times 0.626 \times 0.374 / 0.05^2$ = 360. Therefore, at least 360 dogs were to be sampled for parasites. Prevalence of parasites was estimated at 50% for horses since no data on prevalence from previous work in the study area could be obtained. During the period of this study, no data had been published on haemoparasites and gastrointestinal helminths of horses in the study area. From the formula, 384 horses were to be sampled to obtain maximum sample size.

3.4 Sampling of dogs and horses

Based on the sampling frame that was acquired from records at the Veterinary clinics in the study areas, a simple probability sampling technique was designed to sample dogs in the communities. Dogs were assigned numbers on pieces of paper. The numbers corresponded to the address of dogs in the communities. The pieces of paper were uniformly folded, placed in a container and mixed thoroughly. One piece of paper was drawn at a time without replacement and the container

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was shaken after each draw to mix the contents. Dogs that were selected by drawing lots were involved in the study. Sample size obtained from sampling frame was insufficient so convenience sampling in house-to-house visits was employed to add up to the sample size. Horses were conveniently sampled because a sampling frame was not available at the time of the study.

3.5 Classification of dogs and horses

Dogs were classified as exotic breed if they were foreign and as mongrels if they were of unidentifiable breed. Dogs were classified as puppies if they were between the ages of 0-6 months, juveniles if they were between the ages of 7-12 months and as adults if they were above the age of 12 months as described by Johnson *et al*. (2015). Horses were classified as exotic breed if they foreign and as local breed if they originated from Ghana or West Africa. Horses were classified into less than 4 years, 4-10 years and above 10 years based on sexual maturity as described by Tesfu *et al* (2014)

3.6 Faecal collection, examination, processing and copromicroscopy

3.6.1 Rectal faecal extraction

A gloved finger was lubricated with water-based lubricant. With the tail raised, the index finger was gently inserted into the rectum of dogs and horses. The finger was used to gently massage the rectum, curled upwards and gently withdrawn. About 5-10 g of faecal matter was placed into appropriately labelled faecal collection containers. Faecal containers were stored on ice in an ice chest. Rectal faecal extraction in puppies was done with a small size lubricated spatula. The lubricated spatula was gently inserted into the anus of well restrained puppies. The spatula was used to gently scoop out about 5-10 g of faeces into appropriately labelled faecal collection

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containers and stored on ice in an ice chest. In cases where rectal faecal extraction was impossible, stool samples were immediately collected from the top of fresh stool with gloved hands into appropriately labelled containers after defecation.

3.6.2 Examination of faecal sample

Faeces was physically examined for colour, blood, consistency and presence of tapeworm proglottids.

3.6.3 Modified McMaster technique

The Modified McMaster faecal egg count method described by (Urquhart *et al*., 1996; MAFF, 1986) was used to process faecal samples and quantify eggs in faeces. Faecal sample (2 g) was measured in a container on a scale. A 28 ml of NaCl flotation solution (360 g of NaCl in 1000 ml of water) was dispensed into the container, mixed and allowed to soak for 5 minutes. The mixture of faeces and flotation medium was stirred and strained into another container. Both chambers of McMaster slide were then filled with the mixture of faeces and flotation solution using a pipette. The slide was set aside for 5 minutes to allow parasite eggs to float to the surface. The slide was then observed under the microscope using 4× and 10× objective lens. All eggs inside the grid of the slide were counted using the 10× objective lens including those on the grid lines if they were greater than half of the number of eggs inside the grid in both chambers. The number of eggs in both chambers was multiplied by 50 to obtain the number of eggs per gram (epg).

3.6.4 Formol ether sedimentation technique

The formol ether faecal sedimentation procedure outlined by (Cheesbrough, 2009) was used to concentrate the eggs of helminths. About 1 g (pea-sized) faeces was emulsified in 4 ml of 10%

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v/v formalin in a test tube using a stick. A 4 ml of 10% formalin was added to the tube, capped and mixed well by shaking. The emulsified faeces was sieved into a beaker. The suspension was transferred into a centrifuge tube and 3-4ml of diethyl ether was added. The tube was unstoppered and mixed for 15s using a vortex mixer. The tube was centrifuged at low 750-1000 g (about 3000 rpm) for 1 minute. Using a plastic bulb pipette, the plug of faecal debris was loosened from the side of the tube. The tube was upturned to remove the ether, faecal debris and formalin. The tube was returned to its upright position and the fluid from the side of the tube was allowed to drain to the bottom. The bottom of the tube was gently tapped to resuspend and mix the sediment. The sediment was transferred onto a slide, a drop of iodine was added and then covered with a cover slip. The preparation was examined at 10× and 40× objective lens.

3.7 Collection of blood and preparation of blood film

A cephalic or saphenous venipuncture or ear prick blood was collected from dogs after consent had been sought from owners. The method of blood collection was decided after examining pets for veins that were accessible and convenient. Dogs were restrained with a tether and muzzle. In most cases, ear prick blood was the best choice. The puncture area was gently massaged and rubbed with 70% alcohol to force blood into the area and disinfect the puncture area. A lancet needle was used to gently pierce the ear margin and a drop of blood was placed on two frosted end glass slides, one for thin film and the other for thick film preparation. In cases where intravenous blood collection was possible, about 2 ml of intravenous blood was collected with a sterile 21-gauge hypodermic needle attached to a 5 ml syringe into appropriately labelled EDTA tubes for further analysis, and a drop on appropriately labelled glass slides. With a piece of cotton wool, the puncture area was firmly pressed to stop bleeding. Thin and thick blood film as

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described by (Cheesbrough, 2009) was quickly made on appropriately labelled glass slide, air dried and stored in a slide box.

3.7.1 Preparation of thin and thick film

A drop of blood (about 5 µl) was placed on the end of a clean dry frosted end slide labelled with appropriate information. Another drop of about 5 µl blood was placed on the middle of the slide. A spreader slide was drawn back to touch the drop of blood at the middle of the slide and the blood was allowed to spread along the edge of the spreader. The drop of blood was spread to make a thin film. The other drop of blood was spread with an applicator stick to make a thick smear. The film was left to dry and then stored in a slide box.

3.7.2 Fixing and staining of slides

Thin films prepared on the field upon return to the laboratory were fixed by dipping the thin films in methanol for 2 minutes and allowed to dry on a rack. The slides were placed on a staining rack and the methanol-fixed thin films and unfixed thick films were stained with approximately 0.5 ml 10% Giemsa stain for 10 minutes. The stain was washed off with water and left to dry.

3.7.3 Blood microscopy

Thin and thick blood films were observed under the compound light microscope. The blood films were examined first with 10× and 40× objective to check the staining, morphology of the cells and parasitized cells. A drop of immersion oil was applied to film and spread to cover most of this part of the film and examined under 100× objective lens to identify parasites.

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3.8 Assessment of pet management practises and owners' knowledge on zoonosis

Pre-structured questionnaires were administered to dog owners and horse stable keepers who consented to be interviewed. The questionnaire utilized primary multiple-choice questions (Appendix 1) and was designed to ascertain socio demographic information of owners, purpose of keeping dogs, respondent's knowledge on canine or equine zoonoses and source of information, pet management practices including housing status, deworming status, nutrition, veterinary and health care, and presence of other domestic animals.

3.9 Parasite identification

Identification of helminth eggs was done using morphological characteristics described by (Griffiths, 1978; Soulsby, 1982; MAFF manual, 1986; Anderson, 2000; Lichtenfels *et al*., 2008). *Ancylostoma caninum* was identified using morphometrics and number of blastomeres described by Lucio-Forster e*t al.* (2012) and Ehrenford (1953). *Trichostrongylus* was identified using information from Issarapong *et al*. (2013). *Spirocerca lupi* was identified using information from Jan (2013). Identification of *Babesia* was done using information provided by Akel & Mobarakai (2017) and Griffiths (1978).

3.10 Statistical analyses

Data was analysed using Statistical Package for Social Scientists (SPSS) Software Package, version 23. The results for continuous variables such as eggs per gram were expressed as means and as numbers and percentages of participants for categorical data such as infection status, age, and sex. Pearson's chi-square test of association and Fisher's exact test, where appropriate, was used to assess the association between risk factors and helminth infection status in dogs and horses. Kolmogorov Smirnov test of normality was used to test for normality of eggs per gram

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(epg). The intensity of eggs was compared among risk factors using Kruskal Wallis test. A p value less than 0.05 was considered statistically significant.

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CHAPTER FOUR

4.0 RESULTS

4.1 Prevalence of helminth infection in dogs

A total of 285 out of 428 dogs were infected with at least one species of gastrointestinal helminth. The overall prevalence of helminth infection was 66.6%. *Ancylostoma caninum* eggs (Image 1) were found in 169 dogs with a species-specific prevalence of 39.5%. *Dipylidium caninum* proglottids and some eggs (Image 2) were found on stool samples of 112 dogs, representing a species-specific prevalence of 26.2%. *Spirocerca lupi* eggs (Image 3) were found in 13 dogs from Madina, representing a species-specific prevalence of 3.0% as indicated in Figure 1. *Toxocara* sp. ova (Image 4) were found in 171 dogs, which represented a species-specific prevalence of 40%. The overall species-specific prevalence is shown in Figure 1. The species-specific prevalence among sex, age and breed of dogs is indicated in Figure 2.

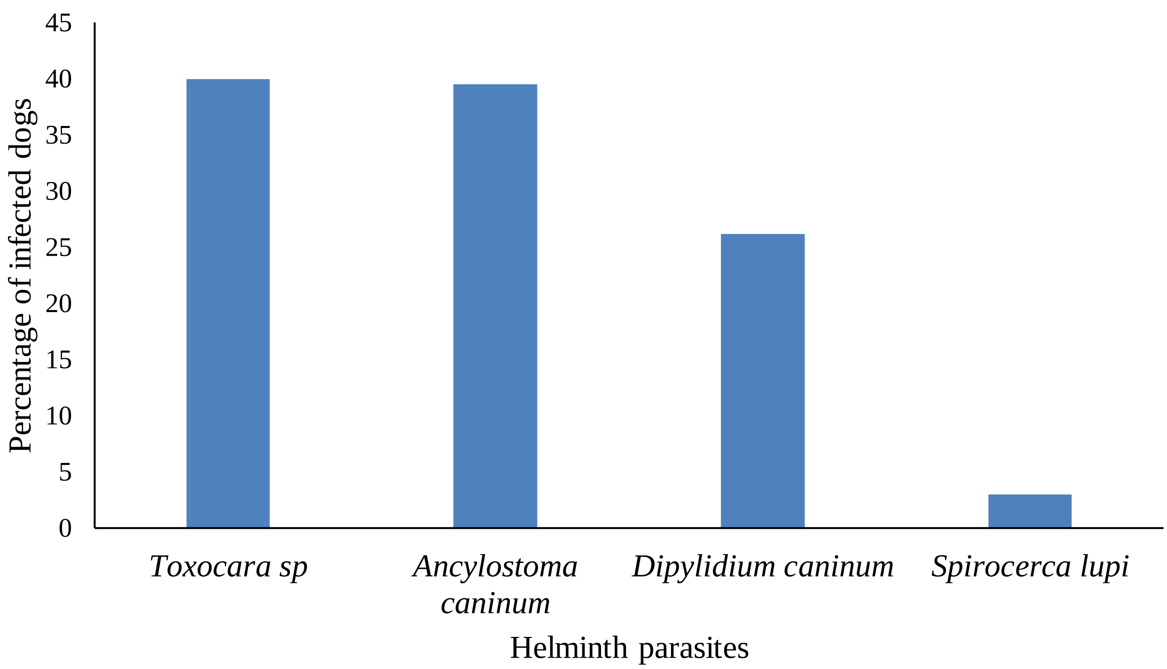

Figure 1: Prevalence of gastrointestinal helminth infections in dogs from Nsawam and Madina.

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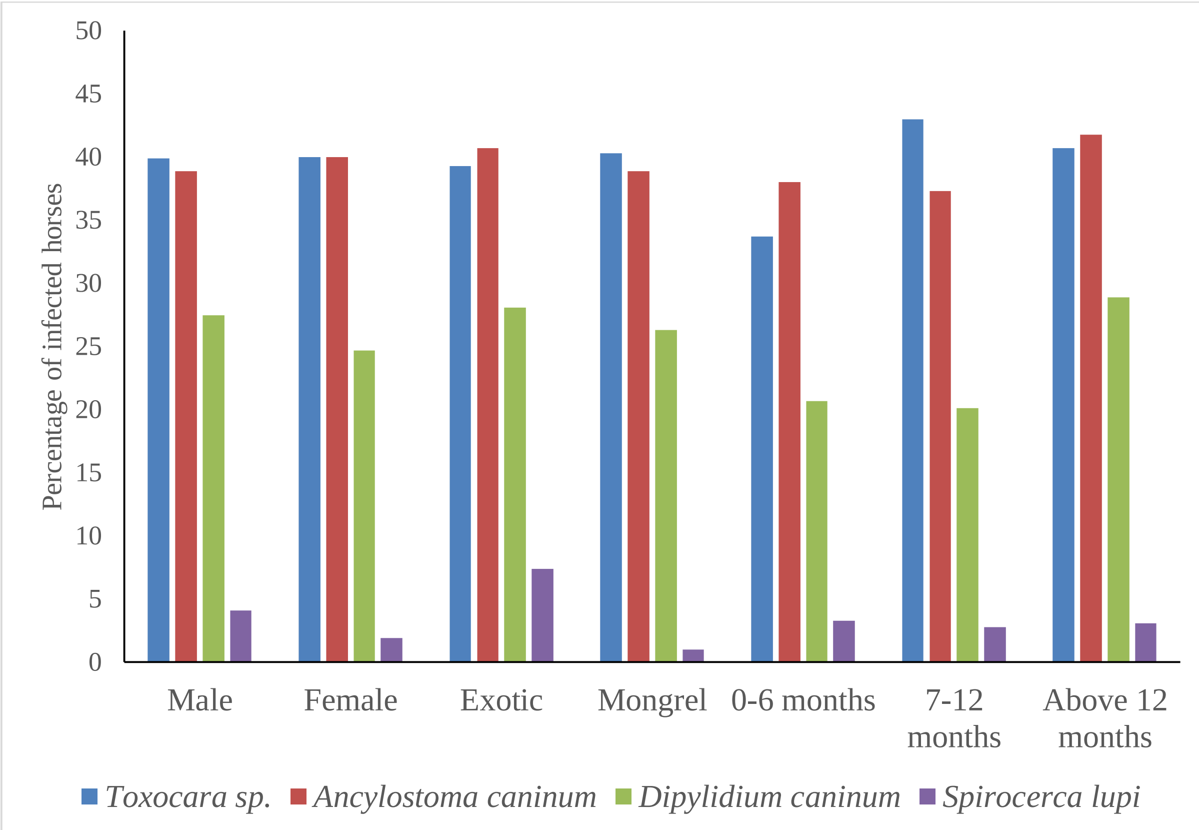

Figure 2: Species-specific parasite prevalence among sex, breed and age of dogs.

4.2 Effect of age, sex and breed of dog on helminth species prevalence

Toxocara, *Ancylostoma* and *Dipylidium* infections were not statistically associated with age, sex and breed of dog ($p > 0.05$). *S. lupi* infection was significantly associated with breed of dog ($p < 0.05$). The results are summarised in Table 1.

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Table 1: Chi-square and Fisher's exact test of association of helminth infection with age, sex and breed of dog

Variable	*Toxocara*		*A. caninum*		*D. caninum*		*S. lupi*	
	P	**χ^2 p value**	**P**	**χ^2 p value**	**P**	**χ^2 p value**	**P**	**Fisher's p value**
Age (months)								
0-6	33.7		38		20.7		3.3	1.000
7-12	43	0.498	37.3	0.416	26.1	0.336	2.8	
> 12	40.7		41.8		29		3.1	
Sex								
Male	39.9	0.880	39	0.809	28	0.516	4.1	0.261
Female	40		40		25		1.9	
Breed								
Exotic	39.3	0.762	41	0.343	24.4	0.582	7.4	0.001
Mongrel	40.3		39		27		1.0	

4.3 Intensity of helminth infection in dogs

The overall mean intensity of *Toxocara* was 2106 ± 159 and the mean intensity of *Ancylostoma caninum* was 4653 ± 214. The mean intensities of helminth infection among age, sex and breed of dogs are summarized below in Table 2. The results indicate the difference in mean intensities was not statistically significant ($p > 0.05$) as indicated in Table 2.

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Table 2: Intensity of helminth infection among age, sex and of dogs

Variable	*Toxocara*		*Ancylostoma caninum*	
	Mean intensity	**Kruskal-Wallis p value**	**Mean intensity**	**Kruskal-Wallis p value**
Age (months)				
0-6	2051 ± 342		5014 ± 522	
7-12	1726 ± 220	0.498	3989 ± 351	0.416
> 12	2416 ± 265		4933 ± 306	
Sex				
Male	2043 ± 224	0.880	4695 ± 323	0.809
Female	2173 ± 228		4610 ± 283	
Breed				
Exotic	2635 ± 338	0.762	5284 ± 377	0.343
Mongrel	1871 ± 171		4348 ± 257	

4.4 Risk factors affecting prevalence of helminth infection in dogs

A chi-square analysis of the risk factors associated with helminth infection in dogs revealed that only deworming status as a management practice was significantly associated with helminth infection ($p < 0.05$). All other variables (risk factors) were not statistically associated with helminth infection. Among the age groups, prevalence was higher in dogs above 12 months but the result was statistically insignificant. Among sex, female dogs recorded higher helminth prevalence than male dogs. The results however, was statistically insignificant ($p < 0.05$). Helminth prevalence was higher in exotic dog breeds, semi-restricted dogs and dogs that were fed both homemade and commercial food. In all cases, the results were statistically insignificant. The results of the analysis are summarised in Table 3.

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Table 3: A chi-square analysis of some factors associated with overall helminth prevalence in dogs

Variables	Total (428)	Number of dogs infected (%)	χ^2	p value
Age				
0-6 months	92	56 (60.9)	1.897	0.387
7-12 months	142	95 (66.9)		
> 12 months	194	134 (69.1)		
Sex				
Male	218	140 (64.2)	1.120	0.290
Female	210	145 (69.0)		
Breed				
Exotic	135	94 (69.6)	0.820	0.365
Mongrel	293	191 (65.2)		
Deworming status				
Yes	122	72 (59.0)	4.398	0.036
No	306	213 (69.6)		
Mobility of dog				
Restricted	247	158 (64)	1.804	0.179
Semi-restricted	181	127 (70.2)		
Food type				
Kibble	19	11 (57.9)	2.173	0.337
Homemade	375	248 (66.1)		
Both	34	26 (76.5)		

a. Restricted dog were dogs that were confined to a house and were not allowed to freely roam outside without supervision

b. Semi-restricted dogs (Neighbourhood dogs) were dogs that roamed freely outside usually without supervision and were dependent on owners for food and shelter.

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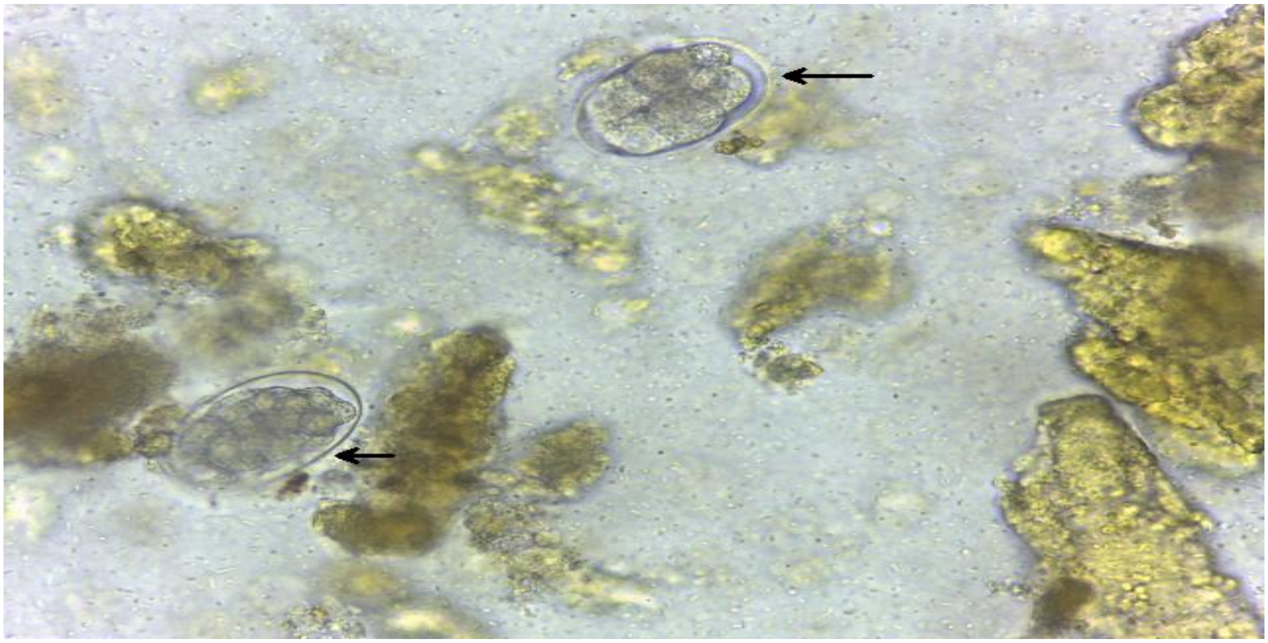

Image 1. A micrograph of *Ancylostoma caninum* eggs viewed under ×400 magnification. Source: Baah (2019)

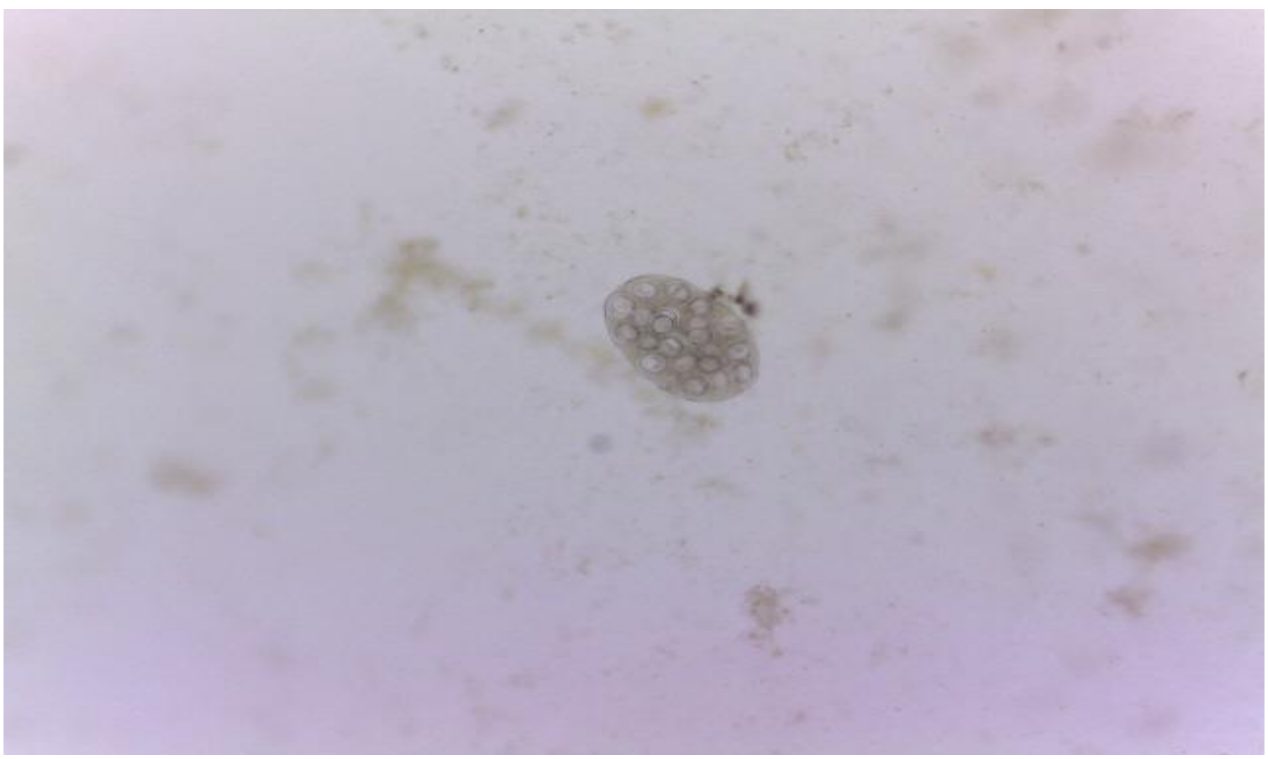

Image 2. A micrograph of *Dipylidium caninum* egg packet viewed under ×400 magnification. Source: Baah (2019)

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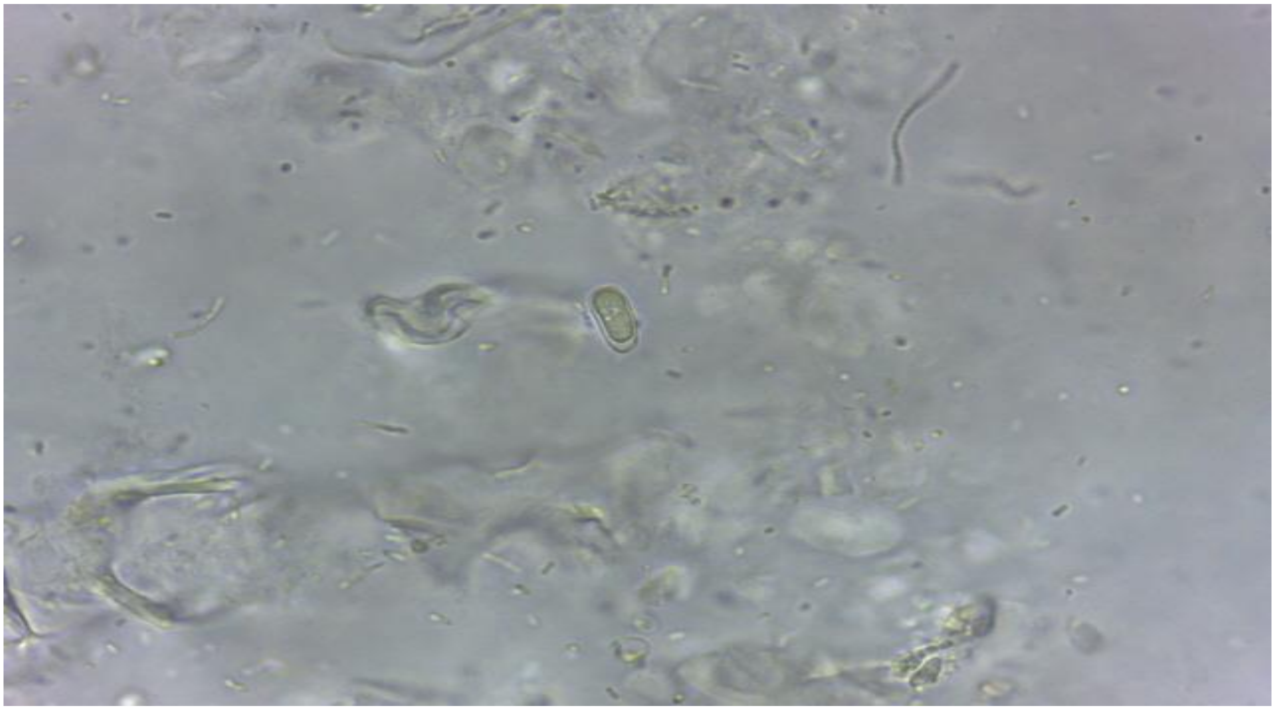

Image 3. A micrograph of *Spirocerca lupi* ova under ×400 magnification. Source: Baah (2019)

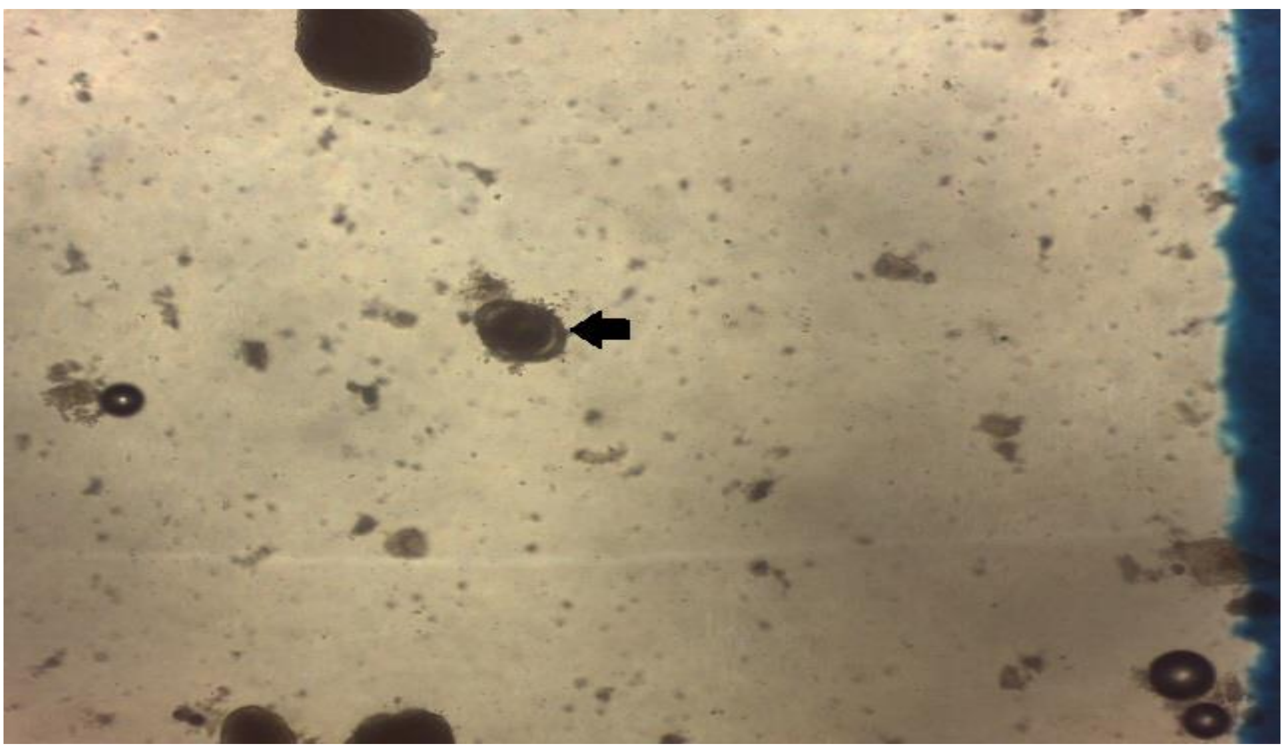

Image 4. A micrograph of a one cell stage of *Toxocara* sp. viewed under ×100 magnification on a McMaster slide. Source: Baah (2019)

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4.5 Prevalence of helminth infections in horses

A total of 29 out of 73 horses were infected with at least one species of gastrointestinal helminth. The overall prevalence of helminth infection was 39.7%. *Strongyle*-type eggs (Image 5) were found in the stool of 19 horses representing a prevalence of 26.0%. *Trichostrongylus* sp. eggs (Image 6) were identified in 6 horses, representing a prevalence of 8.2%. *Parascaris* sp. eggs (Image 7) were found in the stool of 24 horses, which represented a prevalence of 32.9%. The prevalence of helminths in horses is summarized in Figure 3. The species-specific prevalence among age, sex and breed of horses is shown in Figure 4.

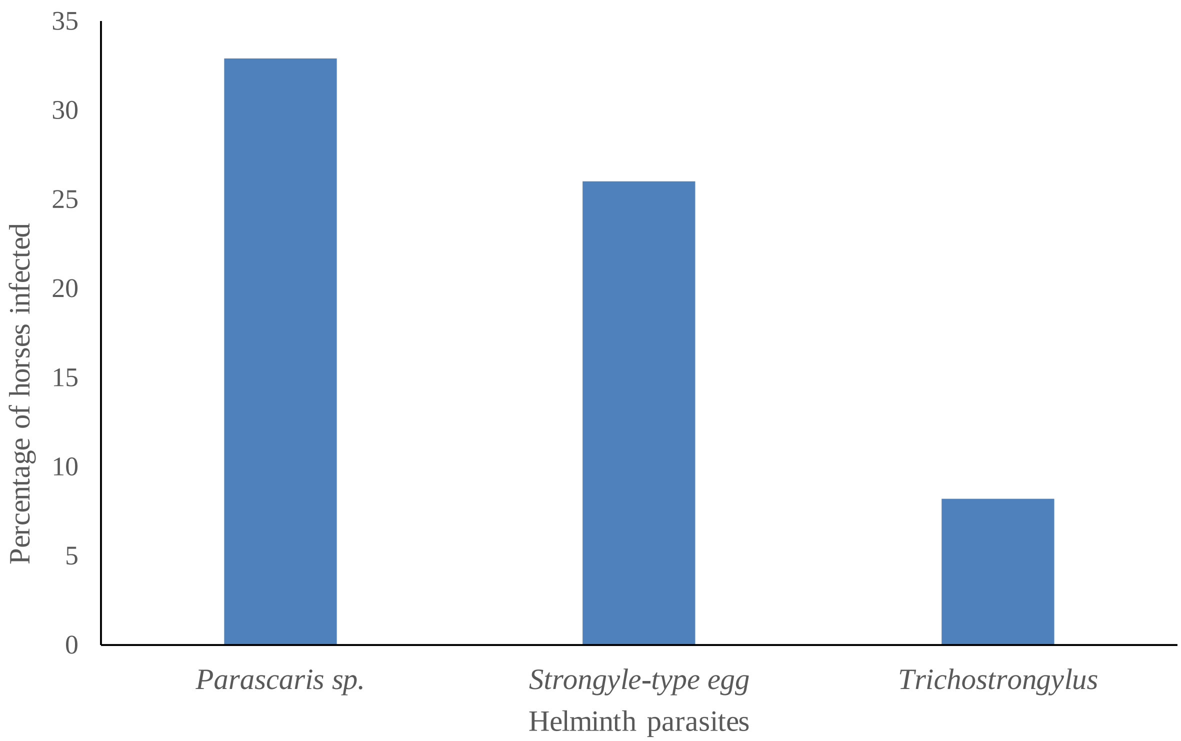

Figure 3. Prevalence of gastrointestinal helminths in horses.

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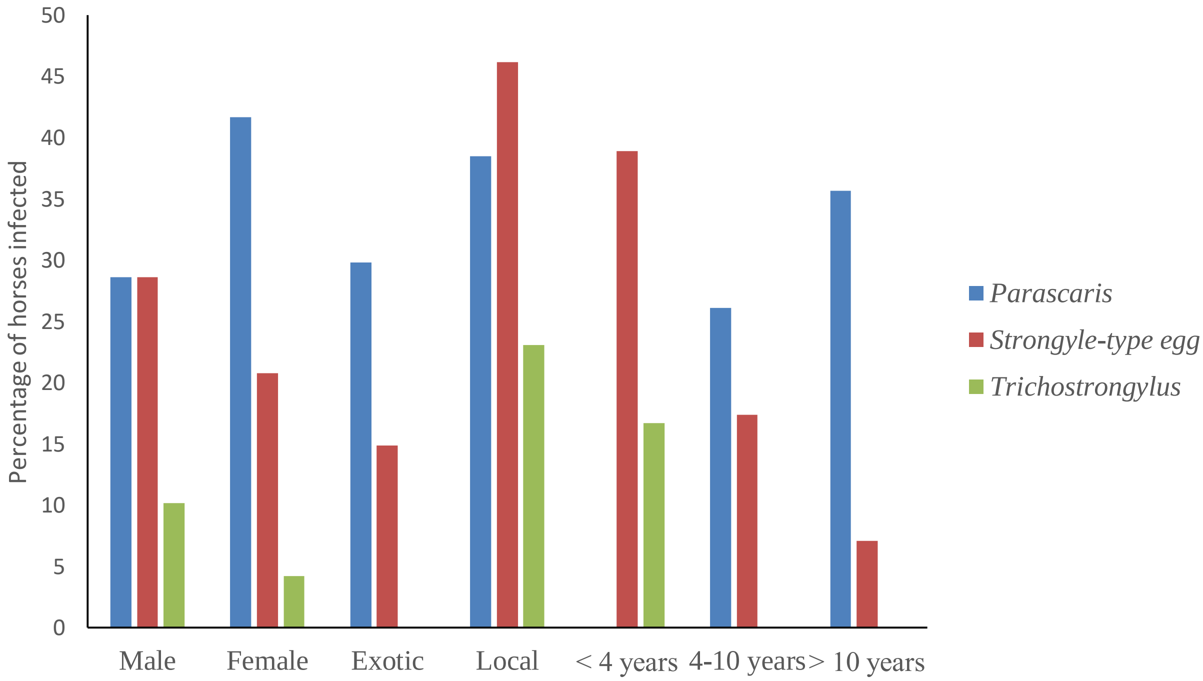

Figure 4: Species-specific prevalence of gastrointestinal helminths among age, sex and breed horses.

4.6 Factors affecting the prevalence of helminth infection in horses

Management practices like deworming status, frequency of deworming and even food type that affect infection were same in all the two horse stables. Hence the only variables that could be used to explain helminth infection status were inherent variables like age, sex, breed, and stables. The results are summarised in Table 4.

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Table 4: A chi-square test of association of some factors that affect prevalence of helminths in horses

Variables	Total (73)	Number of dogs infected (%)	χ^2	p value
Age (years)				
< 4	36	18 (50)	3.468	0.177
4-10	23	6 (26.1)		
> 10	14	5 (35.7)		
Sex				
Male	49	18 (36.7)	0.557	0.455
Female	24	11 (45.8)		
Breed				
Exotic	47	17 (36.2)	0.697	0.404
Local	26	12 (46.2)		
Stables				
Polo grounds	51	16 (31.4)	4.932	0.026
Ayigbe town	22	13 (59.1)		

Image 5. A micrograph of *Strongyle*-type egg under ×400 magnification. Source: Baah (2019)

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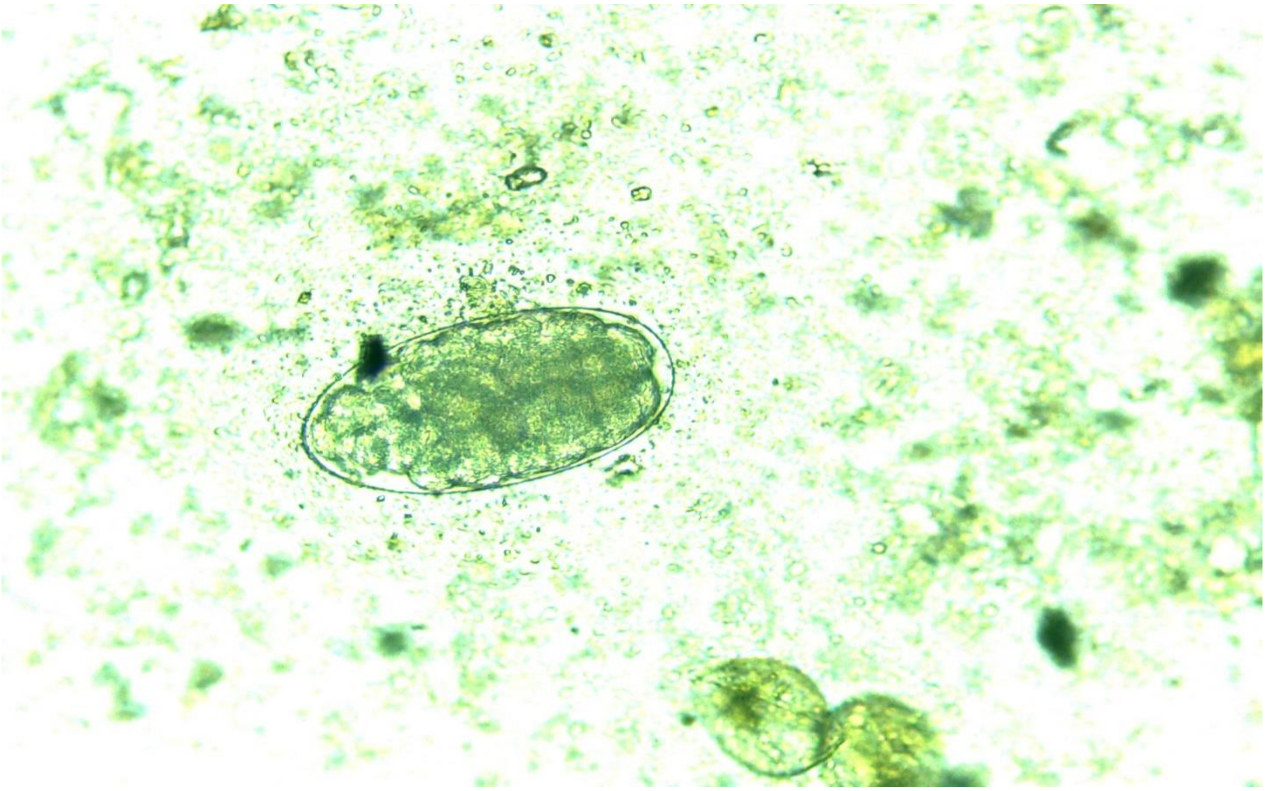

Image 6. A micrograph of *Trichostrongylus* egg under ×400 magnification. Source: Baah (2019)

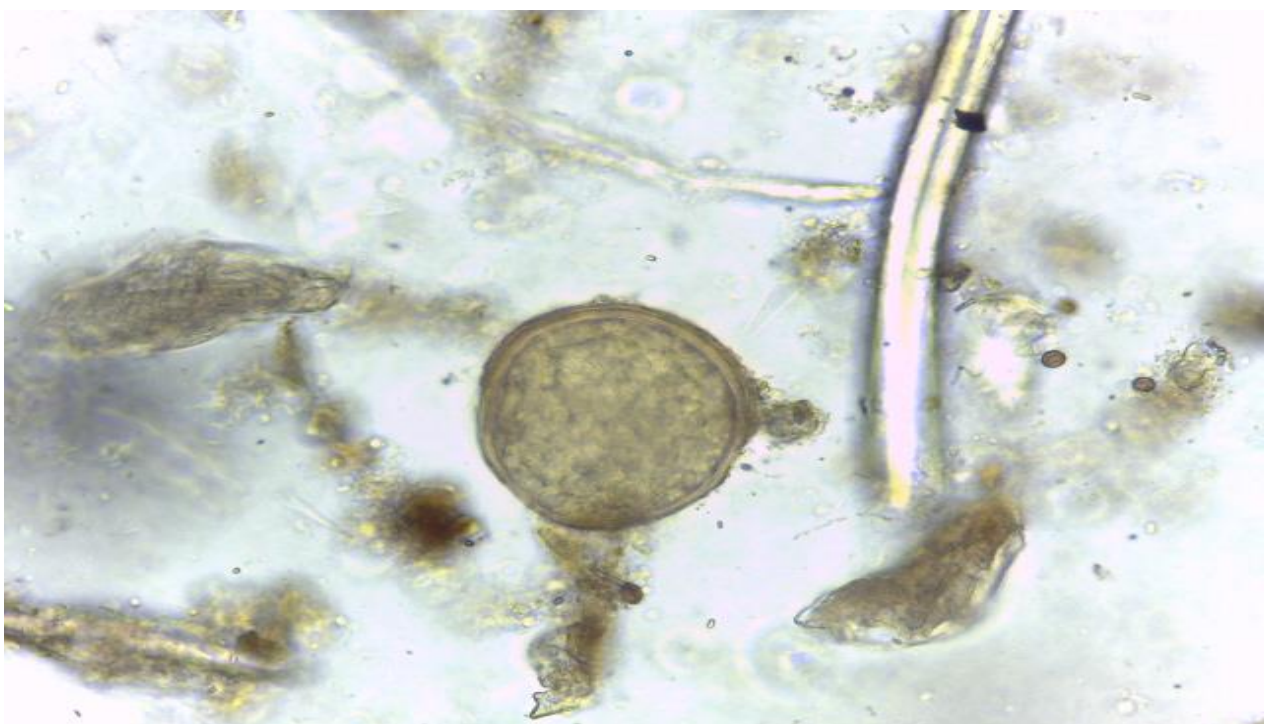

Image 7. A micrograph of egg of *Parascaris* sp. under ×400 magnification. Source: Baah (2019)

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4.7 Effect of age, sex and breed on species-specific helminth prevalence in horses

Parascaris infection were not statistically associated with age, sex and breed of dog ($p > 0.05$). Strongyle-type egg infection and *Trichostrongylus* egg infection were significantly associated with breed of dog and breed of dog ($p < 0.05$). The results are summarised in Table 5.

Table 5: Fisher's exact test of association of age, sex and breed with species-specific helminth infection in horses.

Variable	***Parascaris***		***Strongyle-type egg***		***Trichostrongylus***	
	P	**χ^2 p value**	**P**	**χ^2 p value**	**P**	**χ^2 p value**
Age (months)						
< **4**	36.1		39		16.7	
4-10	26.1	0.757	17.4	0.041	0	0.041
> 10	35.7		7.1		0	
Sex						
Male	28.6	0.297	28.6	0.577	10.2	0.656
Female	41.7		20.8		4.2	
Breed						
Exotic	29.8	0.603	14.9	0.005	0	0.001
Local	38.5		46.2		23.1	

4.8 Intensity of equine helminth infection

The mean intensity of *Parascaris* egg infection was 802 (range 100-2000), while the mean intensity of *Strongyle*-type egg was 390 (range 150-2050) and that of *Trichostrongylus* egg was 791 (range 350-1250) among all horses Age-, breed- and sex- specific mean intensity of helminth species in horses is shown in Table 6.

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Table 6: Intensity of helminth infection among age, sex and breed of horses.

Variable	*Parascaris*		*Strongyle-type egg*		*Trichostrongylus*	
	Mean intensity	**Kruskal-Wallis p value**	**Mean intensity**	**Kruskal-Wallis p value**	**Mean intensity**	**Kruskal-Wallis p value**
Age (months)						
< 4	615 ± 145		790 ± 114		791 ± 149	
4-10	1025 ± 106	0.863	733 ± 109	0.009	0	0.037
> 10	1020 ± 258		2050		0	
Sex						
Male	768 ± 140	0.221	867 ± 155	0.776	820 ± 179	0.375
Female	850 ± 162		792 ± 108		650	
Breed						
Exotic	2635 ± 338	0.659	1114 ± 207	0.005	0	0.001
Local	1871 ± 171		700 ± 118		791 ± 149	

4.9 Prevalence of canine haemoparasites

Out of 156 dogs that were examined for haemoparasites, 54 were from Madina and 102 were from Nsawam. Only 12 dogs were positive for haemoprotozoan parasites (7.7%). All infected dogs were adult mongrels from Nsawam. The haemoprotozoan parasites were identified as *Babesia* spp. (Image 8).

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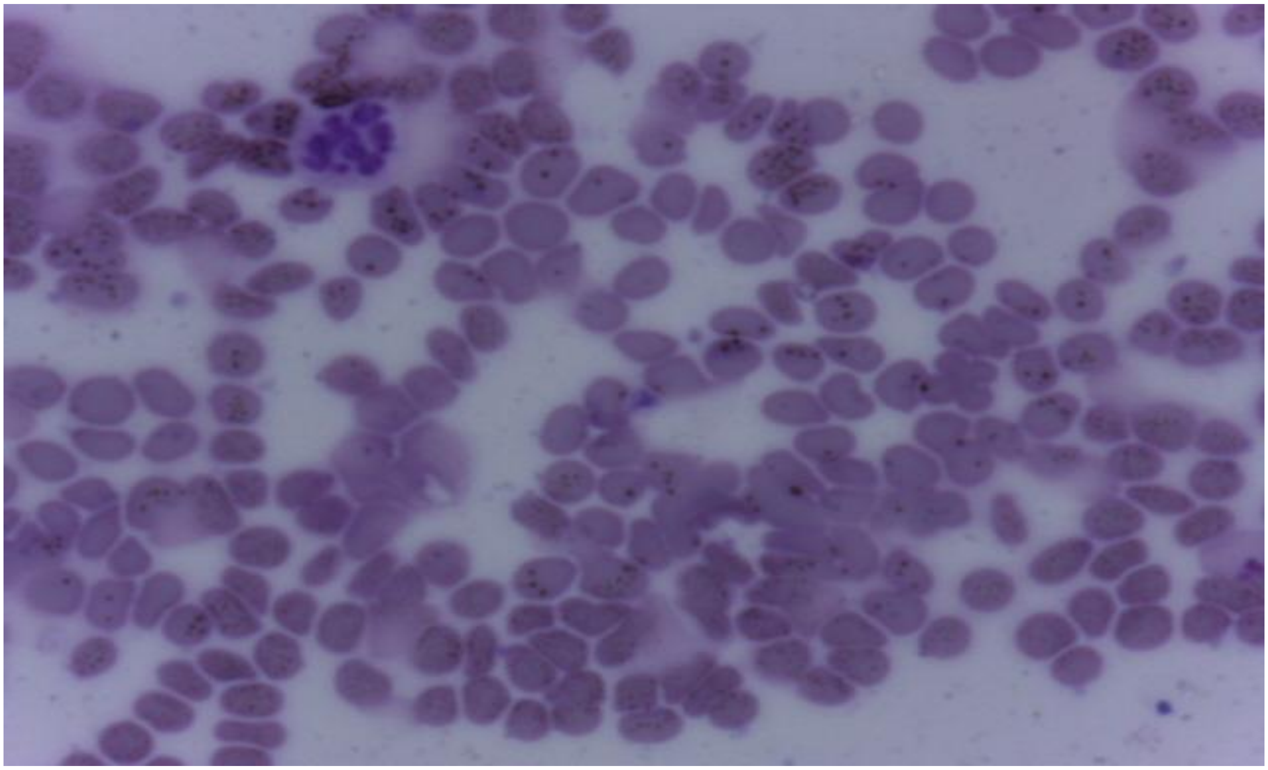

Image 8. An image of giemsa stained blood smear showing intraerythrocytic haemoprotozoan *Babesia*-like parasites in red blood cells of dog. Source: Baah (2019)

4.10 Prevalence of equine haemoparasites

Out of 73 horses that were examined for haemoparasites, 22 were from Ayigbe town stable and 51 were from Polo grounds stable. Eight (11.0%) horses were positive for haemoprotozoan parasites. This prevalence was recorded in adult horses from Ayigbe town stable. There were no positive cases of haemoparasites in horses from Polo grounds stable. Haemoprotozoan parasites were identified as *Babesia* spp. (Image 9).

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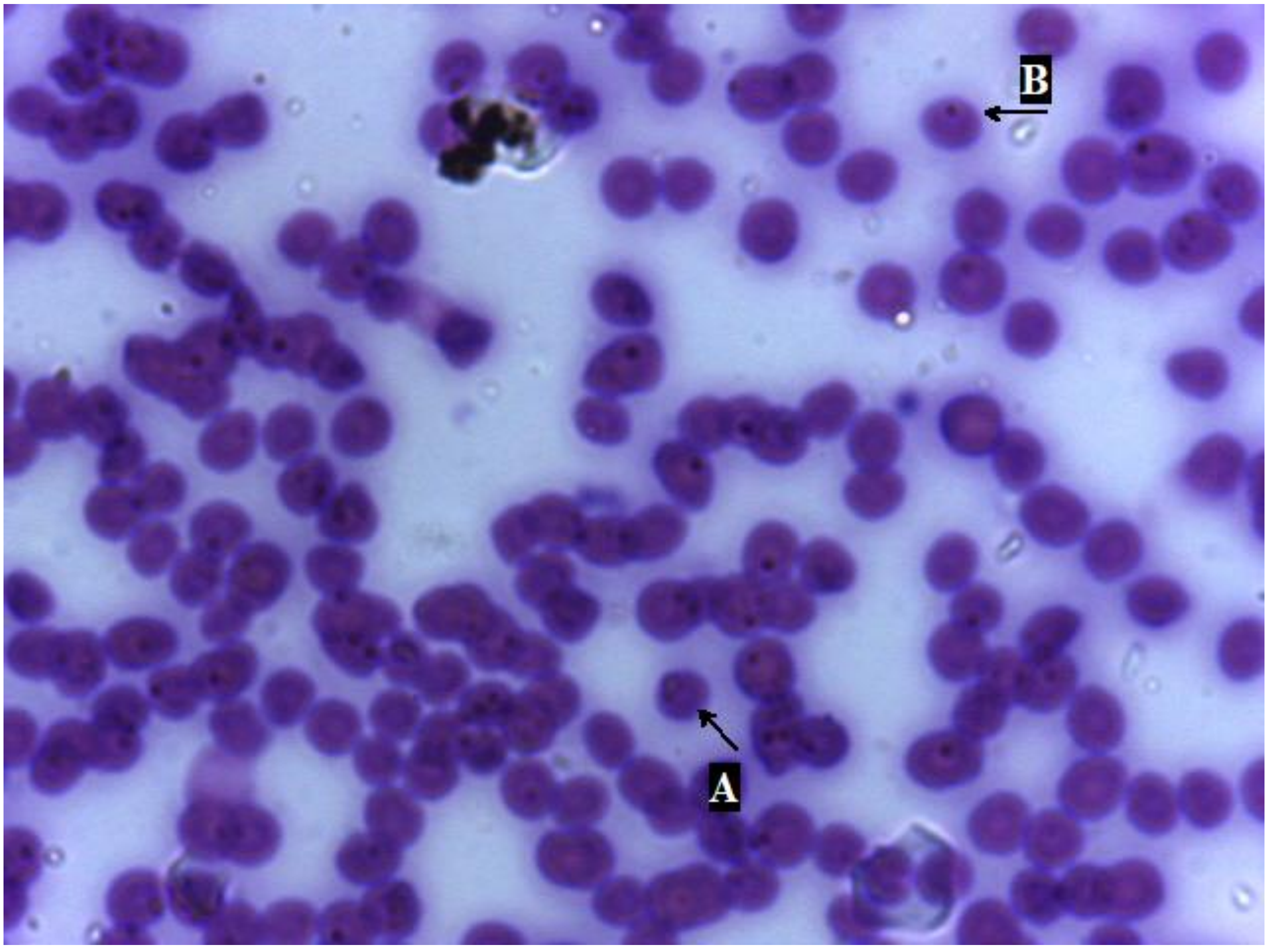

Image 9. A micrograph of *Babesia*-like haemoprotozoan parasite under oil immersion lens. A: Red blood cell with thin, delicate pyriform ring consisting of cytoplasmic rim with chromatin dot. B: Parasite appears as chromatin dot in red blood cell.

4.11 Socio-demographic characteristics of respondents

A total of 428 dog owners were recruited from both study communities and included in the study (Table 7). The mean age of dog owners (standard error of mean) was 37.9 (0.5), ranging from 21-68 years. All respondents had formal education. Trading was the commonest occupation.

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Table 7: Summary of socio-demographic characteristics of dog owners from the study sites.

Demographic information	**Number (%) of respondents in the study area**		
	Nsawam (n=245)	Madina (n=183)	Total (n=428)
Gender			
Male	196 (80)	145 (79.2)	341 (79.7)
Female	49 (20)	38 (20.8)	87 (20.3)
Age (years)			
18-35	124 (50.6)	101 (55.2)	225 (52.6)
> 35	121 (49.4)	82 (44.8)	203 (47.4)
Level of education			
Primary	53 (21.6)	33 (18.0)	86 (20.1)
Junior High	44 (18.0)	27 (14.8)	71 (16.6)
Senior High	60 (24.4)	67 (36.6)	127 (29.7)
Tertiary	88 (36)	56 (30.6)	144 (33.6)
Religious status			
Christian	233 (95.1)	170 (92.9)	403 (94.2)
Muslim	12 (4.9)	13 (7.10)	25 (5.8)
Occupation			
Farming	40 (16.3)	13 (7.1)	53 (12.4)
Trading	105 (42.9)	93 (50.8)	198 (46.3)
Office work	40 (16.3)	47 (25.7)	87 (20.3)
Teacher	38 (15.5)	19 (10.4)	57 (13.3)
Artisan	22 (9.0)	11 (6.0)	33 (7.7)

4.12 Number of owned dogs

A total of 428 participants (dog owners) were interviewed in households. The number of dog owners that owned one dog was 76 (17.8%), 98 (22.9%) owned two dogs, 80 (18.7%) owned three dogs, 68 (15.9%) owned four dogs and the remaining 106 (24.8%) owned 5-9 dogs. The average number of dogs per dog owning household was 3.23 ± 1.76. A stratification by number of dogs owned in the study sites is summarised in Table 8.

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Table 8: Summary of number of dogs owned by dog owners from the study sites

	Number of owners (%)	
Dog per owner	Madina	Nsawam
1	31 (16.9%)	45 (18.4%)
2	47 (25.7%)	51 (20.8%)
3	28 (15.3%)	52 (21.2%)
4	17 (9.3%)	51 (20.8%)
5	28 (15.3%)	46 (18.8%)
6	13 (7.1%)	0
7	8 (4.4%)	0
8	6 (3.3%)	0
9	5 (2.7%)	0
Total	183	245

4.13 Factors affecting dog ownership

From the survey, there were more dog owners that were males (79.7%) than dog owners that were females (20.3%). Dog owners primarily kept dogs for security reasons (89.7%) than for companionship reasons (10.3%). No dog owner kept a dog for hunting reasons. Majority of the dog owners were Christians (94.2%), whilst only a few were Muslims (5.8%). A one sample chi-square analysis indicated that the differences in percentages of owners based on gender, religion and role of dogs were statistically significant ($p < 0.001$). The results are summarised in Table 9.

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Table 9: A one sample chi-square analysis of differences in percentages of some variables that affect dog ownership

Variable	Number of owners (%)	Chi-square (χ^2)	p value
Sex of owner			
Male	341 (79.7)	150.738	< 0.001
Female	87 (20.3)		
Religion of owner			
Christian	403 (94.2)	333.841	< 0.001
Muslim	25 (5.8)		
Role of dog			
Security	384 (89.7)	270.093	< 0.001
Companionship	44 (10.3)		
Educational background			
Primary	86 (20.1)		
Junior High	71 (16.6)	32.766	< 0.001
Senior High	127 (29.7)		
Tertiary	144 (33.6)		
Owner's occupation			
Farming	53 (12.4)		
Trading	198 (46.3)	201.907	< 0.001
Office work	87 (20.3)		
Teacher	57 (13.3)		
Artisan	33 (7.7)		
Age group of owners			
18-35 years	225 (52.9)	1.131	0.288
Above 35 years	203 (47.1)		

4.14 Dog management practices

From the questionnaire interview, it was observed that 371 (86.7%) of the respondents (dog owners) were aware of rabies as a canine related zoonotic disease, whilst 57 (13.3%) were not aware of rabies as a canine related zoonosis. The difference in response, in terms of knowledge on rabies as a zoonosis, was statistically significant ($p < 0.001$). When the responses were stratified into educational background of dog owners, 64 (17.3%) of primary school level dog owners knew

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about canine rabies, 57 (15.4 %) of Junior High School level dog owners knew about canine rabies, 117 (31.5%) of Senior High School level dog owners knew about canine rabies and 133 (35.8%) of tertiary school level dog owners knew about canine rabies. When asked about their source of awareness of canine rabies, 28.4% of the respondents said they were educated on rabies by peers, 25.2% by media sources and 46.4% by veterinary service officers. None of the respondents knew of any canine helmintho-zoonoses. Data collated on dog management practices, owners' knowledge and attitudes with respect to zoonoses from the questionnaire survey was as tabulated below in Table 10.

Table 10: Knowledge, practices and attitudes of respondents with respect to dog ownership

Management practices	**Number (%) of respondents in the study area**		
	Nsawam (n=245)	Madina (n=183)	Total (n=428)
Deworming status			
Yes	63 (25.7)	68 (37.2)	131 (30.6)
No	182 (74.3)	115 (62.8)	297 (69.4)
Frequency of deworming			
At least once every six months	10 (15.9)	1 (1.5)	11 (8.4)
At most once a year	53 (84.1)	67 (98.5)	120 (91.6)
Food type			
Commercial dog food (Kibble)	2 (0.8)	17 (9.3)	19 (4.4)
Homemade food	239 (97.6)	136 (74.3)	375 (87.6)
Both	4 (1.6)	30 (16.4)	34 (8)
Homemade food[a]			
Gari + palm oil + other accompaniment	98 (41)	14 (10.3)	112 (29.9)
Leftover household meal	102 (42.7)	87 (64)	189 (50.4)
Cooked offal + other accompaniment	23 (9.6)	7 (5.1)	30 (8)
Uncooked offal	12 (5.0)	21 (15.4)	33 (8.8)
Frequency of feeding dog			
Once a day	232 (94.7)	145 (79.2)	377 (88.1)
Twice a day	13 (5.3)	38 (20.8)	51 (11.9)
Dog food dish			
Bowl	185 (75.5)	153 (83.6)	338 (79)
On the ground	60 (24.5)	30 (16.4)	90 (21)
Housing of dog			
Housed (Kennel)	49 (20)	66 (36.1)	115 (26.9)
Unhoused	196 (80)	117 (63.9)	313 (73.1)
Mobility of dog			

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Restricted	158 (64.5)	89 (48.6)	247 (57.7)
Semi-restricted	87 (35.5)	94 (51.4)	181 (42.3)
Frequency of bathing			
Once a month	3 (1.2)	22 (12.0)	25 (5.8)
At least twice a year	23 (9.4)	41 (22.4)	64 (15.0)
Never	219 (89.4)	120 (65.6)	339 (79.2
Do you take dog out on walk?			
Yes	16 (6.1)	114 (62.3)	130 (30.4)
No	229 (93.9)	69 (37.7)	298 (69.6)
Where does dog defecate?			
On house compound	219 (89.4)	133 (72.7)	352 (82.2)
Outside house compound	24 (10.6)	50 (27.3)	74 (17.8)
Reason for keeping dogs			
Companionship	26 (10.6)	18 (9.8)	44 (10.3)
Security	219 (89.4)	165 (90.2)	384 (89.7)
Cohabitation of dogs with other domestic animals			
Yes	142 (58)	68 (37.2)	210 (49.1)
No	103 (42)	115 (62.8)	218 (50.9)
Ectoparasite control			
Yes	84 (34.3)	69 (37.7)	153 (35.7)
No	161 (65.7)	114 (62.3)	275 (64.3)
Means of ectoparasite control			
Removal of ectoparasites with hand	46 (54.8)	17 (24.6)	63 (41.2)
Use of acaricide	38 (45.2)	52 (75.4)	90 (58.8)
Owners' awareness of canine zoonoses			
Yes	206 (84.1)	165 (90.2)	371 (86.7)
No	39 (15.9)	18 (9.8)	57 (13.3)
Canine zoonoses			
Rabies	206 (84.1)	165 (90.2)	371 (86.7)
Helminthozoonoses	0	0	0
Protozoonoses	0	0	0

Restricted dogs were dogs that there were strictly kept in the confines of a home and were not allowed to roam outside without supervision. Semi-restricted dogs (Neighbourhood dogs) were dogs that roamed freely outside usually without supervision and were dependent on owners for food and shelter. Unhoused dogs were dogs with no shelter that roamed freely on house compound or were neighbourhood dogs that returned home on daily basis. Homemade food included a mixture of "gari" and palm oil, boiled offal or left-over food cooked for the family.

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Homemade food sometimes included offal from slaughtered livestock such as domestic fowl, goat and innards of cattle from slaughter houses.

Table 11: Chi-square test of association of canine management practices with breed of dog

Management practices	**Breed of dog**		**Chi-square test (χ^2)**	**p value**
	Local breed (Mongrel) n = 293	**Exotic breed n = 135**		
Deworming status				
Yes	42 (14.3)	89 (66)	115.817	< 0.001
No	251 (85.7)	46 (34)		
Food type				
Commercial dog food (Kibble)	0 (0)	19 (14)		
Homemade food	293 (100)	82 (61)	131.287	< 0.001
Both	0 (0)	34 (25)		
Frequency of feeding				
Once a day	279 (95.2)	98 (72.6)	45.089	< 0.001
Twice a day	14 (4.8)	37 (27.4)		
Dog food dish				
Bowl	208 (71)	130 (96.3)	35.641	< 0.001
On the ground	85 (29)	5 (3.7)		
Housing				
Kennel	47 (16)	68 (50.4)	55.429	< 0.001
Unhoused	246 (84)	67 (49.6)		
Mobility of dog				
Restricted	150 (51.2)	97 (71.9)	16.159	< 0.001
Semi-restricted	143 (48.8)	38 (28.1)		
Frequency of bathing				
Once a month	10	15		
At least twice a year	14	50	92.321	< 0.001
Never	269	70		

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4.15 Socio-demographic characteristics of stable keepers and horses

4.15.1 Stable keepers

A total of 6 stable keepers were recruited and interviewed in the study. All the stable keepers were males between the ages of 12-23 years. All the stable keepers had no secondary school level education.

4.15.2 Horses

The commonest horse breeds that were encountered were West African pony (local breeds) representing 26 (35.6%) of horses sampled. Forty-seven (64.4%) were exotic breeds. Thirty-six (49.3%) of the horses were less than the age of 4 years, twenty-three (31.5%) were between the ages of 4-10 years and 14 (19.2%) were above 10 years. Male horses that were sampled were 49 (67.1%), whilst female horses were 24 (32.9%).

4.16 Horse management practices

From the results, all horses received anthelminthic treatment. However, other management practices were different in the stables that were studied. The results are summarised in Table 12.

Table 12: Summary of data on horse management practices and percentage of horses under management practices at Ayigbe town stable and Polo grounds stable.

Management practices	**Percentage of horses**	
	Polo grounds stable	Ayigbe town stable
Deworming status		
Yes	100	100
No	0	0
Frequency of deworming		
Once every three months	100	100
Veterinary care		

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Yes	100	0
No	0	100
Food type		
Wheat bran + pasture	100	100
Foraging		
Yes	100	0
No	0	100
Housing		
Stall	100	0
Unhoused	0	100
Frequency of cleaning faeces in stalls or compound		
Once a day	100	100
Twice a day	0	0

Unhoused horses were restrained with a leash and were not allowed to freely roam on their own.

4.17 Caretakers and stable keepers' perception on equine zoonoses

From the interview of stable keepers, it was revealed that the stable keepers were unaware of any potential zoonotic infections that could be contracted from horses. Stable keepers from Ayigbe town stable reported that they sometimes picked dung of horses with their bare hands without wearing gloves or any form of protection. When asked why they picked dung with their bare hands, one stable boy said that he picked the dung when they are dry in the sun and any "germ" in the dung would already be dead. Another stable keeper responded that the dung is simply grass and it is not as foul and disgusting as the faeces of a dog. Image 10 shows an image of a stable keeper picking horse dung with his bare hands.

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Image 10. A stable keeper picking dung with bare hands. Source: Field survey, Baah (2019)

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CHAPTER FIVE

5.0 DISCUSSION

5.1 Factors and trend of dog ownership

To the best of my knowledge, this study is the first of its kind to investigate the factors that influence dog ownership in Ghana and its potential implications for public health. Investigations were centred on a small study area; hence generalisations cannot be translated to the whole of Ghana.

Dog owning households were randomly selected within a defined geographic area, hence minimising bias. In this study, a one sample chi-square analysis indicated that there was a highly significant difference in percentages of male and female dog owners. More males owned dogs than females. This is probably because the head of most Ghanaian households are mostly males. This is in agreement with a report by Knobel (2008) who reported more dog owners who are males than dog owners who are females. This is contrary to a study by Westgarth *et al*.(2007) who reported more dog owners who are females in households and concluded that adult females were positively associated with dog ownership in UK. Similary, Wise & Kushman (1984) reported that females were more likely to own dogs than males. The difference possibly reflects the socio-cultural and socio-economic factors that affect dog ownership in these countries.

Among religion, there was significantly lower number of muslim dog owners compared to Christian dog owners in this study. The difference can be attributed to the perception of dogs in the Islamic religion. In Islam, dogs are considered impure in a spiritual sense, although dog ownership is not prohibited (Foltz, 2005; Beck, 2000). Knobel *et al*. (2008) also found significant

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association between religion and dog ownership where few dog owners were muslims than christians in Tanzania.

Dog ownership pattern reported in this study is consistent with Knobel, 2008 who reported a high percentage of dog owners (61.9%) that kept dogs for security reasons in Tanzania. However, this is contrary to the findings of Leslie *et al*. (1994) who reported that the highest scoring reason for dog ownership was companionship in a study in Canada. Other studies have reported that the reason for owning a dog in the western world is companionship (Staats *et al*., 2008; Bennett & Rohif, 2007).

In this study, age of owner did not significantly influence dog ownership. This finding was in contrast to (Knobel, 2008) who reported that households headed by people within 16-35 years were significantly less likely to own dogs than household headed by middle-aged individuals. Owner's level of education and occupation have been considered as a proxy for socio-economic status (Holland, 2019). A study by Murray *et al*. (2010) reported that the likelihood of dog ownership decreased with increasing educational level. Murray and colleagues' findings is somewhat contrary to the findings in this study. In this study, a one sample chi-square analysis revealed that there were more tertiary education level dog owners. The reason for this observation could be of socio-economic or socio-cultural status. It is likley that tertiary education level dog owners have the financial resources to cater for a dog.

The effect of owner's occupation has been variably reported with regard to the likelihood of dog ownership. In a multivariable analysis in the UK (Westgarth *et al*., 2007) and Canada (Leslie *et al*., 1994), the effect of owner's occupation was not significantly associated with dog ownership. Dog ownership has been reported to be associated with high income (Franti & Kraus, 1974).

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Differences in dog ownership pattern with respect to income level (Leslie *et al.*, 1994; Franti & Kraus, 1974) are possibly comparable to variations in owner's occupation (Westgarth *et al*., 2007). In this study, a one sample chi-square analysis revealed that the were more dog owners who were traders and most traders (market sellers, artisans, etc.) are not expected to receive high income. The differences between findings of these studies might be explained by the different measures used to access occupation and income. The variability in findings also suggest that these factors may also be inter-dependent with other influences (Holland, 2019). Generally, differences in dog ownership pattern in Ghana compared to patterns in other parts of the world may be due socio-cultural variations and owners' demographics.

5.2 Prevalence of gastrointestinal helminths in dogs

The overall prevalence of gastrointestinal helminths in dogs in this study was 66.6%, which was similar to the prevalence reported by Johnson *et al*. (2015) in Greater Accra Region of Ghana (62.6%), Ugbomoiko *et al*. (2008) in Nigeria (68.4%). However, the prevalence in this study was higher than the prevalence reported by Amissah-Reynolds *et al*. (2016) in Mampong, Ashanti region of Ghana (52%), Wyckliff *et al*. (2017) in Kenya (35.29%), Anene *et al*. (1995) in Nigeria (37.6%), Okoye *et al*. (2011) in stray dogs in Nigeria (52.6%), Sowemimo & Ayanniya, (2017) in Nigeria (41.7%). The prevalence in this study was lower than the prevalence reported by Tamerat *et al*. (2015) in Ethiopia (91%), Komatangi (2005) in Cameroon (88.5%), Abere *et al*. (2013) in Ethiopia (84.78%).

The prevalence of helminth parasites varies significantly from one locality to another depending on the helminth species involved, the host species, management practices, anthelminthic treatment, diagnostic procedures use and local climatic conditions such as humidity, temperature,

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rainfall (Katagiri & Oliveira-Sequeira, 2008; Oliveira-Sequeira *et al*., 2002; Robertson *et al*., 2000).

The poor veterinary attention given to owned dogs in this study is emphasized when the higher prevalence of 66.6% in this study is compared to the lower prevalence of 52.6% in stray dogs in Nigeria reported by Okoye *et al*. (2011). Also, Amissah-Reynolds *et al*. (2016) and Wyckliff *et al*. (2017) employed a single flotation technique which may have underestimated the prevalence since a combination of methods have been reported to increase the chances of recovering more parasites (Zewdu *et al*., 2010).

The helminths indentifed in this study were *Ancylostoma caninum*, *Toxocara* sp., *Dipylidium caninum* and *Spirocerca lupi*. These helminths have been identified and reported in Ghana (Amissah-Reynolds *et al*., 2016; Johnson *et al*., 2015; Anteson & Corkish, 1975) and other parts of the world with geographical, ecological, epidemiological and seasonal variations in prevalence (Alvarado-Esquivel *et al*., 2015) in Mexico, Gracenea *et al*. (2009) and Cantó *et al*. (2011) in Spain, Ngui *et al*. (2014) in Malaysia, Kutdang *et al*. (2010) in Nigeria, Davoust *et al*. (2008) in Gabon and Minnaar & Krecek (2001).

In the works done by Amissah-Reynolds *et al*. (2016) and Johnson *et al*. (2015), a single flotation technique with sodium chloride as a flotation medium was used and *Spirocerca lupi* was not reported. Reports by Fox *et al*. (1988), Evans (1983) and Traversa *et al*. (2008) indicated that classical flotation methods are insensitive diagnostic techniques for *Spirocerca lupi*. This may explain why *S. lupi* was not identified in their study. It is also possible that the dogs were not infected with *S. lupi*. In this study, a low prevalence of 3.0% was reported for *S. lupi*. According to Christie *et al*. (2011), the reported sensitivity for the detection of *S. lupi* eggs in faeces is low

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and was highest when centrifugal flotation technique with $NaNO_3$ was used. *Spirocerca lupi* in this study however, were recovered using the formol-ether sedimentation technique. This is in contrast to (Markovics & Medinski, 1996) who recorded no *S. lupi* egg using faecal sedimentation tests. Faecal samples sometimes require repeated examinations when the first examination is negative for *S. lupi* since the shedding of eggs is often intermittent (Dvir *et al*., 2010). It is likely that *Spirocera lupi* was underestimated in this study considering samples were analysed once and that floatation and sedimentation techniques are ineffective for *S. lupi* diagnosis (Minnaar & Krecek, 2001).

The findings in this study agree with Amissah-Reynolds *et al*. (2016) in Ghana, Ugbomoiko *et al*. (2008) in Nigeria and Kimura *et al*. (2013) in Japan who reported *Toxcara* as the most prevalent helminth. In this study, a prevalence of 40% was recorded for *Toxocara* spp. *Toxocara* is a cosmopolitan soil-transmitted helminth and hence habits like feeding off the floors and sleeping on bare grounds may account for this observation (Amissah-Reynolds *et al*., 2016). *Toxocara* has sticky eggs and eggs may stick to the coat of dogs when they sleep on the bare ground (Kleine *et al*., 2017; Rapini *et al*., 2012). Infection may occur when dogs groom their fur by licking them. Species identification of *Toxocara* by microscopy was impossible since micrographs of the eggs on McMaster slide could only be viewed under ×10 objective lens. This power of lens could not present clear details for identification to species level. It is known that dogs can harbour both dog and cat *Toxocara* spp. (*T. canis* and *T. cati*) (Anderson, 2000). Considering that dogs are coprophagous and may live with cats in the same household, brings up the possibility that some of the *Toxocara* eggs found in this study could be feline *Toxocara cati*. A more sensitive molecular technique like PCR (Polymerase chain reaction) can distinguish between the two *Toxocara* species.

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This study also recorded a lower prevalence of *D. caninum* infection than already reported prevalence by Johnson *et al*. (2015) in Ghana. However, prevalence of *Dipylidium caninum* was higher than the prevalence reported in Poland (Tylkowska *et al*., 2010) and Ghana (Amissah-Reynolds *et al*., 2016). Postmortem examination of dogs by Zewdu *et al*. (2010) and Anteson & Corkish, (1975) revealed significantly higher prevalence than the prevalence reported from copromicroscopy in this study. It is believed that *D. caninum* eggs are focally distributed and are rarely seen in stool due to the intermittent nature of proglottid shedding (Barnett *et al*, 2013), hence necropsy is more effective in recovering *D. caninum* (Minnaar & Krecek, 2001). It is therefore likely that *D. caninum* infection in this current study was underestimated considering the method of diagnosis that was used.

In this study, there was no significant difference in the overall helminth infection among age groups of dogs. This finding is in agreement with reports from Abere *et al*. (2013), Cantó *et al*. (2011), Alvarado-Esquivel *et al*. (2015) and Awoke *et al*. (2011). However, reports from Ehimiyein *et al*. (2018), Idika *et al*. (2017), Amissah-Reynolds (2016), Tamerat *et al*. (2015), Johnson *et al*. (2015), Panigrahi *et al*. (2014), Okpara *et al*. (2015), and Adamu *et al*. (2012) stated otherwise. Authors like Johnson *et al*. (2015) and Tamerat *et al*. (2015), Swai *et al*. (2010) have reported significantly higher prevalence in puppies. However, some authors used different age group classifications from the one that was used in this study, hence age-wise prevalence comparisons may not be valid.

This study reported no statistical significance in the difference between *Ancylostoma caninum*, *Toxocara* spp., *Dipylidium caninum* and *Spirocerca lupi* infections among age groups. Senlik *et al*. (2006), Zelahem & Mekonnen (2012), Overgaauw & Boersema (1998), Katagiri & Oliveira-Sequeira (2008), Swai *et al*. (2010) and Ferreira *et al*. (2016) reported otherwise. *Toxocara* and

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Ancylostoma infections in puppies have been attributed to transmammary route through milk and transplacental transmission in utero (Burke & Robertson, 1985; Gillespie, 1988; Anderson, 2000). *Dipylidium* infections are acquired through the ingestion of infected flea (Neira *et al*., 2008; Ramana *et al*., 2011). *Dipylidium* infection in puppies is therefore attributable to ingestion of infected fleas from their mothers when puppies lick their fur or when they accidentally ingest infected flea whilst breastfeeding.

There was no significant difference in helminth prevalence among sexes in this study. Female dogs had a higher helminth prevalence than male dogs, but the difference was not statistically significant Other researchers have reported similar findings. Idika *et al*. (2017) reported higher prevalence in male dogs but did not report statistical significance. This is in agreement with reports by Amissah-Reynolds *et al*. (2016), Tamerat *et al.* (2015), Wyckliff *et al*. (2017), Abere *et al*. (2013), Jones *et al*. (2011), Awoke *et al*. (2011) and Ehimiyein *et al*. (2018). However this finding is in contrast to reports by Adamu *et al*. (2012), Okpara *et al*. (2015) and Alvarado-Esquivel *et al.* (2015) who reported significant differences in infection among sexes.

There was no significant association between breed of dog and helminth prevalence in this study. Significant difference in prevalence among breeds have been reported by Idika *et al*. (2017) in Nigeria. A number of reports have also reported significant association among breeds with local dogs (non-exotic breeds) having higher helminth prevalence (Abere *et al*., 2013, Idika *et al*., 2017; Awoke *et al*., 2011). In Nigeria, Onyenwe & Ikpegbu (2004) reported a significantly higher prevalence in cross breeds over the local and exotic breeds. However, a report by Anosike *et al*. (2004) and Swai *et al*. (2010) found no statistically significant association between breed and helminth infection. The high prevalence of infection in local dogs is probably due to the different management practices given to local dogs. In this study, it was found that management practices

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such as deworming, food type (kibble or homemade food), dog housing (kennel or unhoused), mobility of dog (semi-domestic or strictly domestic), dog food dish (dog bowl or ‘’fed off the ground’’) and even frequency of bathing differed significantly among dog breeds. It is suspected that because exotic dog breeds are expensive, they are appreciated and given proper veterinary and husbandry care with little or no roaming range outside of their homes. On the contrary, local dogs are cheaper, common, less appreciated and are allowed to freely roam and either become communal, semi-domestic or stray dogs where they are most likely to harbour infections from other dogs or from the food they eat from the streets (Idika *et al*., 2017; Aiyendun & Olugasa, 2012). A greater proportion of dog owners with low socio-economic status who owned local dogs did not exercise proper veterinary and management practices. They exposed their dogs to infections by allowing unrestricted maneuverability of their dogs. Resources and education were lacking and owners may exercise veterinary care only when the dog is obviously sick, hence the high prevalence in local dogs. Local dogs that were fed ‘gari and palm oil’were emaciated and look malnourished. According to Taylor (2007), heavy helminth infection in malnourished dogs cause anaemia and protein loss.

A highly significant association was found between deworming status and helminth prevalence in this study (Table 8). This is in line with reports from Alvarado-Esquivel *et al.* (2015) in Mexico and Satyal, *et al*. (2013) in Nepal. Other authors however, have found no significant association between deworming and helminth prevalence. Johnson *et al*. (2015) in Ghana, Wyckliff *et al*. (2017) in Kenya and Swai *et al*. (2010) in Tanzania did not find any significant association between deworming and helminth prevalence in dogs. In Johnson and colleagues’ work, the sample size of dewormed and undewormed dogs was low, hence their conclusion may not be representative of the population.

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A chi-square test of association revealed that food type (homemade and kibble) was not significantly associated with helminth infection in dogs. Ahmed *et al*. (2014), found statistical significance in helminth prevalence among dogs that were fed dry food (kibble) and uncooked food. Zelahem & Mekonnen (2012) also found significant difference in prevalence among dogs that were fed raw food and dogs that were fed cooked and mixed food.

5.3 Intensity of helminth infection in dogs

The overall mean faecal egg count of *Toxocara* spp. was lower than the mean faecal egg count of *Ancylostoma caninum* in this study. The mean egg count of *Toxocara* and *Ancylostoma caninum* in this study was lower than that reported by Komatangi (2005) in Cameroon, Ayinmode *et al*. (2016) in Nigeria. The mean intensity of *A.caninum* was higher than the mean intensity reported by Idika & Nwosu (2017) who experimentally infected dogs in Nigeria, Perera *et al*. (2013) in Sri Lanka, Sowemimo (2017) in Nigeria, de Souza *et al*. (2015) in Brazil, Degefu *et al*. (2011) in Ethiopia and Cantó *et al.* (2011) in Mexico.

The difference in intensities may be due to the technique used in estimating the intensities; as the McMaster faecal egg count and Kato-Katz have shown considerable effectiveness in estimating faecal egg count over the formol-ether concentration technqiue (Vadlejch *et al*., 2011; Rashid *et al*., 2018; Sowemimo & Asaolu, 2009), geographical variations and management practices (Oliveira-Sequeira *et al*., 2002). Some studies also estimated intensity at necropsy which is most likely to recover more helminths than coproscopy. *S. lupi* and *D. caninum* egg count could not be estimated in this study since they were only observed using formol-ether sedimentation technique and hence reliable egg counts could not be obtained. There was no statistically signifcant difference in mean egg count of *A. caninum* and *Toxocara* spp. among breeds in this study. This

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is contrary to a report by Komatangi (2005) who reported heavier infections of *A. caninum* and *T. canis* in local dog breeds. The sex-wise and age-wise mean intensities of *A. caninum* and *Toxocara canis* were higher than the intensities reported by Okoye *et al.* (2011) in Nigeria. In this report and Okoye and colleagues' report, intensites among sex and age groups were statistically insignificant. This is also in agreement with a report by Degefu *et al*. (2011) in Ethiopia and Malgor *et al*. (1996) in Uruguay. However, a report by Katarynza & Błaszkowska (2017) in Poland showed significant association of *T. canis* intensity with age of dog, where dogs lesser than 12 months old harboured significantly higher numbers of *Toxocara canis* than dogs above 12 months old. Sowemimo (2007) also reported significant intensities in male and female dogs, with males harbouring more *Toxocara canis* than female dogs.

5.4 Prevalence of canine haemoparasites

A prevalence of 7.69% was reported for *Babesia*-like haemoprotozoan parasites in dogs. *Babesia canis* has been reported in dogs in Ghana (Owusu, 2015), so the detection of *Babesia*-like parasites in dogs in this study was anticipated. Other authors have reported *Trypanosoma*, *Dirofilaria immitis*, *Hepatozoon canis* in Nigeria (Opara *et al*., 2016) and *Ehrlichia canis*, *Mycoplasma haemocanis, Babesia vogeli* in dogs in Australia (Barker *et al*., 2012).

The prevalence and distribution of parasites is known to differ according to geographical location and even climatic variations. The prevalence of *Babesia*-like parasites was lower than 57.1% that was reported by Opara *et al*. (2016) in Nigeria. The low prevalence reported in this study is probably due to small sample size or the source of blood. The detection of *Babesia* has been shown to be feasible in most cases when peripheral blood is taken from the ear or the tail (Jacobson, 2006). In this study, blood was taken from the cephalic vein of dogs and only a few

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blood samples were collected from the ear. Detection of *Babesia* in blood film is often difficult in chronic stages than in acute stages of infection (Mosqueda *et al*., 2012). The diagnosis of *Babesia* through microscopy is often misdiagnosed as *Plasmodium* and vice versa because the intraerythrocytic parasites are morphologically identical (Akel & Mobarakai, 2017). However, trophozoites of *Babesia* can assume tetrad forms and has a characteristic maltese cross, although rare in *B. microti*, that distinguishes it from *Plasmodium* (Akel & Mobarakai, 2017). In this study, no tetrad form or maltese cross was seen. However, extracellular merozoites which is characteristic of *Babesia* (Akel & Mobarakai, 2017) was seen.

Infection outcome in dogs can be attributed to ectoparasitic control. 64% of the respondents reported that they did not control ectoparasites on their dogs. Those who reported that they controlled ectoparasite either used acaricides or handpicked the ticks. Picking of ticks by hand has been reported to facilitate infection when it is improperly done (Huygelen *et al*., 2017). Molecular technique such as PCR is effective and sensitive in the diagnosis of *Babesia* infection. However, PCR could not be done at the time of the study. Further research involving haematological studies in conjunction with PCR-based detection of haemoparasites in dogs in Ghana is suggested to clarify the potential role of canine haemoparasites and their distribution. Inferences from statistical analysis were limited by the sample number that was obtained, hence inherent risk factors of infection such as age, sex and breed could not be assessed. An insufficient number of exotic dog breeds, puppies and juveniles were sampled for haematological analysis. Local dogs were readily available than exotic dogs and adult dogs were more accessible than puppies and juveniles, hence any inference drawn from their association with infection may not be statistically reliable.

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5.5 Management practices, zoonotic implications and awareness on canine zoonoses

Management practices such as feeding dogs uncooked offal, irregular deworming and allowing unrestricted roaming of dogs expose dogs to infections. The percentage of owners who do not deworm their dogs (69.6%) is alarming and poses a significant public health risk. Anthelminthic treatment of dogs is effective in controlling the helminth burden in dogs. Feeding dogs uncooked offal exposes them to infective stages of meat-borne helminths such as *Echinococcus* even after successful deworming. Free-roaming dogs are exposed to parasitic infections as they interact with other dogs that may harbor these parasites. Free roaming dogs may also acquire infections from their coprophagous feeding habits. Hookworms (*Ancylostoma caninum*) and *Dipylidium caninum* are common parasites of dogs and are capable of causing larva migrans syndromes and Dypilidiasis respectively in humans (McCarthy & Moore, 2000).

Toxocara canis also has zoonotic implications and has been reported in children in Ghana (Kyei *et al*., 2015). There is a potential transfer of *Toxocara* through direct contact with the fur of an infected dog (Aydenizöz-Özkayhan *et al*., 2008). Other reports do not consider this to be a significant risk because the eggs need several weeks to become infective (Overgaauw *et al*., 2009). One of the objectives of this study was to ascertain owner's knowledge on canine zoonoses. A greater percentage of the respondents (86.7%) appeared to be well-informed of the potential for rabies transmission from dogs to humans. However, more common and less severe helminthozoonoses and protozoonoses were not known by respondents (0%). Awareness of zoonotic disease risk is a prerequisite for effective prevention (Stull *et al*., 2012). The limited public's knowledge of helminth related zoonotic diseases is a public health concern. This clearly reflects the gaps in veterinarian-client education. It is evident that majority of veterinarians do not

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educate their clients on canine helminthozoonoses and protozoonoses. On the contrary, progress has been made in educating the public on rabies; which is a more serious viral zoonosis.

5.6 Prevalence of equine helminths

The overall prevalence of helminths in horses was 39.7%. The prevalence of helminths in this study is lower than the prevalence of 63.7% reported by Tesfu *et al*. (2014) in Ethiopia, 76.1% reported by Wosu & Udobi (2014) in Nigeria and higher than the prevalence of 15.7 reported by Sawsan *et al*. (2008) in Sudan. The helminths reported in this study are *Parascaris*, *Strongyle*-type eggs and *Trichostrongylus* sp. Identification of *Parascaris* to the species level was difficult with microscopy as *Parascaris equorum* and *Parascaris univalens* are morphologically identical. Nielsen *et al*. (2014) reported that *Parascaris univalens* is most likely to be wrongly identified as *Parascaris equorum*. Eggs of *Strongylus edentatus*, *Strongylus asini*, *Strongylus equinus* and *Strongylus vulgaris* are morphologically identical with slight variations in the size of egg (Mehlhorn, 2015). To avoid misidentification, all *Strongylus* eggs were described as *Strongyle*-type eggs in this study. Some of these parasites have been reported by other researchers (Umar *et al*., 2013, Rosa *et al*., 2018).

Several studies have reported significant difference in infection among age groups of horses. In this study there was no statistically significant association helminth infection with age, sex and breed of horses. This is probably due to the small sample size that was used in this study. Umar *et al*. (2013), however, found significantly high prevalence in stallions and foals used for cadet training in Nigeria. Similar findings have been reported in horses in a report by Regassa & Yimer (2013). Mezgebu *et al*. (2013) and Fikru *et al*. (2005) also reported no statistically significant difference in helminth infection among sex in horses.

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Parascaris was highly prevalent than *Strongyle*-type eggs in this study. This is in contrast to Mezgebu *et al*. (2013), Tesfu *et al*. (2014) and Wannas *et al.* (2012) who reported *Strongyle*- type eggs as the most prevalent in their studies. The prevalence of *Parascaris* (32.9%) in this study is higher than the prevalence of 11.7% recorded by Tolossa & Ashensfi (2013), 4.6% reported by Tesfu *et al*. (2014) and quite similar to the prevalence of 26.2% reported by Tesfu *et al*. (2014). *Parascaris* infection was not significantly associated with age in this study. This is contrary to a report by Hinney *et al*. (2011) who reported that the true prevalence of *Parascaris* is age dependent. The prevalence of *Strongyle*-type eggs (26%) reported in this study is in contrast with the prevalence of 68.8% reported by Umar *et al*. (2013) in Nigeria. The prevalence of *Trichostrongylus* (8.2%) in this study was slightly higher than the prevalence of 4.44% reported by Umar *et al*. (2013). The difference in prevalence can be attributed to management practices, climatic differences, sample size and even diagnostic techniques (Rosa *et al*., 2018).

5.7 Intensity of equine helminths

The mean egg intensity of helminth among age and sex group was highly significant in a report by Tesfu *et al*. (2014). Contrary to Tesfu *et al*. (2014), the mean intensity of *Toxocara* infection among age, breed and sex was not significant in this study. However, the mean intensity of *Strongyle*-type eggs and *Trichostrongylus* was significant among age and breed of horses but not sex. The highest egg count of *Strongyle*-type eggs was observed in local horse breeds and horses more than 10 years old. This is contrary to a report by Tesfu *et al*. (2014) who reported the highest intensity in horses less than four years old in Ethiopia. A significantly high intensity of *Trichostrongylus* was observed in horses less than 4 years old and in local horse breeds. This is probably because younger horses do not have strong immune system as adult horses and local

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horse breeds are not given proper veterinary attention as exotic horse breeds that are valued because they are expensive.

5.8 Prevalence of haemoparasites in horses

A prevalence of 10.96% of haemoprotozoan *Babesia*-like parasites was reported in horses in this study. This prevalence was lower than the prevalence of 22% reported by Oladipo *et al.* (2015) in Nigeria and 55.0% for *Babesia equi*, reclassified as *Theileria equi* in Nigeria (Pam *et al.*, 2013). Infection of horses with *Babesia*-like haemoparasite may be attributable to interspecies transmission. In the Ayigbe town stable, horses cohabited with domestic animals like dogs, cats and livestock such as cattle. Horses were not kept in stalls and hence were more exposed to infection from infected dogs and cattle that had free maneuverability. It is possible that these animals acquired tick infection elsewhere and introduced them into the stable. Notwithstanding, horses were not treated against ectoparasitic infections at Ayigbe town stable. Horses from Polo grounds stable were routinely treated against ectoparasite by a licensed veterinarian. There was no evidence of cohabitation with other free-roaming domestic animals. This is probably the reason why horses from the Polo grounds stable had no tick-borne haemoparasites. Statistical inferences were not drawn from results due to small sample size. Risk factors such as age, sex and breed could not be assessed with respect to infection because there was great disparity in sample numbers. All horses sampled for haematological examination were local adult breeds.

5.9 Management practices, zoonotic implications and awareness on equine zoonoses

Horse management practices such as deworming status, frequency of deworming and food type were same for all horses in both stables. Horses in the study were allowed to sometimes graze in

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the open field and were given cut grass to supplement their feed. Re-infection in horses is likely to result from their grazing habit or from cut grass (pasture) that is infected with infective stages of a parasitic helminth even after anthelminthic regime. The highly significant difference in helminth prevalence among Polo ground stable and Ayigbe town stable could be associated with management practices. In the Polo grounds horses were dewormed and treated by licensed veterinary personnel. However, horses from the Ayigbe town stable were dewormed and treated by the stable keepers who had no veterinary training. Stable keepers from Ayigbe town stable bought drugs and administered them to horses when they fell sick. It suspected that horses from the Ayigbe town stable were probably underdosed with anthelminthic drugs.

Horses from Ayibe town stable cohabited with domestic animals such as cats and dogs and livestock such as cattle. It is possible that some infections may be transferred from these animals to the horses. According to Griffiths (1978), both horses and cattle can host *Trichostrongylus*; which was only found in horses from Ayigbe town stable. *Trichostrongylus axei,* a common helminth in horses and cattle has been identified and confirmed by molecular evidence in human infections (Issarapong *et al*., 2013). Rosa *et al*. (2018) reported that stables that raised horses together with cattle had an average median intensity greater than others that did not raise horses together with cattle. In all the stables, stable keepers alleged that they cleaned the stalls daily. Cleaning of faeces from stables prevents reinfection of treated horses. None of the stables treated pasture before feeding them to horses. Studies have reported management of pasture is vital to the control of helminths in the stable, hence reducing the rate of anthelmintic treatments in horses (Earle *et al*., 2002; O'Meara & Mulcahy, 2002). The effect of management practices on helminth infection could not be assessed because all horses in this study received the same husbandry practices except for slight variations in the way management practices were done. None of the

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stable keepers were aware of any equine zoonotic infection, hence did not exercise sanitary precautions when dealing with horses. This is probably due to lack of education as most of the stable keepers had no formal education.

6.0 CONCLUSIONS, RECOMMENDATIONS AND LIMITATIONS

6.1 Conclusions

The study revealed that sex of dog owner, religion of dog owner, reason for keeping dog, educational background of dog owner and occupation of dog owner influence dog ownership. This study determined the prevalence of helminths and haemoparasites in both dogs and horses in Ghana and demonstrated similar prevalence of canine helminths as previously reported by Johnson *et al.*, (2015) in Ghana. Some of the helminths identified in dogs in this study were of zoonotic importance. *Toxocara canis* was the most prevalent helminthozoonotic parasitic recorded in this study. *Dipylidium caninum* and *Ancylostoma caninum* were the other helminthozoonotic parasites reported in this study. A low prevalence of canine *Babesia*-like haemoparasites was reported in this study. Most owners (69.4%) did not deworm their dogs and owners were predisposed to giving proper care and management to exotic dog breeds than local dogs. Infrequent or non-deworming of dogs was found to be significant risk factors for intestinal helminthiasis.

Age, sex, housing unit, food type and manoeuvrability of dog were not significantly associated with infection in dogs. Local dog breeds (Mongrels) were managed under poor management practices as compared to exotic breeds. Significantly more local dogs were managed under free range system, homemade food, and no “veterinary care and anthelminthic treatment”. Majority of dog owners (61%) fed their dogs homemade food and 24.5% of owners fed their dogs off the

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ground. Majority of dogs (89.7%) were kept for security reasons and 57.7% were unrestricted and roamed with or without supervision. No exotic dog breed roamed without supervision. No dog owner knew about canine zoonotic helminths and zoonotic protozoan parasites. Majority of the owners (86.7%), however knew about canine rabies, yet most dog owners who owned local dogs did not vaccinate their dogs against rabies. Dog owners who kept exotic breeds were found to have good knowledge on dog management and positive attitudes toward dogs than those who kept local dogs.

Horses from the Ayigbe town stable were significantly infected with helminths than horses from the Polo ground stable. Horses from the Polo ground stable received proper veterinary care than horses from the Ayigbe town stable. *Parascaris* was the most prevalent helminth in horses, followed by *Strongyle*-type helminth and then *Trichostrongylus.* Age, sex and breed of horses were not significantly associated with helminth infection in horses. *Babesia*-like parasites were identified in horses at low prevalence. Stable keepers were completely unaware of possible equine zoonoses and hence did not exercise proper precautionary sanitary practices when handling horses or their faeces.

6.2 Recommendations

1. Interaction of multiple variables that affect dog ownership should be investigated.
2. The results show the need for education of dog owners and stable keepers, routine surveillance programmes and preventive health measures such as vaccination and parasite control strategies to mitigate the effect of canine and equine parasitism.

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3. It is also recommended that further research on canine and equine haemoparasites and helminths should employ molecular techniques to determine their molecular prevalence and identification to the species level.
4. A wider study that covers several other geographic regions will provide more information on the prevalence and parasite distribution in companion animals.

6.3 Limitations

1. The absence of molecular work in this study made parasite identification based on morphometrics and identification keys quite challenging.
2. The number of horses sampled for coprological and haematological analysis was too small and lesser than estimated sample size. Hence, inferences drawn from the analysis would not be statistically reliable.
3. The estimated sample size calculated for dogs could not be attained because most dogs were semi domestic and were not available at the time of sample collection.
4. Only dogs brought to the veterinary clinics at the time of the study were included in haematological examination, hence a small sample size was obtained.
5. Parasites may have been underestimated because stool samples were collected once from dogs and horses

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APPENDIX

APPENDIX 1 : QUESTIONNAIRE FOR THE STUDY OF PET OWNERSHIP PARASITIC INFECTIONS IN COMPANION ANIMALS IN SELECTED COMMUNITIES IN SOUTHERN GHANA

Dear Respondent,

This questionnaire is designed for an M. Phil research from the Department of Animal Biology and Conservation Science, University of Ghana, Legon. Please FILL IN correct information. All information will be treated confidentially and the information will be used for this research work only. Thank you.

Please tick [√] or fill where appropriate.

Basic Data

1. Pet

Type of animal A. Dog [ ] C. Horse [ ]

Breed………………………………………………………………

Age of dog: 0-6 months [ ][1] 7-12 months [ ][2] 12 months and above [ ][3]

Age of horse: 0-4 years [ ][1] 4-10 years [ ][2] 10 years and above [ ][3]

Sex: Male [ ][1] B. Female [ ][2] Sample No……..................

Socio-demographic Factors

2. Owner/Caretaker's educational qualification? A. Primary [ ][1] B. JHS [ ][2] C.SHS [ ][3] D. Tertiary [ ][4] Others [Specify]…………......................................….

3. Owner/Caretaker's Occupation? A. Farming [ ][1] B. Fishing [ ][2] C. Trading [ ][3] D. Office work [ ][4] Others [Specify] …………………………………….

4. Religious denomination? A. Christian [ ] B. Muslim [ ] C. Traditionalist D. Other [Specify]………………………………

5. Sex Male[ ][1] B. Female[ ][2]

6. Age. Specify.........................

Nutrition/ Feeding habit of Pet

7. What type of food does dog eat? A. Dog kibble [ ][1] B. Raw fish/meat/offal[ ][2] C. Cooked fish/meat/offal [ ][2] D. Leftover household food[3] Other[Specify]...

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8. How often do you feed dog in a day? A. Once [ ] B. Twice [ ] C. Three times [ ]

Housing, hygiene and health

9. Pet housing A. Kennel [ ] Other [Specify]...

10. How often do you clean pet housing unit? A. Once daily [ ][1] B. Once every week [ ][2] C. Once every month [ ][3] Other [Specify]..

11. How often do you bath pet? A. Once a month[1] B. At least twice a year [ ][2] C. Never [ ][3] Other [Specify]..

12. On what do you dish out your pet's food? A. Pet bowl [ ][1] B. On the floor [ ][2]. Other [Specify]..

13. Do you wash your dog's bowl A. Yes [ ] B. No [ ]

14. If No, why? [Specify]..

15. How often do you deworm your pet? A. Once every 3 months [ ][1] B. Once every 6 months [ ][2] Other [Specify]..

16. Do you take your pet to a veterinary clinic? A. Yes [ ][1] B. No [ ][2]
If No, why?..

17. How often do you take your pet to the vet? A. Once every 3 months [ ][1] B. Once every 6 months [][2] C. Once a year [ ][3] [Specify]..

18. Where does your pet defecate? A. In the house [ ][1] B. Outside the house [ ][2] C. Inside kennel/housing unit [ ][3] Other [Specify]..

19. How do you control ectoparasites on dog/horse? A. Use acaricides [ ][1] B. Handpick them [ ][2] Other [Specify]..

Mode of housing

20. What is the housing mode of dog? A. Strictly domestic [ ][1] B. Semi-domestic [ ][2]

Purpose of keeping pet

21.What role does pet play in your house? A. Hunting [ ][1] B. Companionship [ ][2] C. Security [ ][3]

Owner's knowledge on pet zoonoses

22. Do you know any disease(s) you can contract from your pet? A. Yes [ ][1] B. No [ ][2]

23. If Yes, specify..

24. Where did you get information on diseases (s) from?..

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Presence of Domestic Animals

25. Presence of other animals in household? Yes [ ][1] No [ ][2]

Specify type of animal A. Dog [ ][1] B. Cat [ ][2] C. Goat [ ][3] D. Sheep [ ][4] E. Fowl [ ][5]

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