STUDIES ON POPULATION DYNAMICS OF DOGS IN RELATION TO RABIES CONTROL IN KADUNA METROPOLIS, KADUNA STATE, NIGERIA

By

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M.Sc./Vet-Med/0386/2011-2012

A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES,AHMADU BELLO UNIVERSITY, ZARIA

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF A MASTEROF SCIENCE DEGREE IN VETERINARY PUBLIC HEALTH AND PREVENTIVE MEDICINE

DEPARTMENT OF VETERINARY PUBLIC HEALTH AND PREVENTIVE MEDICINE,AHMADU BELLO UNIVERSITY, ZARIA, NIGERIA.

OCTOBER, 2015

DECLARATION

I declare that the work in this dissertation entitled **"Studies on Population Dynamics of Dogs in Relation to Rabies Control in Kaduna Metropolis, Nigeria"** has been carried out by me in the Department of Veterinary Public Health and Preventive Medicine.The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this dissertation was previously presented for another degree or diplomaat this or any other university or institution.

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CERTIFICATION

This Dissertationentitled **"STUDIES ON POPULATION DYNAMICS OF DOGS IN RELATION TO RABIES CONTROL IN KADUNA METROPOLIS, NIGERIA"** by Nicolas Basor MAGAJI meets the requirement governing the award of degree of Master of Science (Veterinary Public Health and Preventive Medicine) of Ahmadu Bello University and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This research work is respectfully dedicated to Mr. Andrew Magaji and to the memory of Mrs. Sarah Richiot Magaji.

ACKNOWLEDGEMENT

I am grateful to God Almighty for seeing me through this work. I would also like to express my sincere gratitude to my supervisors, Prof.J. U. Umoh and Dr. B. V. Maikaifor the tremendous amount of support and guidance they have given me throughout the research work. They were, without doubt, the best supervisors I could have hoped for and without their time, expertise, engaging support, encouragement and, most importantly, their faith in me and what I was doing, this work would not be what it is.

I am also grateful to Dr. Asabe Adamu Dzikwi, who provided valuable expertise in particular areas. The theoretical framing of this research, and the way this informed data analysis, benefited enormously from her. She ensured I was well-informed about Geographic Information System.

My sincere appreciation goes to all my lecturers and colleagues at the department for creating a professional and social environment that is most inspiring.
I also want to express my appreciation to family and friends, especially my dad (Mr. Andrew Magaji) who has supported me unconditionally throughout all these years.

ABSTRACT

Dogs perform a range of cultural, social and economic functions in the society. Dogs are kept as pets and companions, for hunting, as guards or for commercial purposes. Dog population dynamics have a major impact upon the effectiveness of rabies control strategies. As such, understanding domestic dog population has been recognized as central to the design of effective rabies control programmes. This study was carried out to determine the spatial distribution of dog population, vaccination status of dogs, and rabies related dog bites in Kaduna metropolis, Nigeria. Dog population census was carried out within Kaduna metropolis in May-July 2014 using direct street count and questionnaire survey aided by aerial photographic coverage of the city to define enumeration areas, with the use of Geographic Information System to ascertain the spatial spread of dog population. The city was classified into four zones, namely Kaduna North, Kaduna South, Chikun and Igabi Local Government Areas. One thousand questionnaires were directly administered at household and compound levels to capture data on socio-economic profile of dog owners, reasons for/not keeping dogs and types of management system practiced, and dog count. Information on rabies vaccination status was obtained from the Ministry of Agriculture Zonal Veterinary Clinic Magajin Gari, Kaduna, Kaduna State from 2004-2010, the existing records of reported cases of dog bite in humans was also obtained for a period of ten years (2004-2014). The results of questionnaire survey revealed a total of 324 dogs. There were 199 (61.4%) male and 125 (38.6%) female dogs in the population. Young dogs (<6months old) were 67 (20.7%), while adult dogs (>6months old) were 257 (79.3%). The finding of this study showed a dog to human ratio of 1:28.9. Dog distribution ranged from172 (53.1%) in Chikun L.G.A, to 3 (0.9%) in Igabi L.G.A. There was no significant difference ($\chi^2 = 2.1$, $P > 0.05$) in the distribution of sexes of dogs. Most dogs (94.4%)

are kept as guard dogs in their owner's premises. The majority of respondents who do not own dog (29.6%) said it was due to religious reasons. The anti-rabies vaccination coverage of dogs in the houses surveyed was estimated at (35.5%). The study revealed low vaccination coverage in native breed of dogs (50.98%), in females (36.6%) and in dogs greater than 12 months of age (29.0%), therefore vaccination against rabies should be instituted regardless of sex, breed and age of dogs so as to attain the 70% vaccination coverage as prescribed by the World Health Organization. Out of 86 dogs reported to be involved in dog bite cases, 76 (88.4%) offending dogs were owned dogs and 10 (11.6%) were found to be stray dogs. Analyses of vaccination status of those dogs involved in dog bite revealed that 55.8% of dogs had been vaccinated, while 29.1% of dogs had no current anti-rabies vaccination. The number of dogs with unknown vaccination status were 15.1%. The implications of these findings are very critical in the control of rabies and other dog-borne diseases. Therefore as part of an effective rabies control programme, there should be regularvaccination campaign programmes, and mobilization of residents for more responsible dog ownership in Kaduna metropolis.

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ABBREVIATIONS

GIS	Geographic Information System
LRE	Local Resource Enhancement
NGO	Non-Governmental Organization
OIE	Office Internationale des Epizooties
RSPCA	Royal Society for the Prevention of Cruelty to Animals
SPSS	Statistical Package for Social Sciences
WHO	World Health Organization
WSPA	World Society for the Protection of Animals

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Dogs were domesticated from wolves as recently as 15,000 years ago (Morey, 2006), or perhaps as early as 100,000 years ago based on recent genetic fossil and DNA evidence (Savolainen *et al*., 2002; Lindbald-Toh, 2005). Evidence suggests that dogs were first domesticated in East Asia, possibly China, and the first people to enter North America took dogs with them (Savolainen *et al*., 2002).

The domestic dog *(Canis lupus familiaris*) is generally considered as the first domesticated mammal and has co-existed with man as a working partner and house pet in all eras and culture since the days of the cave dwellers (Brickner, 2002).Dogs perform a range of cultural, social and economic functions in society. Dogs are kept as pets and companions, for hunting, as guards or for commercial purposes. Some studies also suggest that keeping pets is associated with a higher level of self- esteem in children (Paul and Serpell, 1996; Knobel *et al*., 2008).

A geographic information system (GIS) is a system designed to capture, store, manipulate, analyse, manage, and present all types of geographical data. The acronymGIS is sometimes used for geographical information science or geospatial information studies to refer to the academic discipline or career of working with geographic information systems and is a large domain within the broader academic discipline of Geoinformatics. In the simplest terms, GIS is the merging of cartography, statistical analysis, and computer science technology (Maliene *et al*., 2011).There are

many different types, brands and configurations of GIS available, and most of these are capable of conducting a wide variety of analyses, both statistical and spatial (i.e. an analysis of how features are related to each other in the 'space' represented on a map) (Longley *et al.,* 2005).

GIS is well-established in habitat-based studies of animal populations to analyse remotely-sensed databases (Johnson and Naiman, 1990) and as a predictive tool for animal or plant species distributions (Scott *et al*., 1993). In addition, GIS is now used to create databases, manipulate spatially-explicit surfaces to represent specific parameters, and to displace spatial relationships through simulation modelling, hydrologic constructs, and species relationships (Keller, 1990; Aspinall and Veitch, 1993).

1.2 Statement of Research Problem

The dog population in urban and suburban regions is composed of dogs that roam only with their owners and stray dogs which are ownerless (Beck *et al.*, 2000). In both cases, the animals come in close contact with humans and their dwellings and act as reservoirs and transmitters of zoonotic diseases (Gracenea *et al*., 2009).

Uncontrolled population of stray and semi-domesticated dogs in close proximity to increasing densities of human population in urban environments is a common fact in developing countries, in conjunction with the lack of veterinary attention and zoonotic awareness, increases the risks of disease transmission (Traub *et al*., 2005). Kaduna is a densely populated city and there are no legal restrictions to the keeping of dogs; hence dogs are freely kept by homes in the city. Presence of dump sites in some locations in the city encourages dog movement as they scavenge for food. Dog meat processors also

ply their trade in specific regions in the city and majority of these individuals are unaware of the risk they are exposed to in the course of their activities.

A study by Omudu *et al.*, (2010) in a survey of dog population in some residential areas of Makurdi, established a Dog-human ratio of 1 dog to every 4 persons while the average number of dogs per household was 1.43. Also Aiyedun and Olugasa, (2012) reported a dog population density of 1:13 dog per household, in a research carried out within llorin city. They recorded an estimated dog population of1,258 dogs, they also stated that poorly managed garbage collection points were found to be associated with and aid the distribution of roaming dogs in Ilorin city. There have been several other research works carried out on dog population in Nigeria (Oboegbulem and Nwakonobi, 1989; Adeyemiand Zessin, 2000; Awoyomi *et al*., 2007; Hambolu *et al*., 2013; Mshelbwala *et al*., 2013; Atuman*et al*., 2014 Otolorin *et al*., 2014). Since dog has been established as the predominant vector of rabies in Nigeria, the most logical and cost effective approach to rabies control is elimination of stray and ownerless dogs combined with a programme of single mass immunization in the shortest possible time, at least 80% of the entire dog population (WHO, 2001)

There has been steady increase in the incidence of dog bites, rabies transmission and unprecedented contamination of public parks with ova of dog ascaris *Toxocara canis* in Nigeria and elsewhere (Ovegrauuw and Knapen, 2000; Omudu *et al.*, 2003; Okoh, 2007; Omudu and Amuta, 2007). Despite the mutual relationship between man and dogs, the concerns of medical and community health officials about responsible pet ownership have increased. Dog populations depend on the availability of resources humans make available or deliberately withhold. Several health and environmental

problems have been associated with the ever-increasing dog population, especially free roaming dogs. These include biting children, killing livestock, barking and fighting, indiscriminate defecation and transmission of diseases like rabies (Beck *et al.*, 2000; Matter *et al*., 2000).

1.3 Justification

Planning control programmes for diseases such as rabies, babesiosis and other dog-borne zoonoses requires information on the size and population dynamics of dogs in a particular location. Studies on dog population and ecology have over the years provided veterinary public health officials with estimates used in planning rabies vaccination and control of dog internal and external parasites (Prosperi *et al*., 1992; Nunes *et al.*, 1997; Butter and Bingham, 2002). Dogs are the most widely spread and abundant of all carnivores (Wandeler *et al*., 1993). Knowledge of the pattern of the spread and distribution of dogs, population of ownerless and stray dogs in Kaduna metropolis will aid in the control and management of dangers caused by these animals such as dog bites, road traffic accidents, pollution from faeces, urine, and tearing of open garbage.

Dog population dynamics have a major impact upon the effectiveness of rabies control strategies. An understanding of domestic dog ecology has been recognized as central to the design of effective rabies control programmes (Slater, 2001; Hsu *et al*., 2003; Cleaveland *et al*., 2006). To understand the epizootiology of canine rabies, the ecology and population biology of the dog must be considered. Information on dog populations (in relation to different habitats, cultures, social strata of human populations and epizootiological situations) must be studied (Wandeler *et al*., 1993). Cost-benefit analysis of control strategies (such as mass vaccination) cannot be made without reliable

information on the population distribution of dogs and accessibility of dogs to vaccination campaigns (WHO, 1980). Careful analysis of the number of dogs accessible to vaccination is required to assess the cost-effectiveness of eliminating rabies from its canine reservoir (Bögel and Motschwiller, 1986).

The fouling of public parks and open spaces is one of the major grievances among the non-dog owning population against dog owners (RSPCA and Kennel club, 1998). The presence of free-roaming dogs may have a negative impact in countries with a tourist industry, tourist may be upset by seeing mongrel dogs roaming the street (Fielding and Plumridge, 2005). The presence of free-roaming dogs may project an image of inner-city decay, drugs, and violence all of which are detrimental to a tourist-based economy (Ross and Mirowsky, 1999).

The use of geographical information systems (GIS) together with remote sensing and spatial analytical models is highly relevant to animal and public health research and its applications in said areas are quite broad in their scope ranging from real-time tracking/surveillance of animal diseases, risk assessment and in assessing prevention strategies for diseases. A plethora of recent studies in medical, veterinary and public health research have employed geospatial analysis to solve different problems (Durr and Gatrell, 2004; Meade and Emch, 2010).

1.4 Theoretical Framework

The population dynamics of dogs is an important factor in the epidemiology of endemic canine rabies. Lack of reliable estimates of dog populations hampers rabies control campaigns in developing countries, as cost-benefit analysis of control strategies cannot

be made accurately (Oboegbulem and Nwakonobi, 1989). The structure and turnover of a dog population is determined by a great number of different factors. Its analysis depends on vital statistics such as sex and age ratios, natality and rearing success, survival and mortality rates (WHO/WSPA, 1990). Dogs inhabit a great variety of different habitats. An analysis of these habitats should reveal the abundance, distribution and predictability of resources (shelter, water, food) for dogs. Once the resources determining the carrying capacity of a habitat are known, it might become possible to influence dog abundance by habitat control e.g., by removing an important food resource. Considerable effort has been devoted to defining and quantifying wildlife habitats and relating habitat quality or "carrying capacity" to animal densities and distribution (Gysel and Lyon, 1980). The sizes of different segments (owned, unowned) of a dog population depend very heavily on the proportion of the human population keeping dogs, tolerating dogs, or rejecting dogs in their neighbourhood. Besides the duties dogs are kept for, they may also fulfil beneficiary functions in other ways. Dogs can also be rejected because they are unclean (in a religious or a hygienic sense), because they bite, or because they are disease vectors, pests or nuisances (Westbrook and AlIen, 1979).

Rabies has a high incidence in dogs in areas where dog populations reach high densities and where the animals are poorly supervised (WHO/WSPA, 1990). Free roaming and unvaccinated dog population may increase the likelihood of the spread of rabies virus. Well planned and executed vaccination campaigns may reduce rabies incidence in dog drastically and may even eliminate the disease in areas where the virus is not maintained in wildlife.

Dog questionnaire surveys produce information on dog human ratios, dog keeping practices, reproduction, morbidity and mortality (Wandeler *et al.*, 1993). Also understanding some determinants or risk factors associated with rabies such as age, breed, season and location are all critical in the epidemiological studies of rabies (Widdowson *et al*., 2002).

Data incorporated into a GIS usually have (or are given) a spatial reference. This reference links the data to the features they describe in a particular geographic 'space'. A common format of a GIS is a digital, interactive map of an area or location (typically) on the Earth's surface, which is linked to a database containing tables or spread sheets of data (i.e. feature datasets) associated with some or all of the features displayed on the map (e.g. roads, water bodies, patches of vegetation and/or the locations of wildlife) (Carter, 1992). This configuration enables relatively quick and easy visual assessment of spatial patterns and relationships in the data, as well as the ability to efficiently edit, update, analyse and create displays of potentially very large quantities of data.

Therefore, the study of the dog population, knowledge of the pattern of spatial dog distribution, the assessment of frequency of dog bites and vaccination of dogs, generated from this study will be valuable for public health planning in Kaduna metropolis, particularly for antirabies control programme among dogs in the city.

1.5 Aim and Objectives of the Study

1.5.1 Aim

The aim of this study is to determine the spatial distribution of dog population in Kaduna metropolis, Nigeria.

1.5.2 Objectives

The specific objectives are to:

i. estimate the dog population density in Kaduna metropolis.

ii. determine the pattern of the spatial distribution of dogs in Kaduna metropolis.

iii. assess the level of dog vaccination against rabies and cases of dog bites in Kaduna metropolis.

1.6 Research questions

i. What is the estimate of the dog population density in Kaduna metropolis?

ii. What is the pattern of the spatial distribution of dogs in Kaduna metropolis?

iii. What are the vaccination status of dogs against rabies and pattern of dog bite cases in Kaduna metropolis?

CHAPTER TWO

LITERATURE REVIEW

2.1 The Dog Population in Urban and Rural Areas

The 2006 census estimated that there were between 2 and 5 million dogs in Nigeria of which many were either home- or owner-less or roamed the streets freely (Meseko, 2010). Populations of dogs vary between different habitats, different cultures and different social strata of the human populations (WHO, 1990). The presence and abundance of stray dogs depends on the attitudes towards dogs of the humans in these areas. Stray dogs have a great impact on human public health and the ecosystems. Due to the close contact with humans, dogs are responsible for the spread of several zoonotic diseases. Dog rabies is endemic in many developing countries and is responsible for most human deaths from the disease (WHO, 1992). Additionally, domestic dogs are potentially effective predators of the native fauna and can have competitive interactions with endemic wild carnivores (Butler *et al*., 2004). Preying of small mammals and birds and transmission of diseases can have disastrous consequences for ecosystems in which feral dogs become established.

Any decision made by responsible authorities concerning dog rabies control should be based on cost-benefit analysis. Cost and benefit of particular control strategies cannot be estimated without knowledge about the involvement of different species in the epizootic, the size and turnover of the dog population concerned, the degree of supervision of owned dogs, the proportion of unowned animals in the dog population, the origin of unowned dogs, the accessibility of dogs for control and vaccination campaigns and the public attitude towards dogs and control measures (Lantis, 1980). Also of great importance is an understanding of the habitat with its man-made resources

(food, water, shelter) supporting a variable number of unowned and owned unsupervised dogs. Part of the information can be gathered by simple means (e.g. questionnaire surveys) but the majority of data needs establishing by time-consuming field observations using wildlife techniques. These efforts are not purely academic; on the contrary, they will lead to the selection of optimal strategies of disease control (Sellitz *et al*., 1976).

2.1.1 Dog abundance

Dog abundance is related to different epidemiological situations, to different culture areas, to different rural and urban habitats, to areas of different human settlement patterns and also to different social strata of human rural and urban populations (Wandeler *et al*., 1988). Dog population density is commonly indicated as a dog to human ratio, occasionally also as dogs per household or dogs/km^2.In general, American and European countries report a dog to human ratio between 1: 10 and 1:6. However there is no doubt that the abundance of dogs varies considerably from country to country and within geographical regions within countries (Wandeler *et al*., 1988). In northern Kaduna State (before creation of Katsina state) there was less than 1 dog per 1000 inhabitants, while in the southern parts of the same state the dog to human ratio lies between 1:27 and 1:3 (Ezeokoli *et al*., 1984). In different areas of Mexico City the ratio varies between 1: 10 and 1:1 (RangeI *et al*., 1981).

In developed countries, the variation of the pet dog population is usually directly related to the income and the vigour of the economy (Franti *et al*., 1974). As a general rule, the ratio of owned dogs to people is greater in the more rural regions of a country (Purvis and Otto, 1976). Where the number of owned dogs is not registered by 1icensing, it may

be estimated by questionnaire surveys. A minimum number of unowned or unsupervised dogs can be estimated by street counts. In order to do that representative districts of the areas under study have to be chosen. These can be a number of streets, or quadrants. In these sample districts all dogs must be counted during the time when the maximum number of individuals is active and visible (WHO, 1988).

2.1.2 Dog habitats

The functions and value attributed to dogs as a result of the culture and ecological setting of the people contributes to the condition in which dogs are kept, and the degree of supervision they receive within human community (WHO/WSPA, 1990; WHO, 2002). However, similar parameters and techniques for evaluating dog habitats are lacking. One obvious difficulty, at least in urban areas, is that one segment of the dog population may be ownerless and completely free-roaming, thus relying entirely on the availability of shelter, food and water found on the street; whereas these needs are wholly supplied to another segment of the population by their owners. Ranging between these two extremes is a third component of the population whose requirements are met in varying degrees by both street and owner.

Another problem complicating habitat analysis is that cultural practices may also vary widely, even within the same city, and this factor will greatly influence the quality and quantity of habitat, food and shelter (Matthews and Miller, 1988). Detailed maps of the area must be obtained or drawn; those prepared by urban planners are particularly useful. Based on aerial photographs (where available) and ground reconnaissance, major land use types are delineated, plotted on maps and area sizes encompassed by each are determined and their occurrence expressed as a percentage of the total available habitat.

The locations of other important elements of habitat such as large vacant buildings, water sources, dumps, open markets, and so on, are also shown. Uses of colour codes, symbols or keys are helpful when mapping various features of the habitat. The information shown on maps can then later be organized and arranged in tables and graphs, and statistically analysed manually or by computer. Such maps can be used as a basis for selecting sample roadways, plots, or quadrants within the entire urban area for intense studies of more specific features of the habitat (as well as for representative analysis of dog population parameters). As previously mentioned, the collection of data from large areas is frequently impractical because of limited funds or manpower (Daniels, 1983).

2.1.3 Dog movements

The analysis of the use of space by a mammal includes the investigation of actual individual movements to feeding places, shelter, breeding places, females in heat among others. Daily movements within a home range or territory must be distinguished from dispersal movements. In mammals, most ·dispersal activity occurs in a short period before or at sexual maturity. The dispersal movement leads away from the place of birth or from the parents to another place or group. This is much more complicated in dogs. Daily movements of dogs may be directly influenced or controlled by man through part or full time confinement to buildings, fenced yards, etc., and through transportation and conduct by leash and obedience. The dispersal of owned dogs is entirely directed by man or dependant on human migratory movements.

Owned, but also unowned dogs may follow human nomads. Knowledge of these movements is important for the understanding of the epidemiology of dog diseases and

of diseases transmitted from dogs to man and to livestock. These observations have their practical application when considering quarantine measures (WHO, 2002).

Owned dogs and urban stray dogs are often individually recognizable, mostly diurnal, and relatively tolerant of human proximity. The· movements and the use of space of such dogs can be tracked by direct observation (Beck, 1973; Fox *et al*., 1975). The use of spot 1ights and dog collars made of 1ight-reflecting materials, or collars carrying battery-operated "pin" lights or beta lights, can be used to facilitate night-time observation of dog activity and movement. Unowned dogs, especially feral dogs in rural areas, are often more secretive (Rubin and Beck, 1982). Other methods exist for studying dog movements. A number of distinctively coloured non-toxic dyes and reflective and fluorescent pigments for the marking of animals can be placed in edible dog baits (Day *et al*., 1980). Baits can also be loaded with coloured plastic markers or metallic paint particles, which do not disintegrate and are resorbed during the intestinal passage (Wandeler *et al*., 1975). Baits containing these markers could be placed at, central feeding sites (for example dumps, open food markets) or within small quadrants, and dog faeces subsequently recovered from outlying areas. The occurrence, location and frequency of marked faeces within given time periods would indicate movement and distribution. If, individual baits contain distinct markers, a more complex, bait lay-out pattern may be chosen (Larson *et al*., 1981)

2.1.4 Feeding habits

Studies on feeding habits of dogs overlap with habitat studies. Spatial and temporal distribution, predictability and availability of food are properties of the habitat. However investigations on dog feeding focus also on nutritional requirements, on food

quality, on feeding strategies, on resource partitioning with other species, on food chains and on energy flow. Food quality, distribution and availability are heavily dependent on cultural practices and on human attitudes towards dogs. Dog feeding habits have public health implications (such as hygiene, spread of parasitic diseases). They can be of ecological importance through garbage removal in one habitat, and through predation on wildlife in another situation. Nutritional requirement of dogs and nutrient content of foods need to be investigated by the methods of animal physiology. Questionnaire surveys should reveal information on whether owned dogs are fed regularly or not, on the proportion of food dogs have to find on their own, on the feeding of other people's dogs and on the feeding of unowned dogs (Beck, 1973).

2.1.5 Activity patterns

The behaviour of dogs varies on a daily cycle. The daily pattern of different activities (behaviour) of a dog is influenced by internal and external factors. Internal factors causing variation are age, sex, phase of breeding cycle, health, etc. External factors are season of the year, weather conditions, other dogs, temporal pattern of food availability, constraints imposed by owners, etc. Activity studies usually rely on the recording of a limited number of rather imprecisely defined activities (behaviour). Some knowledge of the activity pattern of dogs in a given area is essential for investigations of dog abundance, for more detailed behavioural studies, and for planning and executing control and vaccination campaigns (Fox *et al.*, 1975).

2.1.6 Social organization of dog populations

The distribution of group sizes in a population, that is whether individuals live alone or in groups, the sizes of those groups, as well as the form of leadership and the genetic

relatedness of individuals in the groups, describes the social organization for that population (Beck, 1973). The canine social structure is a powerful system in which members clearly understand their social role. Well defined boundaries and non-aggressive signalling among pack-mates preserve the social group without injury. Puppies learn these behaviours through behavioural feedback system used in the litter with their dam to learn appropriate behaviour such as bite strength (Overall, 2001). The puppy that bites its dam or its litter-mate too hard receives immediate feedback swift disciplinary correction from the dam or a high-pitched scream of pain followed by the playmate's withdrawal (Donaldson, 1997).

The social behaviour of dogs in the context of physical contact with other individuals, or groups of dogs within the population, as well as their contacts with humans, has important implications in connection with the transmission of rabies and other density-dependent diseases. Such behaviour also becomes important when dogs are in contact with other pet species in urban environments, with livestock on the fringes of urban areas, and with wild carnivores, especially wild canids and feral dogs, along the urban-rural interface or in wholly rural habitats (Lantis, 1980).

2.1.7 Dog functions in human societies

Human-dog bond is a deep connection between two species that exists like no other in the animal world. Human-dog relationship has existed for several centuries with several advantages and some known disadvantages (Cutt *et al*., 2007). In the industrialized countries, dogs have been put to remarkably high adaptation to human needs in health promotion, adjustment of the elderly, recovery from illnesses, guiding the blind, assisting the deaf, assisting persons that are impaired in their mobility, as well as to alert

epileptic patients that a seizure is imminent. In that instance, the owner can sit down or take some medications before a seizure strikes (Gillum and Obisesan, 2010). Dogs have been trained to turn on/off lights, pick up objects, and pull wheel chairs for those who are physically challenged. Police dogs have been trained to protect officers, as well as sniffing out drugs, explosives, and other dangerous chemicals beyond what the human can do. Dogs trained for search and rescue missions use their powerful sense of smell to locate people, lost or injured (Cutt *et al*., 2007). In Nigeria, however, studies that were conducted on use of dogs have shown that people keep dogs for various reasons, including companionship as pet, house guard, assistance for hunting of wildlife, and as food animal that is eaten by some people. Their perceived economic and social worth thus depends on the community values attached to their use, which varies from one place to another (Oboegbulem and Nwakonobi, 1989).

2.1.8 Dog diseases and public health

As in all other vertebrates, dogs harbour a great variety of macroparasites, microorganisms and viruses. Some of the more pathogenic ones may be important factors of mortality in dog populations. A good proportion of the infectious agents disseminated among and carried by dogs are also harmful for man. Rabies and hydatidosis are among the most important diseases transmitted from dogs to man. Dog bite accidents are also of considerable importance for man. The amount of dog faeces deposited on public or private property becomes a hygiene problem in many cities. On the other hand there are the beneficial effects of garbage and waste removal through dogs. The psychological importance of owning pet dogs has only been recognized quite recently (De Keuster and Butcher, 2008).

Free-roaming dogs are a worldwide problem, and a number of different programs have been implemented by competent authorities and nongovernmental organizations to manage them. Serious public health concerns arise from this issue: Dog bites and attacks cause significant numbers of hospitalisations each year all over the world (Morgan and Palmer, 2007; Georges and Adesiyun, 2008), while rabies and other zoonoses (such as leishmaniasis) find important reservoirs in uncontrolled stray dog populations (OIE, 2007). In addition, at least 65 other zoonoses including ancylostomiasis, echinococcosis, leptospirosis and salmonellosis, may be transmitted to man by direct contact or contact with secretions and excretions of pets (Faulkner, 1975).The occurrence of dog diseases and their demographic importance have to be studied using the methods of veterinary parasitology, microbiology, pathology and epidemiology (Cortes *et al.*, 2007).

2.2 Dog population structure

After an initial exponential growth in a dog population, the birth rate begins to decrease and the rate of death increases reaching equilibrium depending on the capacity of the environment to keep this balance (carrying capacity of the environment). The carrying capacity of the environment varies with habitat and it depends on the availability, distribution, and quality of the resources (shelter, food, water). The density of a population of dogs is almost always near the carrying capacity of the environment (WHO, 1990). The structure and turnover of a dog population is determined by a great number of different factors. Its analysis depends on vital statistics such as sex and age ratios, natality and rearing success, and survival and mortality rates (Dixon, 1981).

2.2.1 Sex ratios

The local resource enhancement (LRE) model predicts that in cooperatively breeding species, sex ratios will be biased in favour of the more helpful sex (McNutt and Silk, 2008). When parents gain more benefits from helpers of one sex than the other, they are expected to adjust their sex ratios in favour of the more helpful sex. The magnitude of sex ratio biases will depend on the relative benefits derived from male and female helpers and the opportunities available to dispersing offspring of each sex (Emlen *et al*., 1986). Human residents more frequently choose male dogs as guardians of the owner's property, though taking no steps to prevent dogs from ranging away from the home site. Furthermore, selection of a male relieves the putative owner of the consequences of unwanted mating with neighbouring dogs. In Newark, it was found that there was a bias toward euthanasia of female dogs by dog catchers since their capture could effectively cause large groups of dogs that were interested in the female during oestrus to disband, these factors may act in concert to skew the adult sex ratio for males (Daniels, 1983). Variation in dog/sex ratios may significantly influence productivityin the population. Sex ratios are commonly expressed as the numberof males per 100 females (for example 150 males: 100 females, or l.5: l),or more conveniently as a per cent 150/250 = 60% males). It shouldbe noted that the sex ratio in different samples of sub-adult andadult dogs may be different from the sex ratio at birth (WHO, 2002).

2.2.2 Age ratios and age determination

The number of animals in each age class is needed to calculate mortality and survival values. Methods of age determination for various domestic and wild species, including canids have been developed (Larson and Taber, 1980). Data on the age structure of the

owned segment of a dog population can be collected by questionnaire surveys of owners because they provide important information regarding the animal while unowned dogs can be by age estimation using tooth wear pattern of animals handled or killed e.g. young to adult ratios are an indication of natality and productivity of the populations and of the pattern of mortality (WHO, 1990).

2.2.3 Natality and rearing success

Measurement of natality and rearing success are indicative of population dynamic processes. They are also indicators of the maximum rate at which populations recover following control efforts or decimation. Data needed to determine natality and rearing success include the number of adult females breeding, the number of young born per adult female and the number of young that remain alive to adulthood. Such data can be collected through questionnaire surveys and post mortem studies for owned dogs and, field observations and post mortem study for unowned dogs (WHO/WSPA, 1990**).**

2.2.4 Mortality and survival

Dogs may be killed by disease, traffic, other dogs or predators, and by man for population control, disease control or the elimination of animals with undesired peculiarities, etc. Besides the information gathered from dog owners and veterinarians, the data collected by government administration on dog control can be used for mortality studies. It should be borne in mind that the number of dogs killed becomes meaningful only when this figure can be related to dog population size (WHO/WSPA, 1990). Four types of methods have been commonly used to calculate mortality and survival; catch-effort techniques, and life, survival and mortality tables (Nassar and Mosier, 1980).

2.3 Stray dog population

In this document, roaming dogs are defined as dogs that are on public areas and not currently under direct control. This term is often used inter-changeably with 'free roaming', 'free ranging' or 'stray' dogs. Note that this term encompasses both owned and unowned dogs; it does not distinguish whether or not the dog has an 'owner' or 'guardian'. Indeed, in many countries the majority of dogs that would be defined as roaming do have an owner but are allowed to roam on public property for part or all of the day (WSPA, 2005). Populations of dogs vary between different habitats, different cultures and different social strata of the human populations. In developing countries, a large number of free roaming dogs have owners and are classified according to the (WHO, 1990) based on the level of restriction or supervision as family dogs (fully dependent; semi-restricted) which can have access to the streets, and neighbourhood dogs (semi-dependent, semi-restricted or unrestricted). The presence and abundance of stray dogs depends on the attitudes towards dogs of the humans in these areas. Stray dogs have a great impact on human public health and the ecosystems. Due to the close contact with humans, dogs are responsible for the spread of several zoonotic diseases. Dog rabies is endemic in many developing counties and is responsible for most human deaths from the disease (WHO, 1992).

Strategies to control the overpopulation of free-roaming dogs include enforcement of law, education of owners and sterilization of pets (Courchamp *et al*., 1999).

2.4 Techniques applied to the study of dog population

The numbers of owned dogs may be established by questionnaire surveys, or from the records of licensing of dogs or during dog vaccination campaigns. Various methods are available for estimating the number of free-roaming dogs (Beran *et al*., 1972).

2.4.1 Questionnaire surveys

Questionnaire surveys can be used to establish the mean number of owned dogs per household and dog: human ratios. Since the total human population or number of households is generally known through national population censuses, an estimate of the owned dog population can then be extrapolated. These surveys can be conducted before, during or after campaigns (for example combined with post-vaccination surveys to estimate vaccination coverage). Households for interview should be selected randomly. Additional information can be obtained on: Dog characteristics (such as sex, age, population turnover and dog handling/keeping practices), household characteristics including determinants of dog ownership (socio-economic status, livestock ownership, religion and sex of the head of households) and knowledge of rabies in the household which can be useful for targeting public awareness campaigns. It should be understood that the additional information is not always necessary and priorities should be based on resources available to carry out the surveys (WSPA, 2012).

2.4.2 Total or direct counts

Indicator counts consist of counting dogs (e.g. males, females and pups) along selected representative routes. Counts can be repeated every year (at the same time of the year) to evaluate changes in population over time (i.e. if the number of dogs has increased or decreased). Direct counts are not practical over large geographical areas or in sizeable

cities but can be used in small communities and rural situations where dog populations are small (WSPA, 2012).

2.4.3 Estimates from rate of capture

Here estimates of dog populations can be obtained by graphically plotting either the sum of daily captures, the cumulative sum of captures, the probability of capture or the catch-effort required. Plots can be smoothed and /or extrapolated to provide estimates of dog population size (WHO, 1990).

2.4.4 Estimates from recaptures

Capture-mark-recapture methods consist of temporarily marking dogs, e.g. with a dye or distinctive collars and then subsequently recording the proportion of marked individuals in the population during a "visual recapture" effort. From the number of dogs marked and the observed ratio of marked to unmarked dogs the total number of street dogs is calculated. Marking can conveniently be done during vaccination campaigns. However, it is important to perform marking and recapture within a time period of a few days in order to minimize mark loss, dog movement and mortality effects. Also it is better to work in a defined area of only 0.5 to 2km^2. The observations can also be combined with estimates of the number of owned dogs obtained through household questionnaires to estimate the number of unmarked dogs (WSPA, 2012).

Estimated dog population =

$$\frac{\text{Number of dogs caught marked and released} \times \text{Number of dogs subsequently caught}}{\text{Number of marked dogs recaptured}}$$

2.5 Population estimates

Population estimates can be obtained by extrapolating counts made in a sample (e.g. randomly selected sub regions) to whole cities. These surveys can also be repeated to detect changes in the number of roaming dogs (WSPA, 2012).

2.6 The dog population situation in Nigeria

Estimates of the world-wide dog population can rise as high as 500 million or more. No other carnivore species occurs so widely and with such a high average population density, and few other carnivore species reach peak densities similar to those observed for dogs. Domestic dogs are present on every continent and practically every island settled by humans. Only in a small minority of cultures are dogs completely rejected. The dog: human ratio most commonly lies between 1:10 and 1:6, but considerable variation exists (Lehner *et al*., 1983). Dogs may even outnumber humans in some areas, as in the Athapaskan villages described by Savishinsky (1975).

Although dogs are the most widespread and abundant of all carnivores, the role of the dog in human cultures and its impact on the environment have rarely been studied. These subjects are reviewed in the context of canine rabies (Wandeler *et al*., 1993).The human population of Africa expanded enormously during the 20th century, and the dog population expanded in parallel (Brooks, 1990). In Africa, dogs are intimately dependent on humans for food and shelter (Brooks, 1990), and this association means that dog populations can be correlated, in size as well as distribution with human populations. Social change, such as urbanization, resulted in an increase in human and dog movement as well as interactions between domestic and stray dogs (Arai *et al*., 2001). The estimated dog population in Nigeria as at early 1990s was between 3-4

million (Oboegbulem, 1994). It is expected to be well above this figure now, and most dogs are kept without any history of vaccination (Dzikwi *et al*., 2011). The 2006 census estimated that there were between 2-5 million dogs in Nigeria (Meseko, 2010). Rabies is an important public health problem especially in the developing countries including Nigeria. This is because dog bites are common and regular routine vaccination of dogs are very low (Adeyemi and Zessin, 2000). Rates of disease transmission depend on the density of the dog population and social behavior that determines the extent of contact (Ratsitorahina *et al*., 2009). Studies of dog ecology and demography have been conducted in different parts of the world (Brooks, 1990;Wandeler *et al*., 1993; Kitala *et al*., 2001; Flores-Ibarra and Estalla-Valenzuela, 2004; Kongkaew *et al*., 2004; Alena *et al*., 2012).

Despite the fact that rabies is reported to be endemic in Nigeria, data on dog ecology including their population densities, population structure and characteristics in different state of Nigeria are scares. In Nigeria, there have been only a few studies that have tried to estimate the dog population size in urban or rural areas; a demography and dog ecology study was last conducted in Lagos state about 24 years ago by Oboegbulem and Nwakonobi (1989) which revealed a dog: human ration of 1:21 and 1:45 in Lagos Urban and rural respectively. Another study was also carried out in Northern and Southern Kaduna (before creation of Katsina state) which revealed a dog: human ratio of 1:3 and 1:27 respectively (Ezeokoli *et al*., 1984). In a similar study conducted in Lagos state, it was extrapolated that there were a total of 1,527,718 dogs with a dog: human ratio of 1:5.6. There was an average of 179 dogs per 1000 individuals (Hambolu *et al*., 2013). Dog population census in Ilorin was investigated in a study, using a combination of direct street counting of dogs, questionnaire survey and the

enhancement of enumeration procedure with aerial photograph and geographic information system to reduce errors in the study. A population of 1,258 dogs was obtained during the study period. In addition, dog population density of 1:13 (dog per household) was obtained (Aiyedun and Olugasa, 2012). Dog to human ratio of 1:139 obtained in the study for Ilorin was considered low, compared to some other Nigerian cities, including Jos which ranged from 1:24 to 1:13 and Kaduna 1:30 to 1:27 respectively (Okoh, 1988).A likely reason for this may be the predominance of Muslims in Ilorin city. Muslims do not keep dogs as they are considered unclean animals (Olorunfemi, 1985). In Aba, Abia state in a study conducted on dog ecology, a dog population of 747 dogs was reported, and the average number of dogs per household was 1.5, while the dog to human ratio was 1:7.8. The street count of dogs was 126 dogs (Otolorin *et al*., 2014). A study of dog ecology, dog bites and rabies vaccination rates was carried out in Bauchi the capital city of Bauchi State, Nigeria using direct street counts and questionnaire survey administered on 10% of the city streets selected by stratified random sampling. The estimated dog population of street counts and compound counts were 5310 and 7670, respectively. The overall human to dog ratio of 4.1:1 was established (Atuman*et al*., 2014).

2.6.1 The use of geographic information system for dog enumeration

Geographic Information System (GIS) has been employed as a viable tool in various epidemiological studies (Dzikwi and Abbas, 2012). The ground survey method for dog population census is considered to be prone to error in enumeration. As a result, use of aerial photography has been suggested as capable of enhancing ground survey methods for more accurate results (Olorunfemi, 1985). Aerial photograph and its supporting Geographic Information Systems (GIS) technology are becoming more available and

affordable in developing countries, and playing increasing roles and importance in both domestic and wild animal census coverage precision and biological risk management (Ramirez *et al*., 2004). Identification of city extent and internal growths are two potential factors that may introduce some bias in census coverage for human and animals alike, especially in densely populated communities. This is one function that makes the use of aerial photography with high resolutions (such as Satellite image at 0.6m resolution) to be valuable in improving the planning and coverage precision, when combined with the traditional ground survey method of dog population census (Aiyedun, 2011).

Dog population census in Ilorin was investigated with the aid of geographic information system to reduce errors in the study (Aiyedun and Olugasa, 2012). Similarly reported cases of rabies was investigated using geographic information system in Kaduna state, to identify the spatial and temporal distribution of the disease, so that the occurrence of the disease can be mapped to guide distribution of rabies vaccines for animals as well as stockpiling of human vaccines in cases of exposures to the disease (Dzikwi and Abbas, 2012). A study in Thailand has shown that control of rabies is achievable following utilization of GIS in studying the epidemiology of the disease (Raunkaew, 2005). Similarly, GIS has been used to study and predict occurrence and distribution of schistosomosis in Local Government Areas of Ogun state, Nigeria. GIS delineates areas for intervention and assesses populations at risk so that resources can be optimized for the control of the disease (Ekpo *et al*., 2008). The locations of black-tailed prairie dog (*Cynomys ludovicianus*) colonies on a 550-km^2 study site in north-eastern Wyoming, United States, were estimated using 3 remote sensing methods: raw satellite imagery, enhanced satellite imagery (integration of imagery with thematic layers via a Geographic Information System), and aerial reconnaissance (observations taken from a

small plane). A supervised classification of the raw satellite imagery yielded an overall accuracy of 64.4%, relative to ground-truthed locations of prairie dog colonies (Assal and Lockwood, 2007). The use of GIS combined with spatial analysis techniques allows the mapping of Leptospirosis and the identification and assessment of health risk factors associated with the disease in the city of Curitiba, Brazil (Daniele*et al*., 2012).

CHAPTER THREE

MATERIALS AND METHODS

3.1 Study Area

The present study was carried out in Kaduna metropolis, which occupies an area of approximately 3,080 km² and has a population of 760,084 (2006 census) Kaduna lies on the intersect of latitude 10º31'N and a longitude 7º26'E(Fig. 4.1). It is the capital city of Kaduna State, located in North Western Nigeria on the Kaduna River, is a trade centre and a major transportation hub for the surrounding agricultural areas with its rail and road junction. It has a political significance as the former administrative headquarters of the North during the colonial era. Kaduna was founded by the British in 1913 and became the capital of Nigeria's former Northern Region in 1917.

Agriculture is the main stay of the economy of Kaduna State with about 80% of the people actively engaged in farming, another major occupation of the people is animal rearing. Kaduna is an industrial centre of Northern Nigeria, manufacturing products like textiles, machinery, steel, aluminium, petroleum products and bearings. Pottery is

highly prized from Kaduna, especially from the Nok culture, which precedes Abuja and Minna. The main highway through the city is called Ahmadu Bello Way. There is a Zonal Veterinary Clinic located in the city, and other government veterinary clinics located in the city, with some privately owned veterinary clinics. Kaduna metropolis consists of four Local Government Areas; Kaduna North, Kaduna south, parts of Igabi and Chikun Local Government Areas (Anonymous, 2013).

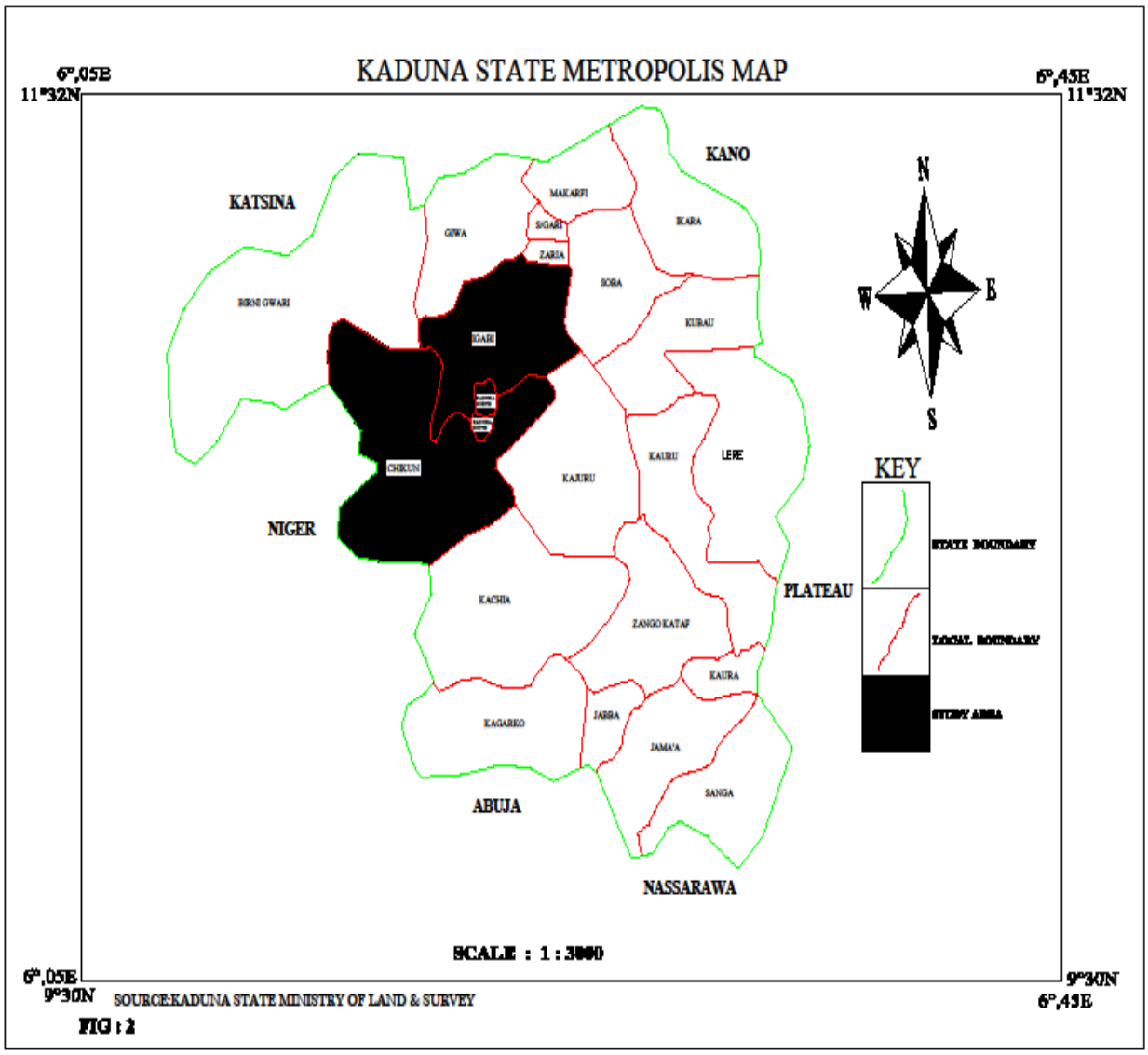


Figure 3.1 Map of Kaduna State showing the study area (Kaduna North, Kaduna South,Igabi and Chikun Local Government Areas).

3.2 Study Design

A descriptive epidemiology was used to evaluate dog bite cases and vaccination records while a cross sectional study was carried out to study dog population in Kaduna metropolis, Kaduna State.

3.3 Sampling Procedure and Data Collection

In each of the four residential areas selected for the study, 250 houses were chosen based on a stratified random sampling of the streets/roads in these areas. Households in each selected street were visited until 1,000 households were surveyed from the selected areas. For each house visited, the human and dog populations were taken, the sex and status of the dog(s) were recorded (A dog is considered to be a stray dog if evidence of restriction, shelter and feeding point is not sighted). Street observation was conducted to observe dog behaviour dynamics. Afterwards, a questionnaire (Appendix 1) was administered to the dog owner or household head to investigate attitudes and practices on issues related to responsible pet ownership. These include attitudes on dog ownership, potential health problems associated with dogs, reasons for owning or not owning dogs and utilization of veterinary health services.

3.3.1 House-to-House Questionnaire Survey

Questionnaire for gathering dog population data and for assessing human attitude towards dog was designed. The questionnaire survey was done on the same areas as the street count. An adult and literate member of the household was interviewed using questionnaire designed for dog population survey (WHO/WSPA, 1990). The questionnaire consisted of two parts: part one covers information about the household and bio data of dog, part two was concerned with management of dogs and cases of dog

bite. In some cases the questionnaire was read to the respondents and the answers they gave were filled in appropriately. The interviews were conducted in the local Hausa and English language, the time for the interviews varies from approximately 10-15minutes. Households with dogs were asked about the number of dogs owned, their ages and sexes. Questions on their reasons for keeping dogs, methods of feeding and dog movement restriction of their dogs were asked. All the households were asked about the presence of other dogs, (owned or free-roaming) at their homes and premises. Each household interviewed was asked about the number of people living on the premises, their waste disposal method, presence of an incinerator, and if they would like to own more dogs. A total of 1,000 questionnaires were administered.

3.3.2 Mapping of Enumeration Units Using Geographic Information System

Aerial photograph of Kaduna was obtained from Quickbird satellite image with 0.6m resolution and geo-referenced for use in AutoCAD Map 3D 2014 by layering on AutoCAD. This was used to guide and focus dog population census. Coordinate of any household with a dog was recorded using GPS; Garmin 76c5x Handheld GPS Receiver and the data obtained was inputted into GIS environment using AutoCAD Map 3D software on a digital map of Kaduna State.

3.3.3 Sample Size

For estimating dog population density in relation to household, WHO recommends sampling 500 to 5,000 households in a major survey (WHO, 1980). A total of 1,000 households were selected for this survey so as to get a higher level of accuracy, 250 each in Kaduna North, Kaduna South, Igabi and Chikun Local Government Area were surveyed. A simple random sample of the metropolitan area was made. A stratified

random sampling of the streets/roads in these area was carried out. Household in each selected street was visited until 1,000 households were surveyed from the selected areas. For each house visited, the human and dog populations weretaken, the sex and status of the dog(s) were recorded.

3.3.4 Street Counts

The estimated dog population of street counts estimated from photographic recapture technique (Beck's methods) was employed for the street count. Streets were sorted into neighbourhood groups each of which could be covered within few hours. It involved two street counts on two different days and the counts were averaged to reduce sampling error. On each day of the study, the counting of dogs was carried out early in the morning (between 6 and 9 a.m) and in the evening (5.30 to 7.00 p.m). Every dog within a given distance was photographed and recorded. The number of counted dogs in the selected streets in each area was estimated using the formula,:

$$N = \sum (Mn)/\sum m$$

Where:

M = the number of dogs photographed each time and considered "marked", i.e. "observed";

m = the number of dogs recognised as being previously photographed i.e. "re-observed";

$\sum m$ = the summation of m to that point in time.

n = the total number of dogs previously observed, i.e. each day's observations (M) less those previously observed (m) would be added to each day;

Mn = the product of each days M and n ;

$\sum$(Mn) = the summation of Mn to that point in time, and

N = the population estimate (WHO/WSPA, 1990).

Data generated were analysed using the Statistical Packages for Social Sciences (SPSS) Version 20.0. Data obtained were presented using tables and charts. Chi square test was used where appropriate to test for association of variables (age, sex, breed, vaccination status, source of dog, source of food, number of dogs in the premises, housing and control of dog movement, history of dog bites) obtained from the questionnaires. Values of $P < 0.05$ weresignificant statistically.

3.4 Information on Vaccination of Dogs and Cases of Dog Bites in Humans

Information on rabies vaccination status was obtained from the Ministry of Agriculture Zonal Veterinary Clinic Magajin Gari, Kaduna, Kaduna State. The existing vaccination records were evaluated for a period of seven years (2004-2010). Records of age (3 - 12months, > 12-24 months and >24 months), sex (male and female), breed (exotic, local, cross) and the number of dogs vaccinated assessed and recorded.

The existing records of reported cases of dog bite in humans was obtained from the Ministry of Agriculture Zonal Veterinary Clinic Magajin Gari, Kaduna, Kaduna State for a period of ten years (2004-2014). The age and sex of dog bite victims, monthly variation of dog bite cases to determine the seasonal index, the site of bite and breed of dogs involved in the bite were assessed and recorded. Data generated were analysed using the Statistical Packages for Social Sciences (SPSS) Version 20.0. Data obtained were presented using tables and charts.

CHAPTER FOUR

RESULTS

4.1. Dog Population Study

4.1.1. Household information on dog population obtained from 1,000 households in Kaduna metropolis, Kaduna State.

In the 1,000 households surveyed, 89.5% (895) households had fences/walls that completely restrained their dogs' movement, 8.2% (82) household had fences that did not restrain dogs movement while 2.3% (23) of the household had no fence (Table 4.1). Most of the households 54.6% (177) let their dogs roam freely, 25.9% (84) had specially constructed house/cage as housing for their dogs, while 19.4% (63) indicated their dogs are kept anywhere on the premises. Also, 11.2% (112) of the respondents indicated the presence of stray dogs in their neighbourhood. Only 1 (0.1%) household had family members that had been bitten by strays dog in the preceding 12 months; 4 (0.4%) had family members that were bitten by their own dogs; 2(0.2%) were bitten by neighbours dogs, while 993 (99.3%) reported no bite. About 65.7% (657) households reported that no stray dogs ate at their homes while 34.3% (343) of the households indicated the presence of stray dogs eating at their homes.

Table 4.1: Household information on dog population obtained from 1,000 households in Kaduna metropolis, Kaduna State (from May to July 2014).

Variable	Frequency	Percentage (%)
Enclosure of home		
No fence	23	2.3
Fence/wall, but does not restrain dogs	82	8.2
Fence/wall, completely restrain dogs	895	89.5
Housing of dogs		
Specially constructed house/kennel	84	25.9
On house passage way/corridor	177	54.6
Anywhere on the premises	63	19.4
Control of dog(s) movement		
Never allowed to leave premises	24	7.2
Allow to roam freely	300	92.8
Do you observe stray dogs on your street?		
Yes	112	11.2
No	888	88.8
Has any member of the household been bitten by household/neighbour dog(s) in the last 12 months?		
Yes	7	0.7
No	993	99.3
Has any member of the household been bitten by stray dog in the last 12 months?		
Yes	1	0.1
No	999	99.9
Do dogs other than yours eat at your home?		
Yes	343	34.3
No	657	65.7
TOTAL	1,000	100

4.1.2. Individual dog information obtained from 1,000 households in Kaduna metropolis, Kaduna State.

A total of 324 dogs were present in the 1,000 household surveyed. Majority of the dogs 235 (72.5%) were native, 49 (15.1%) were cross breeds and 40 (12.3%) were exotic breeds. A total of 199 (61.4%) were males while 125 (38.6) were females. About 67 (20.7%) of the dogs were within 0 to 6 month of age, 23 (7.1%) between 6 to 12 months of age and 234 (72.2%) greater than 12 months of age. About 39 (12.0%) of the dogs were purchased by members of the household from dog breeders/neighbours, 241 (74.4) of the dogs were purchased from outside the neighbourhood, 1 (0.3%) were gifts from families and friends while 43 (13.3%) were offspring of the bitches present in the household (Table 4.2).

The respondents reported that 306 (94.4%) of the dogs were used for security purposes, 16 (4.9%) for breeding, 1 (0.3%) as source of income and 1(0.3%) as source of meat (Fig. 4.1). A total of 324 (100%) of the dogs were fed by household members. A total of 115 (35.5%) of the dogs encountered during the survey had up to date anti-rabies vaccination record, while 178 (54.9%) were unvaccinated, 31 (9.6%) of the dogs were unvaccinated because they were below the age of anti-rabies vaccination (Table 4.3).

Table 4.2: Information obtained from 190 dog owning households in Kaduna metropolis, Kaduna State (from May to July 2014).

Variable	Frequency	percentage (%)
Breed of dogs		
Exotic	40	12.3
Native	235	72.5
Cross	49	15.1
Sex of dogs		
Male	199	61.4
Female	125	38.6
Age of dogs		
0– 6 Month	67	20.7
6- 12 Month	23	7.1
> 12 Month	234	72.2
Source of dogs		
Offspring of own bitch	43	13.3
Bought	280	86.4
Receive as gift	1	0.3
Feeding of dogs		
Household members	324	100
Neighbours	00	00
Find its own food	00	00
Neighbours/household	00	00
Rabies vaccination status		
Yes	115	35.5
No	178	54.9
Not due	31	9.6
TOTAL	324	100

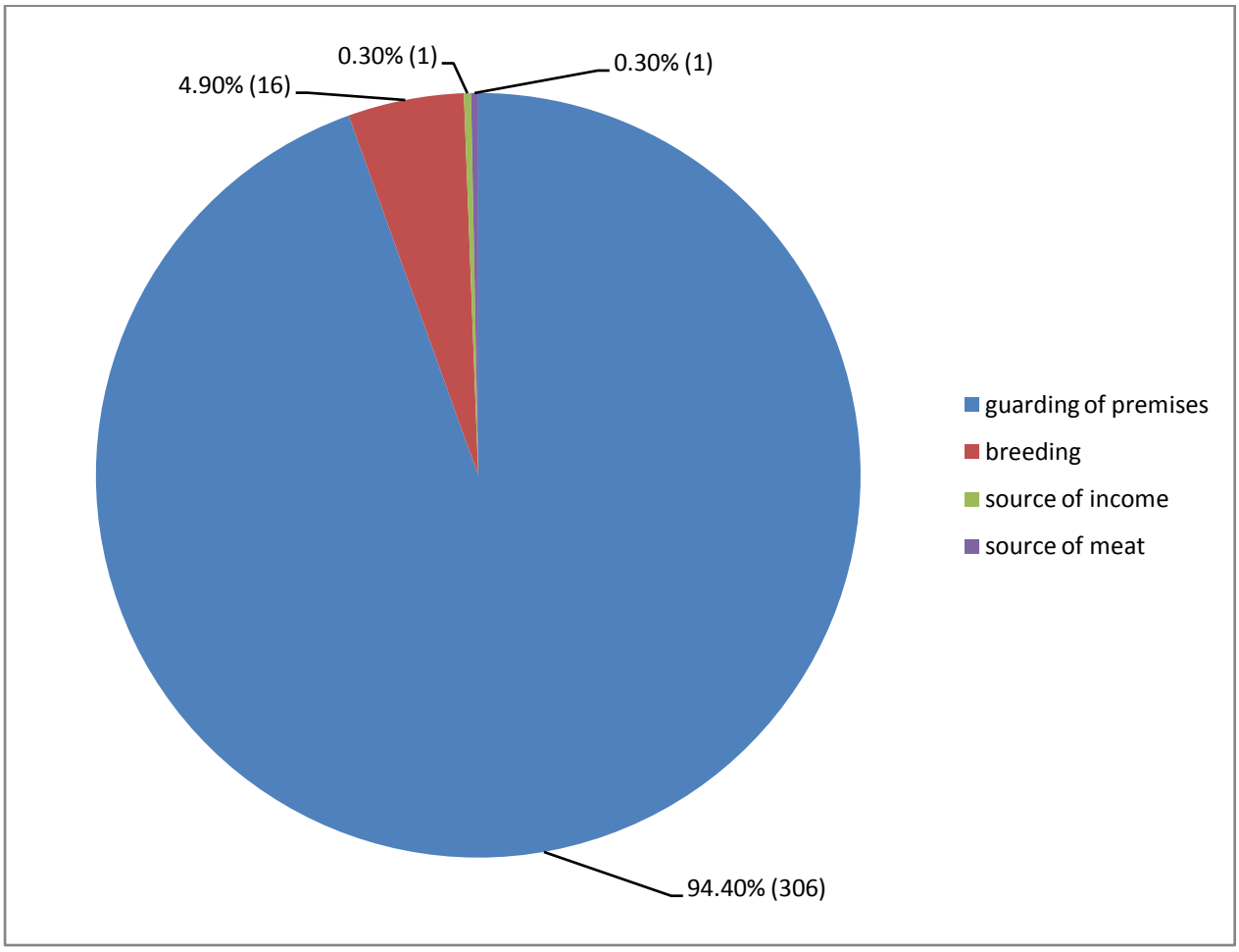


Figure 4.1: Reasons for keeping dogs in the households surveyed in Kaduna metropolis, Kaduna State.

Table 4.3: Distribution of dog vaccination status by breed, sex, age, source of dogs, reason for ownership and who feeds the dogs in Kaduna metropolis, Kaduna State.

Variable (%)	Vaccinated (%)	Unvaccinated (%)	Not due
Breed of Dogs			
Exotic	38(95)	1(2.5)	1(2.5)
Native	47(20)	164(69.8)	24 (10.2)
Cross	30(61.2)	13(26.5)	6(12.2)
Sex of dogs			
Male	71(35.7)	116(58.3)	12(6.0)
Female	44(35.2)	62(49.6)	19(15.2)
Age of dogs			
0– 6 Months	23 (34.3)	13(19.4)	31(46.3)
6- 12 Months	4(17.4)	19(82.6)	0(00)
> 12 Months	88(37.6)	146(62.5)	0(00)
Source of dog			
Offspring of own bitch	15(34.9)	4(9.3)	24(55.8)
Bought	100(35.7)	173(61.8)	7(2.5)
Receive as gift	0(00)	1(100)	0(00)
Reason for dog ownership			
Guard dogs	99(32.4)	176(57.5)	31(10.1)
Sale/breeding	16(100)	0(00)	0(00)
Source of income	0(00)	1(100)	0(00)
Source of meat	0(00)	1(100)	0(00)
Feeding of dogs			
Household members	115(35.5)	178(54.9)	31(9.6)
Neighbours	0(0)	0(0)	0(00)
Find its own food	0(0)	0(00)	0(00)
Neighbours/household	0(00)	0(00)	0(00)
TOTAL	115	178	31

4.2. Structure of dogs and human population in the compound count in Kaduna metropolis, Kaduna state.

Table 4.4 shows the structure of dogs and human population in the compound count in Kaduna metropolis, Kaduna State. Among the 1,000 households surveyed there were 8,578 number of occupants and 324 dogs, the average number of dogs per house was 0.3, while the dog to human ratio was 1:28.9. The street count of dogs was 78 dogs. From the 2006 population census figure of Kaduna metropolis which is estimated as 760,084 people the estimated dog population in Kaduna metropolis is about 28,709.

Table 4.4: Structure of dogs and human population in compound count carried out in Kaduna metropolis, Kaduna State.

Variables	Values
Number of compounds surveyed	1,000
Total number of people in the streets surveyed	8578
Total number of Dogs	324
Dog human ratio	1: 28.9
Average Number of dog per house	0.3
Total dog population size estimated from street count	78
2006 population census of Kaduna metropolis, Kaduna State	760,084
Estimated dog population inKaduna metropolis, Kaduna State	28,709

4.3. Association between rabies vaccination status of dogs and individual dog information in Kaduna metropolis, Kaduna State.

Chi-square analysis was used to determine association between dog vaccination status and individual dog information as shown in Table 4.5. There were associations between breed of dogs (chi^2 =18.7 , df = 2, P< 0.05), age of dogs (chi^2 = 43.3, df = 2, P<0.05), confinement of dogs (chi^2 = 39.7, df =3, P < 0.05), source of dogs (chi^2 = 28.4, df =2, P < 0.05) and rabies vaccination status of dog. There was no statistical association between sex of dogs (chi^2 = 2.1, df =1, P> 0.05),reason for dog ownership (chi^2 = 3.3, df =3, P> 0.05) house number (chi^2 = 290.8, df = 3, P>0.05) and rabies vaccination status of dogs.

Table 4.5: Association between breed, sex and dog vaccination status of dogs up to the age of vaccination obtained from Kaduna metropolis, Kaduna State.

Variable	vaccinated (%)	unvaccinated (%)	chi^2	df	p-value
Breed of Dogs					
Exotic	38(95)	1(2.5)	18.7	2	0.001
Native	47(20)	164(69.8)			
Cross	30(61.2)	13(26.5)			
Sex of dogs					
Male	71(35.7)	116(58.3)	2.7	10.337	
Female	44(35.2)	62(49.6)			
Age of dogs					
0– 6 Months	23 (34.3)	13(19.4)	43.4	2	0.000
6- 12 Months	4(17.4)	19(82.6)			
> 12 Months	88(37.6)	146(62.5)			
Source of dog					
Offspring of own bitch	15(34.9)	4(9.3)	28.4	2	0.000
Bought	100(35.7)	173(61.8)			
Receive as gift	0(00)	1(100)			
Reason for dog ownership					
Guard dogs	99(32.4)	176(57.5)	3.3	3	0.774
Sale/breeding	16(100)	0(00)			
Source of income	0(00)	1(100)			
Source of meat	0(00)	1(100)			

TOTAL	115	178

4.4. Multivariate logistic regression analysis of vaccination status with individual dog information in Kaduna metropolis, Kaduna state.

Table 4.6 shows multivariate logistic regression analysis of vaccination status with individual dog information in Kaduna metropolis, Kaduna State. Exotic breed (partial OR = 2.75; CI= 0.06- 0.66) and native breed of dogs (partial OR= 1.59; CI= 0.08 – 0.49) had higher odds of being vaccinated as compared to cross breed of dogs. Similarly, dogs used as guard dogs (Crude OR = 0.25; CI = 0.04 – 1.58) had higher odds of being vaccinated than dogs kept for other purposes. Dogs within the age range 6 – 12 months (partial OR = 1.68; CI= 0.29 – 1.19)and dogs with age greater than twelve months (partial OR= 1.05; CI= 0.07- 1.72 had higher odds of being vaccinated than dogs within 3-6 months of age. There was no statistically significant association between, confinement of dogs and vaccination status.

Table 4.6: Multivariable logistic regression analysis of vaccination status with sex, age breed, source of dog and reason for dog ownership in Kaduna metropolis, Kaduna State.

Vaccination status							
Variable	**Yes**	**No**	χ^2	**P-value**	**Crude 0R (95% CI on OR)**	**Partial OR (95% CI on OR)**	**Partial OR (95% CI on OR)**
Vaccinated dogs	**unvaccinated dogs.**						
Breed of Dogs							
Exotic	38	1	18.7	0.001	9.02(1.90-42.73)	0.07(0.09-0.97)	2.75(0.06-0.66)
Native	47	164			0.16(0.08-0.31)	0.36(0.27-7.44)	1.59(0.08-0.49)
Cross	30	13			1	1	1
Sex of dogs							
Male	71	116	2.7	0.337	1.05(0.07-1.72)		
Female	44	62			1		
Age of dogs							
0– 6 Months	23	13	43.4	0.000	1	1	1
6- 12 Months	4	19			0.64(0.17-2.34)	0.07(0.92-1.94)	1.68(0.29-1.19)
> 12 Months	88	146			1.14(0.57-2.28)	14.13(0.54-1.43)	1.05(0.07-1.72)
Source of dog							
Own bitch	15	4	28.4	0.000	15.69(0.54-7.44)	11.77(0.16-1.71)	1.14(0.06-1.59)
Bought	100	173			0.25(0.84-1.81)	12.40(2.33-7.25)	13.03(0.27-1.67)
Receive as gift	0	1			1	1	1
Reason for dog ownership							
Guard dogs	99	176	3.3	0.774	0.25(0.04-1.58)		
Sale/breeding	16	0					
Source of income	0	1					
Source of meat	0	1					
TOTAL	115	178					

4.5 Information on Vaccination of Dogs

Figure 4.5 shows information on vaccination of dogs. Data obtained from the clinic records of the Ministry of Agriculture Zonal Veterinary Clinic Kaduna, Kaduna state between January 2004 to December 2010 showed that out of a total of 2,279 dogs presented at the clinic during the period, 1,109/2,279(48.7%) dogs received anti-rabies vaccination. The year 2006 had the highest number of dogs vaccinated, 212/1,109(19.1%) (Figure 4.2). About 63.4% of the dogs vaccinated were males while 36.6% were females. Exotic breed had the highest vaccination rate (56.34%) while 50.98% and 39.39% of the vaccinated dogs were native and cross breeds respectively. Most of the dogs vaccinated (54.1%) were within the ages of 3-12 months followed by dogs in the age 12-24 months (29.0%) and dogs > 24 months(16.9%) (Table 4.7). The greatest values of vaccination of dogs against rabies occurred during the month of December. The lowest indices were observed in January.

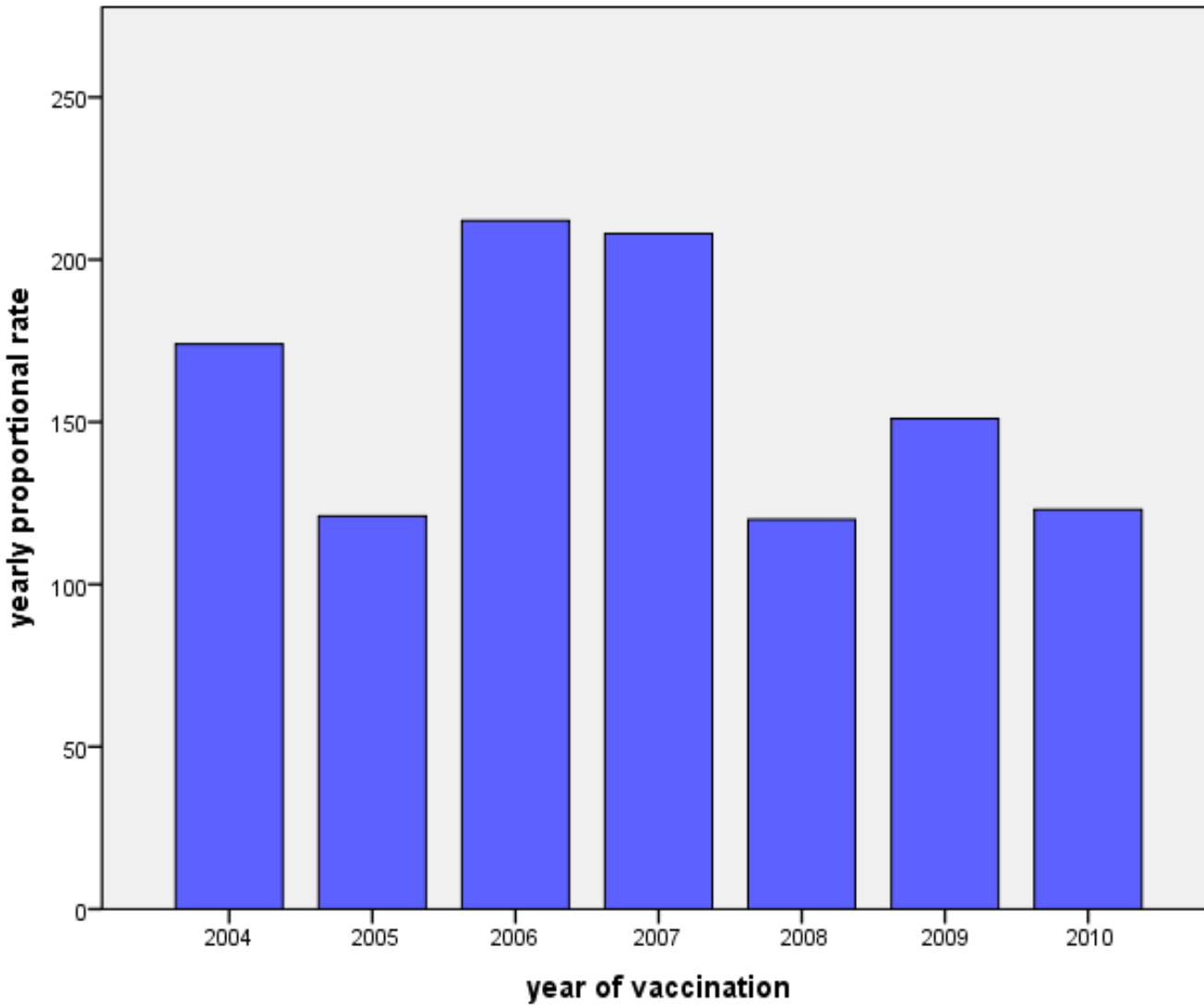


Figure 4.2: Annual distribution of total number of dogs vaccinated against rabies from the Zonal Veterinary Clinic Magajin Gari, Kaduna, Kaduna State, from January 2004 to December 2010.

Table 4.7: Age, sex, breed and year specific rates of dog vaccination at the Zonal Veterinary Clinic Magajin Gari, Kaduna, Kaduna State, from January 2004 to December 2010.

Years under study								
Variable	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Total**
Age (months)								
(%)								
	n = 174	n=121	n =212	n= 208	n = 120	n = 151	n=123	
3-12	95(54.6)	74(61.2)	104(49.1)	116(55.8)	73(60.8)	71(47.0)	67(54.5)	600(54.1)
>12 -24	51(29.3)	27(22.3)	68(32.1)	63(30.3)	27(22.5)	46(30.5)	40(32.5)	322(29.0)
> 24	28 (16.1)	20(16.5)	40(18.9)	29(13.9)	20(16.7)	34(22.5)	16(13.0)	187(16.9)
Sex (%).								
Males	109(62.6)	77(63.6)	137(64.6)	129(62.0)	77(64.2)	96(63.6)	78(63.4)	703(63.4)
Females	65(37.4)	44(36.4)	75(35.4)	79(38.0)	43(35.8)	55(36.4)	45(36.6)	406(36.6)
Breed (%).								
Exotic	42(58.33)	5(62.5)	21(52.5)	49(56.98)	4(57.4)	13(56.52)	17(53.13)	151(56.34)
Native	106(49.1)	91(90.1)	144(50.7)	121(53.78)	92(36.51)	105(45.1)	71(54.19)	730(50.98)
Cross	26(34.21)	25(34.25)	47(43.93)	38(43.18)	24(33.80)	33(39.29)	35(43.75)	228(39.39)
Year (%)								
	n = 1109							
Year rates	174(15.7)	121(10.9)	212(19.1)	208(18.8)	120(10.8)	151(13.6)	123(11.1)	

4.6 Information on Cases of Dog Bites in Humans

Out of 86 reported cases of rabies related dog bite from 2004 – 2014, 34(39.5%) were victims less than 15 years of age, 29(33.7%) were victims between 15-30 years and 23 (26.7%) greater than 30 years of age as shown in Table 4.8. Dog bite victims were more of males 52/86 (60.5%) than females 34/86(39.5%) as shown in Table 4.9. Seasonal changes of dog bite expressed as seasonal index showed the greatest values during the months of August and September. The lowest indices were observed in November as shown in Figure 4.3. The Native breed of dogs (60/86, 69.8%) were the most involved in the dog bites, followed by cross breeds 20/86(23.3%), with exotic breeds 6/86(7.0%) being the least. Also 48/86(55.8%) of the dogs involved in the bites were vaccinated against rabies, 25/86 (29.1%) of the dogs involved were unvaccinated while 13/86 (15.1%) of the dogs had unknown anti-rabies vaccination status as shown in Table 4.10. Most of the dog bites occurred on the leg 50/86(58.1%), followed by the hand 13/86(15.1%), buttock 9/86(10.5%),thigh 6/86(7.0%),face 5/86(5.8%),on the chest 2/86(2.3%) and abdomen 1/86(1.2%) as shown in Figure 4.4. Most of the dog bites on the leg, hand, buttock, thigh, face, chest and abdomen occurred in individual from 15 years and above.

Table 4.8: Distribution of dog bites in humans by age obtained from the Zonal Veterinary Clinic Magajin Gari, Kaduna, Kaduna State from 2004 – 2014.

Year	Age (in years)		
S/N	< 15(%)	15 – 30(%)	> 30(%)
2004	7(46.7)	4(26.7)	4(26.7)
2005	1(33.3)	1(33.3)	1(33.3)
2006	5(41.7)	3(25)	4(33.3)
2007	8(36.4)	8(36.4)	6(27.5)
2008	5(31.3)	7(43.75)	4(25)
2009	4(66.7)	0(00)	2(33.3)
2010	2(100)	0(00)	0(00)
2013	0(00)	2(100)	0(00)
2014	2(25)	4(50)	2(25)
TOTAL	34(39.5)	29(33.7)	23(26.7)

Table 4.9: Distribution of dog bites in humans by sex obtained at the Zonal Veterinary Clinic Magajin Gari, Kaduna, Kaduna State, from 2004 – 2014.

YEAR	SEX	
S/N	Male (%)	Female (%)
2004	9(60)	6(40)
2005	2(66.7)	1(33.3)
2006	8(66.7)	4(33.3)
2007	13(59.1)	9(40.9)
2008	8(50)	8(50)
2009	4(66.7)	2(33.3)
2010	2(100)	0(00)
2013	2(100)	0(00)
2014	4(50)	4(50)
TOTAL	52(60.5)	34(39.5)

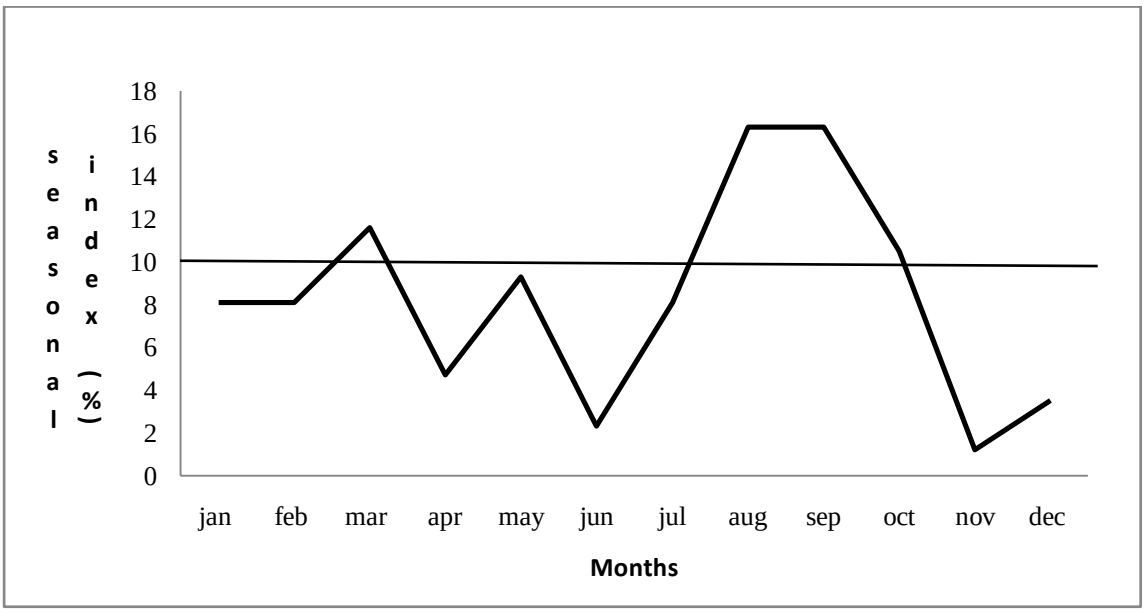


Figure 4.3: Seasonal index of monthly dog bite cases covering the period from 2004 – 2014 obtained from Zonal Veterinary Clinic Magajin Gari, Kaduna, Kaduna State.

Table 4.10: Breeds and vaccination status of offending dogs involved in rabies related bite cases reported at the Zonal Veterinary Clinic Magajin Gari, Kaduna, Kaduna state, from 2004-2014.

	Breed of dogs			
Variable	Exotic	Native	Cross	Total
n = 86				
Breed (%)6(7.0)	0(69.8)	20(23.3)		
Vaccination status specific rates (%)				
	n = 6	n = 60	n = 20	
Unvaccinated	4(66.7)	17(28.3)	4(20)	25(29.1)
Vaccinated	2(33.3)	36(60)	10(50)	48(55.8)
Unknown	0(00)	7(11.7)	6(30)	13(15.1)

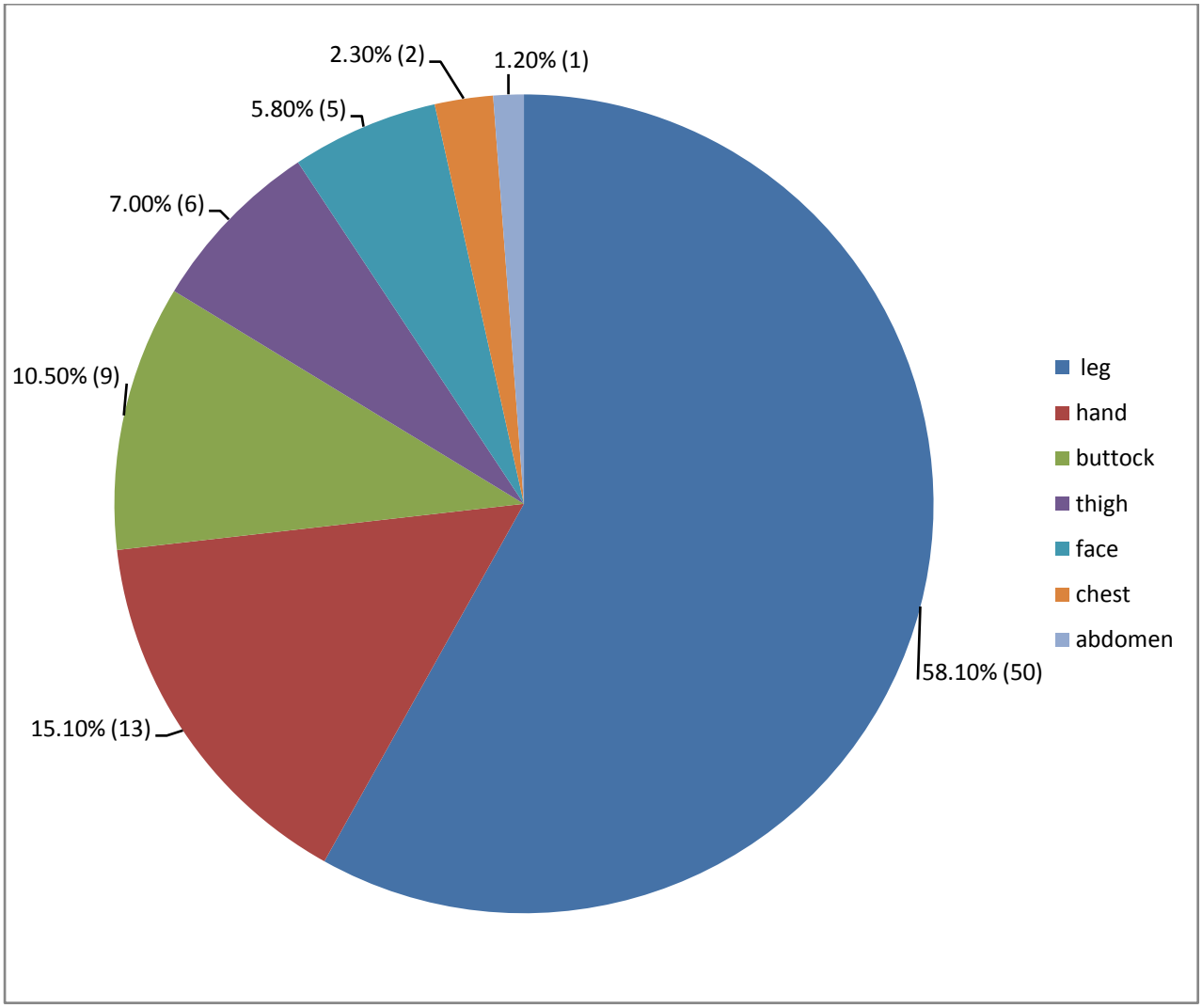


Figure 4.4: Distribution of dog bites by anatomical location on humans as obtained from the Zonal Veterinary Clinic Magajin Gari, Kaduna, Kaduna State, from 2004-2014.

Table 4.11: Reasons for not keeping dogs as given by respondents in houses without dogs in Kaduna metropolis, Kaduna State.

Reasons	**K/North**	**K/South**	**Igabi**	**Chikun**	**Total**
n=220	**n=189**	**n=249**	**n=134**		
(%)	**(%)**		**(%)**	**(%)**	
Compound house	0(00)	2(0.8)	0(00)	21(8.4)	23(2.3)
Do not like dogs	56(23.5)	102(40.8)	16(6.4)	64(25.6)	238(23.8)
Use to keep dogs	0(00)	5(2.0)	0(00)	6(2.4)	11(10.1)
Hate dogs	0(00)	4(1.6)	6(2.4)	5(2.0)	15(1.5)
Easily bites	0(00)	1(0.4)	25(10.0)	2(0.8)	28(2.8)
No particular reason	38(15.2)	11(4.4)	23(9.2)	4(1.6)	76(7.6)
Religious reasons	91(36.4)	42(16.8)	163(65.2)	0(00)	296(29.6)
Annoying	0(00)	0(00)	0(00)	1(0.4)	1(0.1)
Do not care about dogs	0(00)	2(0.8)	0(00)	12(4.8)	14(1.4)
Keep for consumption	6(2.9)	6(2.4)	0(00)	2(0.8)	14(1.4)
Expensiveto maintain	29(11.6)	14(5.6)	16(6.4)	17(6.8)	76(7.6)

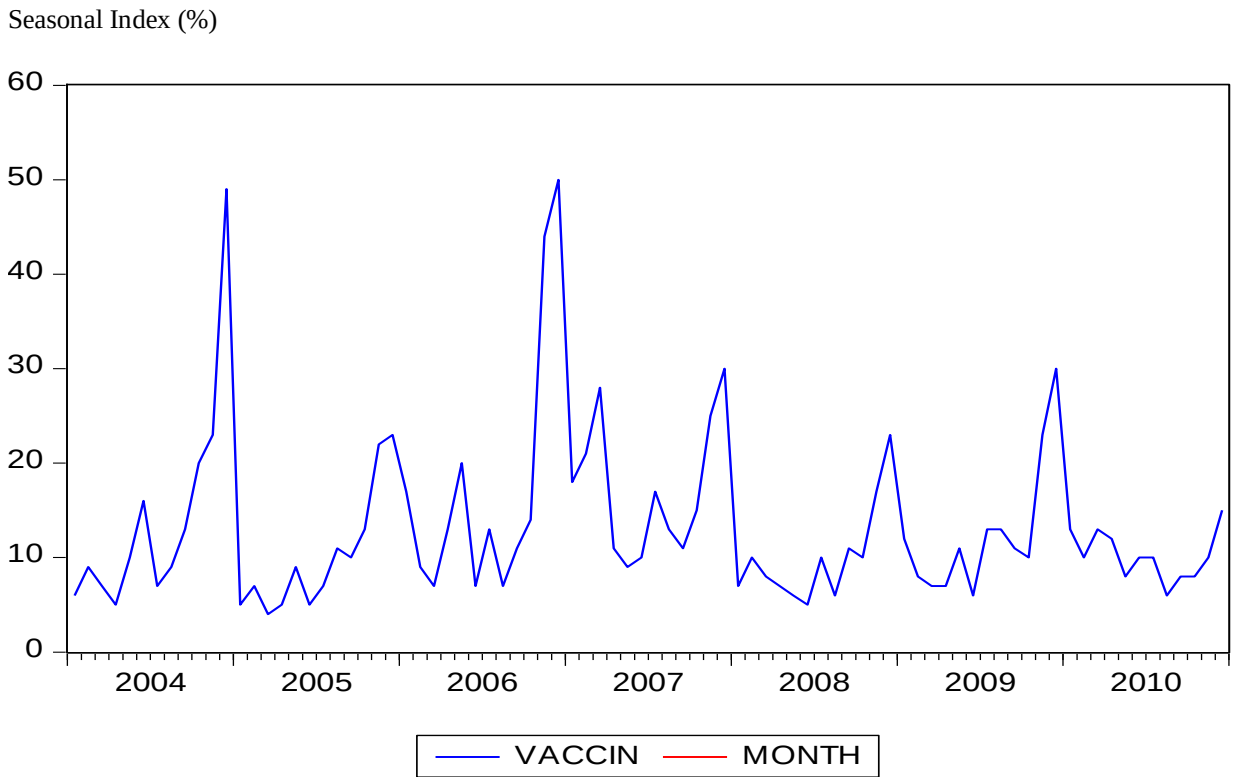


Figure 4.5: Seasonal index of monthly vaccination of dog covering the period from 2004 – 2010 obtained from Zonal Veterinary Clinic Magajin Gari, Kaduna, Kaduna State.

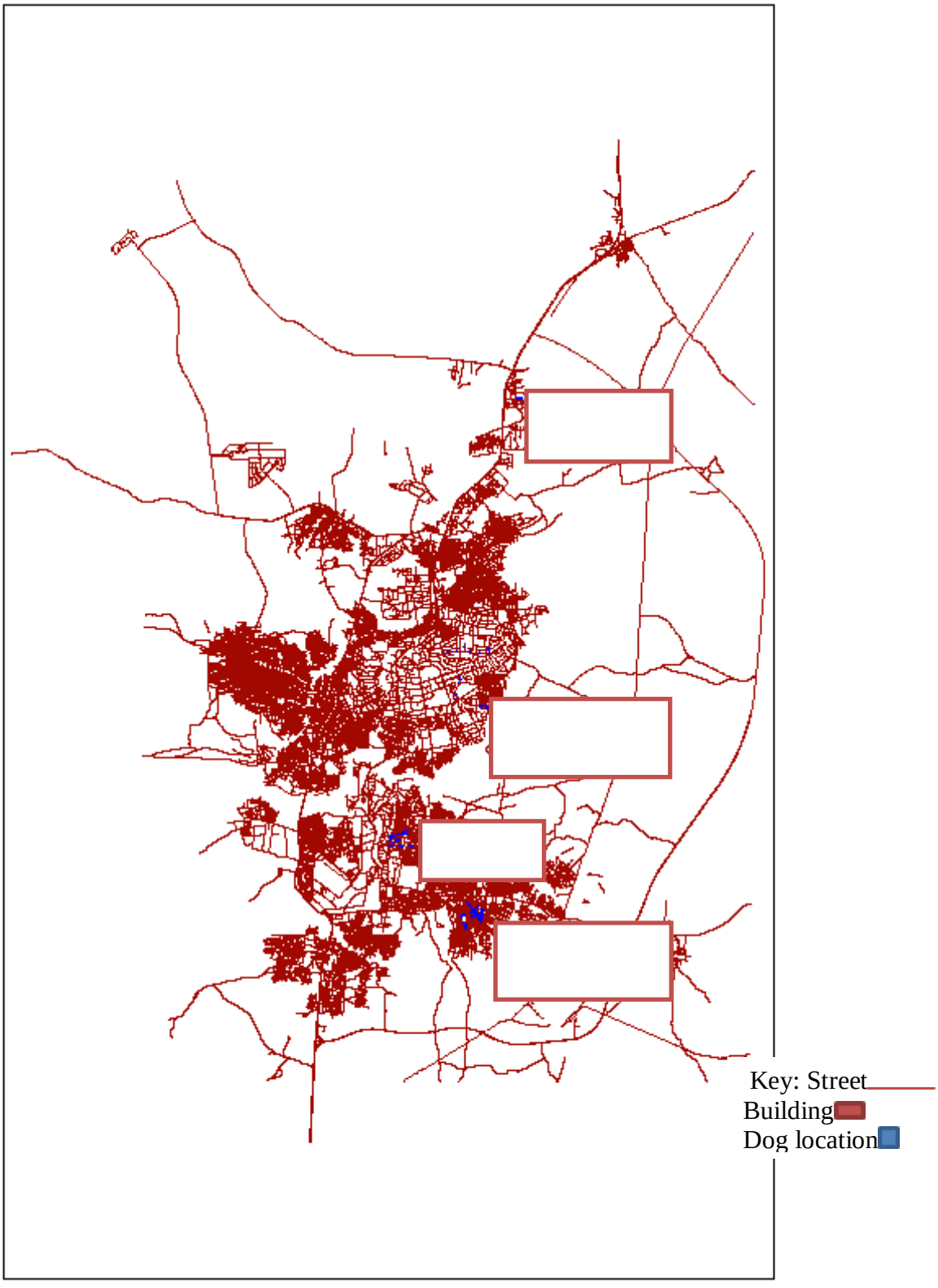


Figure 4.6: Dog enumeration household units on a Vector Map of Kaduna metropolis, Kaduna State, Nigeria.

Table 4.12: Demography and dog-human relationships in Kaduna metropolis, Kaduna State.

Locations	Houses examined	Houses with dog (%)	Dogs seen	Persons in houses counted	Dog: human ratio	Number of dogs (%)			
						Sex		Status	
						Female	Male	Stray	Restricted
Chikun	250	106(55.8)	226	2563	1:15	94(41.6)	132(58.4)	54(23.9)	172(76.1)
K/North	250	26(13.7)	70	1014	1:16	30(42.9)	40(57.1)	7(10)	63(90)
K/South	250	56(29.5)	96	2181	1:25	31(32.3)	65(67.7)	10(10.4)	86(89.6)
Igabi	250	2(1.1)	10	2820	1:940	2(20)	8(80)	7(70)	3(30)

CHAPTER FIVE

DISCUSSION

The dog to human ratio of 1:28.9 is low probably due to religious and cultural inhibitions to keeping of dogs. This is in contrast tothose reported in earlier studies in Nigerian cities of Jos and Kaduna where dogs to human ratio were 1:6 and 1:9 respectively (Okoh, 2007). These Nigerian figures are far higher than those reported in urban areas in Brazil that have 2.8 dogs to every 10 persons (Nunes *et al*., 1997). Most (89.5%) of the dog owning houses had fences that completely restrain dog movement as the study was conducted in an urban area where most houses are properly demarcated from each other by well-defined fences hence restricting movement of dogs from one household to the other. Majority (54.6%) of the households with dogs, house them on passage way/corridor and 92.8% of the households allow their dogs to roam freely in the house.The street observations indicated that free roaming dogs present a mild to moderate problem as dogs were simply ignored by humans. It was common to see dogs mating on street, scavenging for food on refuse dumps and sleeping under parked cars. Dogs owned by inhabitants of the town are mostly native breeds that are not highly priced, hence they are left without much veterinary care as evidenced by the number of dog owning houses that allow their dogs to roam freely especially in areas in Chikun L.G.A, where houses are built either without fence or wall, or fence or wall but does not restrain dogs. A variety of factors have been suggested to influence the number of dogs in these areas, these include socio economic status of owners, availability of mating partners, food and uncontrolled breeding.

Although, there was no significant difference in the distribution of sexes of dogs however 61.4% of dogs seen were males, probably due to the fact that most dog owners

prefer keeping males than females. The higher (94.4%) number of dogs kept as guard dogs in this study area may be due to the fact that Kaduna state which is both a political and economic importance in northern Nigeria has a highly dense human population due to the movement of people from neighbouring states into the state. An increase in human population is related to an increase in dog population due to the need for security, pets and hunting purposes. The area provides an ideal condition for the maintenance of a high and dense population of susceptible dogs that have the potential to act as reservoirs for the maintenance and transmission of canine rabies. Therefore, knowledge of the dog ecology and demography will fill an important logistical gap in rabies control and in understanding the real threat of such pathogens, in achieving effective disease control, and in managing dog population growth in Kaduna state in particular and Nigeria as a whole. The majority of respondents who did not own dog (29.6%) said it was due to religious reasons, a likely reason for this may be because most of the respondents that did not own dogs were Muslims. Muslims do not keep dogs as they are considered unclean animals.

The anti-rabies vaccination coverage of dogs in the houses surveyed was estimated at 35.5%. This still falls below the World Health Organization standard of vaccination of 70-80% dog vaccination in an area to boost herd immunity (WHO, 2004). This vaccination rate can be further improved if there are more veterinary clinics in the city and dog owners who are mainly occupied with their own personal businesses create time out of their busy schedules to give their dogs the required veterinary care. Local breed of dogs were the least vaccinated against rabies (20%) due to the low priority given to this breed by most owners as compared to exotic and cross breeds. Dogs greater than 12 months old had higher anti-rabies vaccination frequency because dog

owners see dogs at this age category as more likely to be aggressive and likely to be involved in dog bites. More male dogs were kept than female dogs as they are perceived as better guard dogs than the females and most owners consider female dogs to be problematic.

Data obtained from the clinic records of the Ministry of Agriculture Zonal Veterinary Clinic Magajin Gari, Kaduna, Kaduna State between January 2004 to December 2014 in relation to rabies related dog bites, indicated that majority of the individuals that were victims of dog bites were males 52 (60.5%).Similar results were also obtained by (Aghahowa and Ogbevoen, 2010; Mshelbwala *et al*., 2013). The reason for this may be that males make up the larger percentage of the work force in the state. Distribution of dog bite victims by age showed that 60.4% of adults aged greater than 20 years and 39.5% of children less than 20 years of age were bitten by dogs. This is comparable to results obtained by (Hambolu *et al*., 2013). This may be due to the fact that individuals of these categories are frequently in close contact with dogs and the commercial activity of the area under study encourages males and adults to be more active in moving from one area to another hence predisposing them to high rate of exposure to dog bites. The 86 cases analysed in the current study is lower than that of earlier report by (Bata *et al*., 2011) who reported 277 dog bite cases in Bukuru area of Plateau State and (Mshelbwala *et al*., 2013) that reported 110 cases of dog bites in Umuahia, Abia State. Native dogs were more involved in the dog bites reports probably due to the fact that most of the dog bite cases reported at the Zonal Veterinary clinic were from individuals living in surrounding close to the main town, where the proportion of native breed of dogs is high and where there is little or no restriction in dog movement. Also 55.8% of the dogs involved in the bites were vaccinated. This is also closely linked to the fact that

vaccination campaigns have been on-going in the state and there has also been an increase in veterinary private practices in the state.

Most of the dog bites (58.1%) occurred on the leg in agreement with (Ojuawo, 2000) who reported the lower limbs as the commonest site of dog bites in a study carried out in Ilorin, Kwara state. This may also be due to the fact that most dogs have easy access to the legs of victims during an attack and most individuals tend to defend themselves with their legs during an attack by an offending dog.

CHAPTER SIX

CONCLUSION AND RECOMMENDATION

6.1Conclusion

The study revealed low vaccination coverage in native breed of dogs, in males and in dogs greater than 12months of age, therefore vaccination against rabies should be instituted regardless of sex, breed and age of dogs so as to attain the 70% vaccination

coverage as prescribed by the World health organization.Cases of dog bite in humans occurred more frequently during the raining season, with native breed of dogs (69.8%) being the most involved in such bites and most of them were unvaccinated. This poses a public health risk as these unvaccinated dogs can serve as source of transmission of rabies to the dog bite victims.Also dog population survey was able to determine an average of 0.3 dogs per household with an estimated dog population of 28,709. The dog population density in the study area is low as compared to other urban cities in Nigeria, but with a relatively higher population in the southern part of the metropolis, this should be borne in mind when planning anti-rabies campaign in Kaduna metropolis. Although most of thehouses in the study area were well fenced, dogs are allowed free movementin the neighbourhood. There appears to be a link between general community neglect of the hygiene of the common environment, contemporary lawlessness that has become well known in Nigerian cities and rabies risk. The present situation makes it very difficult to effectively control human and dog exposures to rabies in Kaduna metropolis, Kaduna State.

6.2Recommendation

1. The law that prohibits free roaming of dogs on the street still needs to be actively propagated through campaigns on the media and in professional enforcement by animal health authorities.

2. A more effective and efficient garbage disposal system, coupled with increased precision in vaccination coverage of free-roaming dogs during government instituted campaign will positively impact on rabies control in Kaduna metropolis.

3. There should be establishment of more veterinary clinics across the city to complement the existing ones to ensure dog owners get access to veterinary services and dog bite victims can readily obtaine medical advice promptly.

4. There is need for the promotion of public health educational program aimed at educating the public on the need to vaccinate their dogs and encouraging responsible dog ownership and also on the need to seek adequate medical attention when they are bitten by dogs.

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APPENDICES

Appendix I: Questionnaire

Survey for dog population in Kaduna metropolis

SECTION A: HOUSEHOLD INFORMATION

1 Number of people in household: Less than 5 years old: ……. 5 - 10 years old: ……

11 - 17 years old: …….. 18 - 50 years old: …….. More than 50 years old: ……

2 Enclosure of home: no fence or wall… fence or wall, but does not restrain dogs… fence or wall, completely restrains dogs…

3 Garbage handling: private disposal in public dump… private disposal in other places municipal pickup more often than weekly… municipal pickup less often than weekly…

4 Livestock kept on range land away from living quarters: cattle… sheep… goats… other…

Herds are accompanied by dogs: YES… NO…

5 Dogs on your premises (give present numbers): adult and juvenile females… adult and juvenile males… puppies…

6 If household has no dog, explain why not: ……

……
…….

7 How many litters did your bitches have in the past 12 months? .....

8 How many dogs did you acquire in the past 12 months? .....

9 How many dogs did you turn out, kill, give away, etc., in the past 12months?

	Adults and juveniles	puppies
Given away		
Abandoned		
Escaped		
Killed by member of household		
Killed by police, dog catcher, etc.		
Brought for euthanasia		
Killed by traffic		
Died from rabies		
Died from other disease		
Disappeared (unknown cause)		

10 Do dogs other than yours eat at your home? fed by your household… eat at your trash container… scavenge your premises…

11 Are there unowned dogs in your neighbourhood? (Give usual numbers): always in the community: …….. unidentified strange dogs: ……

12 Have members of your family been bitten by dogs in the past 12 months? By your dogs…
By neighbours' dogs… By unowned dogs always in the community… By unidentified strange dogs…

SECTION B: Individual Dog Information (one form for each dog)

1 Breed: Identify: Crossbred……Native breed……Exotic……

2 Sex: male… female… pregnant female… lactating female…

3 Age: ……..... years. …… months

(If precise age is not known, please indicate if puppy is juvenile or adult :……..)

4 Source of dog: offspring of own bitch… bought or traded from neighbour… bought or traded from outside neighbourhood… received as gift from neighbour… received as gift from outside neighbourhood…

5 Age of dog when acquired: ……. years …… months

(If precise age is not known, please indicate if dog was received aspuppy, juvenile, or adult……)

6 Uses of dog: guarding of premises… herding… hunting… pet… meat source… other (identify)……..

7 Percentage of time the dog is indoors: outdoors leashed: … outdoors free: …

8 Shelter: dog kennel … owner's house… free…

9 The dog is fed by: household members… by neighbours… dog finds its own food…

10 Source of food: commercial dog food… family garbage and waste… butchers' waste…

Garbage on roads and dumps… small rodents…

11 Persons who handle or play with dog: owner… adults of household… children of household… friends and neighbours… strangers… nobody…

12 Is the dog vaccinated against: Rabies…? Distemper…? Canine hepatitis…?

Leptospirosis…?

13If dog is vaccinated against rabies, indicate: date of last injection: ……..

Type of vaccine: ……..

14 How many litters did the bitch produce in her life? .....

15 Give the approximate date of her last whelping: …….

16 Information on the last litter:

How many puppies were born? .....

How many are still alive and with the household? .....

How many died from diseases? .....

How many were killed by the bitch? .....

How many were killed by people? .....

How many were given away or were sold? .....

How many were abandoned? .....

Appendix II:

Monthly dog bite cases in humans reported at the Zonal veterinary clinic Magajin Gari, Kaduna, Kaduna state. Between 2004 –2014.

Year	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Total
2004	2	2	3	0	1	0	1	5	0	0	0	1	15
2005	0	0	2	0	0	0	0	0	0	0	0	1	3
2006	1	2	1	0	2	0	1	0	2	3	0	0	12

2007	0	0	2	3	2	0	2	3	5	3	1	1	22
2008	0	2	2	0	0	0	0	4	5	3	0	0	16
2009	1	0	0	0	2	1	0	0	2	0	0	0	6
2010	1	0	0	0	0	0	0	1	0	0	0	0	2
2013	1	0	0	0	0	0	1	0	0	0	0	0	2
2014	2	1	0	1	1	0	2	1	0	0	0	0	8
Total	**8**	**7**	**10**	**4**	**8**	**1**	**7**	**14**	**14**	**9**	**1**	**3**	**86**

Appendix III:

Streets surveyed for the street dog count in Kaduna metropolis, Kaduna state.

Area 1……. Total population size estimated from photographic recaptures (Beck's Method) covering 7 streets in Chikun L.G.A.

1. Bareje Street.
2. Fulani Street
3. Funtua Street
4. Gajina Avenue
5. Iri Street
6. Jema'a Road

7. Kakuri Street

Area 2……..Total population size estimated from photographic recaptures (Beck's Method) covering 12 streets in Kaduna North L.G.A.

1. Abijan Street
2. Balarebe Mahmoud Street
3. Garba Ja Abdulkadir Close
4. Garba Ja Abdulkadir Road
5. Guava Close
6. Jabi Road
7. Jabi Road East
8. Ramat Street
9. River Close
10. Sultan Road
11. Surame Road
12. Zobe Road

Area 3……. Total population size estimated from photographic recaptures (Beck's Method) covering 7 streets in Kaduna South L.G.A.

1. Bostwana Crescent
2. Bostwana Street
3. Ethiopia Street
4. Malawi Crescent
5. Malawi Street
6. Uganda Street
7. Zambia Crescent

Area 4…… Total population size estimated from photographic recaptures (Beck's Method) covering 5 streets in Igabi L.G.A.

1. Dan Masani Bello Sani Road
2. Hussaini Road
3. Sarki Fulani Jafaru Road
4. Yusuf Sambo Street
5. Zaria Road

Appendix IV:

Photographs of free roaming dogs in some streets in Kaduna metropolis





Fig. 1. Jema'a road Sabon Tasha, Chikun L.G.A

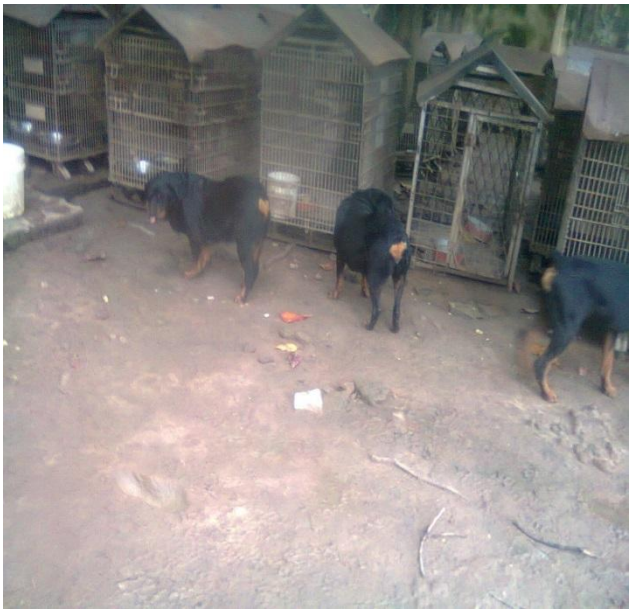
Fig. 2. Kakuri Street Sabon Tasha, Chikun L.G.A



Fig.3. Zaria Road Rigachikun, Igabi L.G.A.

Appendix V:

Photograph of confined dogs in some streets in Kaduna metropolis



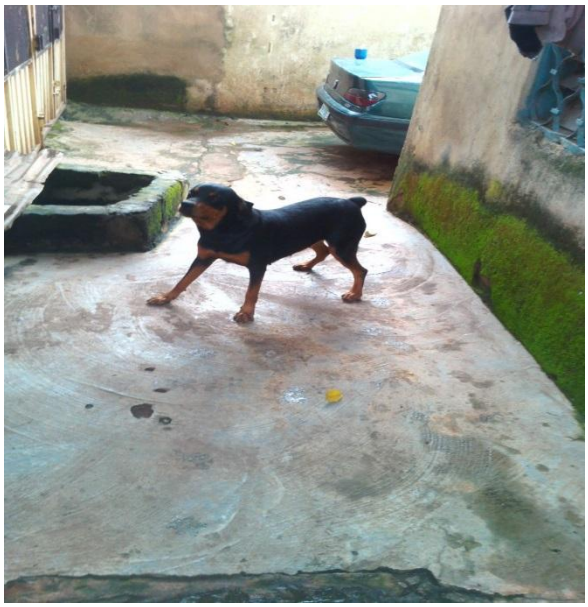


Fig.4. Ethiopia Street, Barnawa Kaduna South L.G.AFig.5. Zambia Crescent, Barnawa Kaduna South

Appendix VI:

Dog enumeration household units on AutoCAD Map 3D GIS for Kaduna metropolis, Kaduna State, Nigeria.

