A STDDY OF THE DOG POPULATION AND ACCESSIBILITY OF THE DOGS TO VACCINATION AGAINST RABIES IN SAMARU, ZARIA, NIGERIA

BY

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DECLARATION

The work presented in this thesis is original and was carried out in the Department of Veterinary Public Health and Preventive Medicine, Ahmadu Bello University, Zaria, under the supervision of Professors J. U. Umoh, S. U. Abdullahi and J. B. Adeyanju.

The work of other investigators was referred to and acknowledged. No part of this thesis has previously been submitted for a degree or diploma.

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CERTIFICATION

This thesis entitled "**A Study of the Dog Population and Accessibility of the Dogs to Vaccination Against Rabies in Samaru, Zaria**" by Dr. Igbakura Innocent Luga meets the regulations governing the award of the degree of **Masters of Science** of Ahmadu Bello University, Zaria and is hereby approved for its contribution to scientific knowledge and literary presentation.

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DEDICATION

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ABSTRACT

A dog population study was carried out in Samaru using the questionnaire and direct street count methods. The characteristics of dogs vaccinated against rabies at the Veterinary Teaching Hospital, Ahmadu Bello University (A.B.U.), Zaria in 1991 as well as the rabies situation in Samaru were studied.

Having estimated the population of household and street dogs in Samaru and analysed the characteristics of dogs vaccinated or involved in dog rabies cases, a vaccination campaign was organised for Samaru residents as a method to estimate the accessibility of dogs to vaccination against rabies in Samaru. The campaign organisation and implementation involved local institutions. Immediately after the campaign, a survey was carried out to ascertain the accessibility of household dogs to the campaign. The Lincoln index was then used to estimate the population of free-roaming dogs as well as the proportion of street dogs reached by the campaign.

The estimated number of household dogs in Samaru was 527 based on an estimated dog-to-human ratio of 16:1 in the prevaccination campaign survey; 68 dogs (37.4%) were vaccinated against rabies. Of the 510 households sampled, 137 (27.1%) owned dogs. Respondents gave various reasons for owning or not owning

dogs, the most important being for security/pet an
dogs respectively.

Mongrels were the dominant breed encountered in both the household and vaccination surveys, accounting for 215 (91.9%) and 100 (100%) respectively. There were 19(8.1%) mixed breed dogs among household dogs. The more common sex of household dogs was the male 121(52.2%). A similar observation was made during the vaccination campaign with males being 76(72.4%). Female dogs were 111(47.8%) and 29(27.6%) respectively. No respondent indicated that his/her dog had been neutered in both censusing procedures. Only 3 respondents could not provide information about the sex of their dogs and the dogs were not available for proper identification in the household survey. The sex ratios were 1.1:1 or 52% males in the household survey and 2.6:1 or 72% males during the vaccination survey. In both surveys, dogs one year and below in age predominated being 109(47.2%) and 67(63.8%) respectively. Dogs 1 to 3 months of age were (47.2%) in the pre-campaign survey; dogs 4-6 months were 28(12.1%); 6-12 months were 34(14.7%); 13-24 months were 55(23.8%); 25-36 months were 31(13.4%); 37-48 months were 14(6.1%) and above 48 up to 240 months were 22(9.5%). The weighted mean age of dogs encountered in the household survey was 26.7 months.

Dog bite was reported to have taken place in 8% of the households within twelve months prior to the survey. Dog bitedepended on the presence of street dogs (P 0.05, X^2). Up to 31.6% of respondents would not carry a dog to a veterinary surgeon for vaccination. This included dog owners. Willingness to carry a dog to a veterinarian was dependent on area of study (P 0.05, X^2). Willingness to carry a dog to a Veterinarian also depended on religion (P 0.01, X^2). Community willingness to participate in a dog identification programme and a public enlightment campaign was independent of dog ownership (P 0.05, X^2) as was the communities knowledge of dog rabies and its transmission (P 0.05, X^2).

The population of free-roaming dogs was 450 based on street counts. Only (23.3%) of these were reached by the campaign. An estimated 42.5% of dogs was reached by the campaign. The accessibility of household dogs to the campaign was 69% based on a post campaign survey.

Based on the results of this study, the unowned dog population of Samaru was high, dog supervision was poor, accessibility to even household owned dogs was poor.

The study concludes that to attain a high level of population immunity, the unowned dog proportion of street dogs in Samaru would have to be extensively vaccinated and dog owners

should be educated on the need to vaccinate their pets yearly. Since dog removal may be resisted by the local community, the vaccine-bait delivery technique to vaccinate dogs orally against rabies could be employed. This will solve the problem of reaching unowned and unsupervised owned dogs that constitute a large proportion of dogs that could not be reached by the vaccination campaign.

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Chapter 1

DOG POPULATION AND ACCESSIBILITY OF THE DOGS TO ANTI-RABIES VACCINATION IN SAMARU, ZARIA

1.0 Introduction

Decisions concerning dog rabies control in developing countries based on models from technologically-advanced countries have frequently failed even with adequate cost-benefit-analysis and availability of funds (Beran, 1981). For effective dog rabies control, information is required in the locality on presence of rabies related viruses, vector species, the size, ecology and turnover of the dog population, the degree of supervision of household dogs, the proportion of street dogs in the population, the origin of street dogs, the accessibility of dogs for rabies control measures and public attitude towards dogs and rabies control measures (WHO, 1987).

WHO (1988) emphasized the need to identity the proportion of household or owned dogs and street or the so-called unowned dogs that are accessible to rabies control programmes such as vaccination. Also, strongly emphasized was the need for special efforts towards mobilizing community participation in the organisation of immunization campaigns.

Dogs are kept by most African peoples. The reasons for keeping dogs vary according to the culture, religion and socio-

economic factors. In Nigeria, basic information is insufficient or lacking on dog rabies epidemiology, population and ecology. However coordinated rabies control efforts are very rare (WHO, 1989). Dog rabies control centres on annual vaccination since capture and destruction of stray or street dogs would be ineffective or strongly resisted by local communities. Moreover, leash laws are not enforced in most areas of the country.

Samaru is a University village and has a mixed human population in a religious and cultural sense. To conduct dog population and rabies control studies in the village, it was imperative to understand the nature of the local situation so as to recommend a control measure that would be suitable for Samaru.

The specific objectives of this study, therefore, were:-

- To determine the dog population structure in Samaru.
- To determine the proportion of household or owned dogs with valid anti-rabies vaccination certificates in Samaru.
- To estimate the population of free-roaming dogs in Samaru based on estimates from recapture.
- To estimate the accessibility of dogs in Samaru to a mass vaccination campaign against rabies when the cost factor to dog owners has been removed.

The study was intended to provide useful information on the strategy for the effective control of dog rabies in Samaru.

Chapter 2

DOG POPULATION AND ACCCESSIBILITY OF DOGS TO ANTI-RABIES VACCINATION:

2.0 A REVIEW OF LITERATURE

2.1 Rabies in Nigeria

In Nigeria, rabies predates written history. Most, if not every Nigerian language has a name or some description for dog rabies. Thus 'Chiwon kare' in Hausa, 'Digbolugi' in Yoruba, 'Ginnaji' in Fulfulde, 'Idat ebua' in Efik/Ibibio 'Ara nkita'in Ibo, 'Anywa u huden' in Tiv, 'Kabvuu njik' in Bajju, 'Tawai' in Jarawa and 'Abu'u njib' in Kataf (Umoh and Belino, 1979; Fagbami *et al.*, 1981). The disease has been reported at one time or the other from all sections of Nigeria (Owoludun, 1968, 1969; Oboegbulem *et al.*, 1981; Okoh, 1976). Comprehensive reviews of the disease have been given by Umoh and Belino (1979) and Fagbami *et al.* (1981). Rabies was however, first recorded in Nigeria by the early colonialist (Annon, 1912).

According to WHO (1987), out of 2903 reported cases of rabies in Nigeria from 1928-1978, 2453 (84.5%) were in dogs, and 340 (11.7%) were in man. The virus therefore, appears to be maintained in nature primarily by the domestic dog in Nigeria. It is not yet clear whether wild animals play a role in the maintainance of the

rabies virus in Nigeria. However, rabies virus has been isolated from wild animals; such as from a monkey and two hydraxes in Ibadan, and one each from a caraccal lynx and civet cat at the Ibadan and Jos zoological gardens respectively (University of Ibadan, 1972; Okoh, 1976; Kasali, 1977). Rabies virus has not been isolated from bats, rats or shrews, and the possibility of wildlife reservoirs in some of these animals species has been looked into but not reported nor proven (Okoh, 1976; Tomori, 1980).

Methods which have been used for diagnosis of rabies in Nigeria include Seller's stain for Negri bodies, mouse inoculation and immunofluorescent (IF) staining. The problem is that only about 75% of naturally occurring casaes of rabies demonstrate Negri bodies (Dupont and Earle, 1965) and mouse inoculation requires at least 28 days observation. As a diagnostic tool, it is sensitive and specific but expensive (Ezeokoli and Umoh, 1987). The major problem of rabies diagnosis in Nigeria is that specimens arrive at the diagnostic laboratory deteriorated due to delays during transit or inadequate refrigeration. Related to diagnosis is the occurrence of rabies related viruses. All known rabies related viruses have been isolated from Africa (Boulger and Porterfield, 1956; Shope *et al.*, 1970; Kemp *et al.*, 1972; Meredit *et al.*, 1971; Tignor *et al.*, 1973).

Rabies control in Nigeria consists mainly of vaccination of household dogs and cats, capture and destruction of stray dogs and

leash laws (WHO, 1989). Individual pet owners are advised to have their pets vaccinated against rabies. The current practice in Nigeria is to vaccinate dogs (3 months or older) with low-egg-passage (LEP) Flurry vaccine and cats (older than 5 months) or rarely cattle with high-egg-passage (HEP) Flurry vaccine. Mass vaccination campaigns have been carried out, usually following unusual rabies outbreaks as in 1977 and 1982. Reports of rabies in puppies under 3 months of age (Adeyanju and Addo, 1977; Onunkwo *et al.*, 1980) have raised the need to review the lower age limit for canine vaccination. Similarly, reports of rabies outbreaks in vaccinated pets (Okoh, 1982), have raised issues about efficacy of the vaccine used, and possible vaccine-induced rabies. Vaccination of pets in Nigeria is beset with other problems. For instance, only enlightened individuals who can afford to pay to vaccinate their pets and veterinary services for pets are not easily accessible to the rural populace. Perhaps the most critical problem is the inadequate supply of vaccine. The National Veterinary Research Institute (NVRI), Vom has a capacity to produce only 100,000 doses of LEP rabies vaccine per year, where as the estimated dog population of Nigeria was put at 2.8 million (WHO, 1993). Maintainance of cold-chain is difficult due to unsteady supply of electricity.

Associated with rabies control is vaccination of stray dogs. There is a high proportion of stray dogs in Nigeria (WHO, 1989). However, anti-rabies vaccination does not reach these stray dogs.

The problem is that in the absence of strictly enforced leash laws, most "owned" dogs are semi-strays, and there are difficulties in differentiating between "owned strays" and bona fide strays. For this reason, stray dog destruction is not a viable method of rabies control in Nigeria (WHO, 1989).

To solve some of these problems, WHO (1989) advocates intersectoral cooperation for rabies control. This health systems approach identifies resources at the local, state and national levels. Of interest is the involvement of traditional institutions at the local level. The approach identifies traditional institutions as having a role in public enlightment at the local level; as any programme accepted by them is likely to be accepted by their community.

2.2 The Dog Population

2.2.1. Dog Abundance

The number of owned dogs may be estimated by questionnaire survey or from records of licensing of dogs (Schurrenberger *et al.*, 1961; Marx and Furacolow, 1969; Nasser and Mosier, 1980; Rangel *et al.*, 1981; Luga and Oduntan, 1991) or during dog vaccination campaigns (Beran *et al.*, 1972).

In the questionnaire approach, care must be taken that the respondents are representative of the population. Dog population density is commonly indicated as dog to human ratio, occasionally as dogs per household (WHO, 1989). In many situations, it would be more meaningful to express it as the number of dogs per unit area or related to both the surface area and the human population (WHO, 1989).

If there is an indication that a sizeable proportion of dogs escape these censusing procedures, the techniques used for estimating wildlife abundance have to be applied (WHO, 1987). Various methods are available for estimating the number of free-roaming carnivores (Caughley, 1977; Davis and Winstead, 1980). These methods are based on two assumptions; that the mortality, emigration and recruitment into the population are minimal during the period of census or that corrective factors can be incorporated into resultant estimates WHO (1989). Secondly, that all individuals within the population to be estimated have an equal chance of being counted. Techniques that can be used to obtained estimates of roaming dog densities include:

Total or Direct Counts: This method simply consist of making direct visual counts of individual dogs in a defined geographical area and within a limited period of time in order to meet the assumptions above. Direct counts may not be practical over large geographical areas or in cities but can be used in small communities and rural situations. The time to carry out the

counting of dogs should coincide with the part of the day with maximum dog activity, excellent visibility and less human activity (Beck, 1973; Fox *et al.*, 1975). Estimates of dog density may also be obtained by counting dogs along stratified samples of randomly selected streets in quadrants. These data can then be extrapolated to the entire study area (WHO, 1987). In some circumstances, data derived from this technique (and others described below) may be used to compare dog densities between areas when expressed for example as the mean number of dogs per unit of land area (dogs/hectare).

Estimate From Recaptures: Also known as the "Peterson-Jackson" or "Lincoln" index and is based on the use of a simple ratio obtained by capturing a number of individuals, marking or tagging them and releasing them back into the population (WHO, 1989). The population is subsequently sampled again by trapping and the total dogs caught and the numbers that are marked are determined. The population estimate is then obtained as follows

$$\frac{\text{Estimated dog population}}{\text{No. dog caught marked and released}} = \frac{\text{No. of dogs subsequently caught}}{\text{No. marked dogs caught}}$$

or

$$\text{Estimated dog population} = \frac{\text{No. dog initially trapped, marked and released} \times \text{Total No. of dogs subsequently caught}}{\text{Number of marked dogs recaptured}}$$

Dogs in urban areas do not have to be physically captured in order to mark them. Beck (1973); Heussner *et al.* (1978) and Daniels (1980) used a method where dogs were "marked" by photographing them, subsequent sampling then determining the number of "recaptures" on any given day based on the number of dogs that had been photographed previously. It has been noted that while the photographic multiple recapture method may be suitable for smaller areas where the dog population consist of mixed breeds and individual dogs can be distinguished on the basis of breed colour, identifying markings and size. Native dogs in some areas are more physically uniform in appearance and distinguishing individual dogs would be difficult or impossible. In such areas, physically marking individual dogs may be necessary (WHO, 1987).

Indices Method: These techniques involve establishing a relationship between the number of animals present in an area to some measurable environmental factor. So far, the only published attempt to estimate dog numbers using this method is Harris (1981).

Reliable estimate for dog populations are rare. In general American and European countries report a dog to human ratio between 1:10 and 1:6 (WHO, 1987). Dog abundance, however, varies considerably from country to country and within geographic regions within countries. In northern Kaduna State, there was less than one dog per 1000 inhabitants, while in southern Kaduna state, the

dog to human ratio was high, lying between 1:27 and 1:3 (Ezeokoli *et al.*, 1981). In Jos, the dog to human ratio was reported to be 1:4 (Okoh, 1986). Oboegbulem and Nwakonobi (1989) reported a dog to human ratio of 1:21 in urban Lagos. Elsewhere in Africa, in the Bamenda, Cameroon, the dog to human ratio of 1:27 has been reported (Tong *et al.*, 1994).

In developed countries, the variation of the pet population is usually directly related to the income and the vigour of the economy (Franti *et al.*, 1974; Purvis and Otto, 1976). In these countries the stray dog populations are the product of release, lost and abandoned owned animals (Beck, 1973, 1974, 1975). As a general rule, in urban areas, straying or loose pets are common in low income higher density areas while ownerless stray dogs are common in lower human density areas (Beck, 1973, 1974; Rangel *et al.*, 1981; Harries, 1981). The density and origin of street dogs in cities of tropical and subtropical areas may be different from the studies above (WHO, 1987).

2.2.2 **Ratio of Owned Versus Unowned Dogs**

It is important to know the ratio in order to estimate the percentage of dogs accessible for vaccination. A ratio can be calculated if the number of owned dogs is established and the total population is reasonably well estimated by comprehensive investigation such as by marking and recapture (WHO, 1987).

However, if one assumes that people are well aware of the dog situation in their neighbourhood, selected respondents may be asked the following questions (WHO, 1987):

- How many dogs are in your neighbourhood?
- How many of them are owned by yourself?
- How many by your neighbours?
- How many are unowned

Studies, in Nigeria, have shown that the owned and unowned dog populations greatly overlap (Okoh, 1986; Luga and Oduntan, 1991) and estimating accessibility of dogs to vaccination by this method would be misleading.

2.2.3 Habitat

Dogs inhabit a great variety of different habitats. Some of the specific elements that comprise dog habitat in urban areas are:

Shelter: The number of vacant buildings accessible to dogs, land fills dumps, parks, open spaces, garages, yards, and roof constitute the dogs shelter (WHO, 1987).

Water: This is made up of the number and extent of naturally occurring sources of water and man made sources (WHO, 1987).

Food: This consists mainly of garbage dumps. The frequency of garbage collection determines availability (WHO, 1987).

Availability of food for free-roaming dogs is probably the most important factor influencing density.

Climate: Harsh climatic conditions, particularly cold winter but also extreme heat, tend to make survival more difficult. This results in lower free-roaming dog densities (Daniels, 1980).

Cultural Practices and Customs: Human affection for or tolerance of both owned and unowned dogs, religious beliefs and customs directly or indirectly influence dog populations (WHO, 1987). In Nigeria, it has been suggested that this is the most important consideration in trying to explain variation in dog to human ratios in various communities (Ezeokoli *et al.*, 1981; Luga and Oduntan, 1991).

2.2.4 Population Structure

The information on dog demography can be related to the incidence and spread of density dependent diseases such as rabies (WHO, 1987). The major components of demographic analysis are:

Sex Ratio: The sex ratio at birth is 1:1 (WHO, 1987). However, in surveys on predominantly owned dogs, there was a preponderance of males. The ratio of females to males was found to be as follows: Mexico City 1:2.3 (Rangel *et al.*, 1981); Sacramento County, California 1:2.4 (Westbrood and Allen, 1979); Rural Ohio

1:1.7 (Schnurrenberger *et al.*, 1961); Baltimore, Maryland 1:1.8 (Beck, 1973); Newark, New Jersey 1:3 (Daniels, 1980); Bamenda, Cameroun (Tong *et al.*, 1994); Jos (Okoh, 1986); and Samaru 1:1 (Luga and Oduntan, 1991). Data on sex ratios are needed in order to understand and interprete other vital statistics that are frequently expressed for each sex (Downing, 1980). Sex ratios are commonly expressed as the number of males per 100 females (e.g. 150 males: 100 females or 1.5:1) or more conveniently as a percent 150/250 = 60% males (WHO, 1987).

Age Structure: The mean age of populations of owned and well supervised dogs in the USA is approximately 4.5 years (Schnurrenberger *et al.*, 1961; Beck, 1973, 1981; Nassar and Mosier, 1980). In these studies, more than one third of the observed dogs were older than 5 years. In a similar study in Mexico City only 12 per cent of the dogs were older than 5 years (Rangel *et al.*, 1981). However, age studies of pets found on the streets in USA cities had a mean age of 2.3 years (WHO, 1987). The mean age of owned dogs was 2.03 years in urban Lagos (Obeogbulem and Nwakonobi, 1989). Analysis of age structure can provide useful information regarding the dog population. For ecample, a structure that is heavy with young dogs is indicative of a high turnover and a pattern of mortality (Downing, 1980).

2.2.5 Dog Functions in Societies

More often than is expressed in literature, dogs are kept as pets. A pet is a companion:

Something to care for

Something to touch

Something to keep one busy

A focus of attention

A reason for exercise

Something to make one feel safer (WHO, 1987).

Dogs are kept for so many other reasons including hunting, draught animals, commercial purposes, beast of burden and to pull sledges or carts (Graburn and Strong, 1973). Dogs are worshipped (Bogel and Joshi, 1990). In Nigeria and most African cultures, dogs are kept as pets for security and hunting (Tong *et al.*, 1994; Oduntan, 1990; Okoh, 1986; Ogunkoya, 1986). In a few, it is an offence to kill a dog except by community consent as in the case of rabid dogs. Dead dogs are often buried with similar rites as humans. Killing a dog by a woman is associated with infertility among the Tiv of the Benue valley (Downes, 1971). Frank (1965) describes ritual killings and eating of dogs by tribes in Africa.

2.3 Dog Diseases and Public Health

As in all other vertebrates, dogs habour a great variety of macroparasites, microorganisms and viruses. Some of these 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 (WHO, 1989). Dog bites are of considerable importance in man for the bites inflict pain, fear and anxiety when the accidents occur (Ogunkoya, 1986). The frequency and the implications of dog bites have to be investigated by questionnaire surveys (WHO, 1989). Information on some aspects of dog bite accidents may be gathered at public health centres for those bites for which medical consultation is requested. Valuable information on the design of questionaire can be found in Payne (1951) and Oppenheim (1966). Dog faeces deposited on public or private property and places constitute a hygienic problem (Dada and Belino, 1979; Umoh and Asake, 1982; Galadima *et al*., 1989; Du-Sai and Vakuru, 1991). No method has been proved so far for the estimation of the percentage of available garbage and waste removed by dogs though dogs have been described as beneficial in the removal of garbage and waste (WHO, 1989). There is a wealth of information in veterinary literature about the occurrence and age, sex and breed dependent frequency of different dog diseases (Jones and Hunt, 1983). Unfortunately this knowledge is largely limited to the well-cared-

for dogs owned by city dwellers (WHO, 1989). Very little is known about the mortality factors of unowned dogs or of owned dogs in rural areas of Africa, Asia and Latin America (WHO, 1989). Very little is known about the mortality factors of unowned dogs or of owned dogs in rural areas of Africa, Asia and Latin America (WHO, 1989). Very little is known about the recognition of different specific dog diseases and zoonoses in different cultures. The anthropological literature gives no indication of whether dogs with signs of diseases are cared about or if they are confined or killed (WHO, 1989). Cultural practices greatly influence the occurrence of zoonotic diseases as demonstrated by Lantis (1980) in the case of echinococcosis and Haskan Eskimos.

The psychological importance of owning pet dogs has been observed (WHO, 1989). Pet dogs may be of value for the health of their owners (Katcher and Friedmann, 1980). Animal owners have been shown to have a higher rate of survival from coronary heart disease, an effect independence of other social support systems. The relationship between animal ownership and survival one year after myocardial infarction was as follows (Friedmann *et al.*, 1980).

Patient Status	No. Patients Without Pets	No. Patients with Pets
Alive	28	50
Dead	11	3

2.4 Accessibility of Dog Populations for Rabies Control Programmes

A community pet population is basically composed of household (owned), roaming, feral and sheltered pets (Nasser and Mosier, 1980). The four sub-sections interact. It should be understood that a roaming dog is one that has an owner or a home to which it returns. A feral animal is unowned and homeless.

The management of dog populations is of great public health significance (Bogel and Joshi, 1990) canine rabies in particular, can be eliminated if, in addition to the classical measures of outbreak control already mentioned, and movement restrictions, 70% of the dog population is immunized (WHO, 1987). In many countries dog control operations are initiated with reluctance because up to 70% of dogs are not accessible to vaccination (Bogel and Joshi, 1990). If these dogs are treated as unowned or stray animals to be removed and destroyed, programmes to eliminate canine rabies in such countries failed, because mass destruction of dogs became increasingly unacceptable for communities and politicians (Bogel and Joshi, 1990).

Accessibility is often ascertained by vaccination coverage attained in a rabies control campaign, questionnaire or interview of people in the neighbourhood and dog population that bears signs of having been the object of religious worship (or were vaccinated during a campaign such as a painted collar) (Bogel and Joshi,

1990). In a study in Kathmandu valley, Nepal, an accessibility rate of 90-95% was determined using the proportion of dogs that bore signs of having been the object of religious worship and other signs of household association; whereas 75-80% of the total dog population was reached in the vaccination campaign (Bogel and Joshi, 1990).

2.5 Methods of Dog Vaccination

2.5.1 Continual Dog Vaccination

It is the responsibility of dog owners to obtain first vaccination for their dogs at three months of age and a booster dose after each year thereafter. The advantages of this method is that little government effort is needed where veterinary clinics already exist and dog owners obtain valid certificates of vaccination against rabies. This method is most applicable where there are few unowned dogs and the human population will voluntarily follow the regulations. The disadvantage is that a high level of compliance by enlightened owners of pets may mask a low level of vaccination coverage in the lower class neighbourhood and non-residential urban areas where rabies is being maintain endemically (Okoh, 1986).

2.5.2 Dog Vaccination Campaign Through Neighbourhood Centres

Community-wide campaigns should be conducted regularly or when focal outbreak appears between scheduled campaigns. Methods should be devised for on-sight identification of vaccinated dogs such as colour-coded collars, and for handling unvaccinated stray dogs (WHO, 1993). The advantages of this method are that neighbourhood centres are more conveniently located for most dog owners than are veterinary clinics. The campaigns are relatively easy to publicise. Neighbourhood centres are relatively economical to operate and if the local community is well mobilizied, can be very efficient during the vaccination. Moreover, vaccination centres may be the only feasible approach when households are not open to vaccinators. The disadvantages are rely on owner initiative to bring their dogs for vaccination. Dogs which are difficult to restrain and unowned dogs will not be brought. Dog owners may hesitate to mingle their dogs at vaccination centres, recognizing hazards of animal fights, picking of fleas, or ticks, and transmission of infectious diseases (WHO, 1984). The method has been used at the community level to control rabies in the Philippines (Beran *et al.*, 1972). The dog was the sole reservoir host.

2.5.3 House to House Dog Vaccination with Complete Coverage of Residential Area and Selected Dog Removal

Communities are usually systematically covered every two years or when focal outbreaks appear between schedule campaigns. The campaigns are based on vaccination of all dogs (both owned and unowned) in residential neightbourhoods and vaccination or removal of dogs in non-residential areas. Usually dogs are vaccinated with charge to residents. The vaccinators follow set house-to-house schedules. They convince the local residents of the importance of dog vaccination, so it is important that they be well acquainted with or preferably be from the locality (WHO, 1984).

The advantages of this method are that a sufficient percentage, usually at least 90% of all dogs in the community, are reached. Community acceptance concerning dog removal is maximised by not killing dogs except on request. The disadvantages are that training and pre-exposure immunization of the vaccinators are costly. House-to-house vaccination does not work well in large urban areas where neighbours do not know each other, and if owners are charged fees for dogs vaccinated (WHO, 1984).

2.5.4 House to House Vaccination Campaign With Entire Community Coverage and no Dog Removal

This modification involves complete systematic coverage of the entire community by vaccinators going from house to house. In addition the teams capture, vaccinate and release all dogs at non-

residential areas such as abattoirs, markets and other areas providing food or shelter to dogs. Usually 90% of the dogs are vaccinated. Surveillance must be continuous and prompt action taken upon re-entry of rabies. Campaigns are usually repeated every two years or when rabies re-appears (WHO, 1984). This method is especially applicable in large scale canine rabies control programmes in developing countries (Beran, *et al.*, 1972).

The advantage of this method is that there is minimal disruption of normal community functions. The disadvantage is that this method is least effective where no natural barriers to re-entry of rabies into control areas exist. Surveillance must be continuous and campaigns promptly re-instituted upon re-entry of rabies.

However, in all these programmes, social, economic and educational differences influence whether or not a particular type of rabies control programme is going to work in a particular area (Sikes, 1971, 1975).

2.6 Rabies Vaccine Situation in Nigeria

The National Veterinary Research Institute (NVRI) at Vom, manufactures low egg passage (LEP) Flurry strain attenuated vaccine for dogs and high egg passage (HEP) for cats. The vaccine laboratory at Yaba, Lagos, prepares vaccine for human use (WHO,

1993). The NVRI has a capacity to produce only 100,000 doses of LEP rabies vaccine per year (WHO, 1989). This is grossly inadequate since the dog population of Nigeria has been estimated to be 2.8 million (WHO, 1992). Other vaccines are imported to satisfy the demand for both animal and human use (WHO, 1993). Even where this vaccines are available, maintainance of cold chain is difficult due to unsteady supply of electricity.

Vaccination of dogs and cats using the Vom prepared Flurry strain attenuated vaccine has undoubtedly proved valuable towards rabies control in Nigeria (WHO, 1989, 1993). However there have been reports of vaccine breaks, most of which were attributed to incorrect application of vaccine, failure of some individuals to respond even to repeated doses of vaccine and previous exposure to street virus (Okoh, 1982). The enthusiasim for mass vaccination of dogs fizzle out due to non-supply of adequate quantity of vaccine at the right time and the vaccination fee for dogs (WHO, 1989). The dogs law and dogs act are silent about vaccination fee for dogs. Therefore, apart from the National Anti-rabies Campaign of 1982, there has been no coordinated approach to rabies control in Nigeria (WHO, 1989).

Chapter 3

DOG POPULATION AND ACCESSIBILITY OF THE DOGS TO ANTI-RABIES VACCINATION:

3.0 MATERIALS AND METHODS

3.1 Study Area

The study was carried out in Samaru (11^0 11'N, 7^0 38'E), a University settlement, situated in the northern finges of the Guinea Savanna vegetation zone. Samaru had a population of 4147 by the 1963 census and 8486 in 1992 by an estimated growth rate of 2.5% (NPC, 1963).

Data about meteorological conditions for Samaru was obtained from the meteorological records of the Institute for Agricultural Research (IAR), Ahmadu Bello University, Samaru, Zaria. The data, spanning the period from 1928 to 1992 indicated that the rains started in April, peaked in July and August and ended in November on the average.

The relative humidity generally followed the pattern of rainfall. The sunshine hours were mostly above 6 hours/day throughout the years (IAR, 1992).

3.2 Pre-vaccination Dog Population Estimation

Dog population estimation was done by the compound questionnaire method (WHO, 1987) to estimate household dog numbers and by direct street count technique (Beck, 1973) with modifications (Okoh, 1986).

3.2.1 Compound Questionnaire Method

Samaru was divided into five areas or strata: Area BZ, C and G, Samaru market area; Area III; Danraka/Sarkin Bomo quarters; and Hayin Dogo. The division was based on land use and socio-economic backgrounds and was representative of Samaru population.

A questionnaire (Appendix 1) was administered to an adult member of every first and fifth household selected by a systematic sampling procedure using the first five households for the initial simple random sample. The questionnaire solicited information on the number of people in each household; whether the household was fenced or walled and the effectiveness of the fence or wall in restricting street dogs from having access to their households; whether or not the household own any dog; the number of dogs; the reasons for ownership; the presence of street dogs as noticed by the respondent in his/her area; whether or not dogs eat at the respondent's household and if any member of the respondents family

had been bitten by a dog in the past year. Respondents were asked about their willingness to participate in rabies control and prevention programmes and their knowledge about rabies. The questionnaires also solicited information on individual dogs where households had any (Appendix 1) (WHO, 1987).

3.2.2 Direct Street Count Technique

The streets in each stratum were listed and numbered serially from maps obtained from the Housing and Passages Unit of Ahmadu Bello University, Zaria and surveys of same areas. Based on the number of streets in each stratum and the street lenths, twenty percent of the total streets in each stratum was selected for dog counting. To ensure that counting on the streets in a stratum was done at the same time thereby reducing the chances of multiple counting of mobile dogs, final year students of the Faculty of Veterinary Medicine, Ahmadu Bello University, Samaru, Zaria aided in dog counting after receiving proper instructions. A survey was carried out in each stratum walking up or down selected streets and recording each dog seen using a proforma (Appendix 2) for recording counts. The counting was undertaken in the morning between 6.00 a.m. and 7.30 a.m. in April, 1992. This was a time of good visibility, high dog activity and low human activity, conforming to WHO (1987) recommendations. Counting was done on four consecutive days and an average obtained for each stratum. Some characteristic

features to identify the dogs were noted once sighted. These features included breed, colour, sex, size and special features or markings.

3.3. Characteristics of Dogs Vaccinated Against Rabies at the Veterinary Teaching Hospital, Ahmadu Bello University, Zaria in 1991

All the files of dogs vaccinated in 1991 were studied. Information was collected on the origin, age, sex and breed of the dogs vaccinated. This would reveal areas of most risk and priority in organising a mass vaccination campaign against rabies.

3.4 Rabies Status in Samaru

Records of suspected rabies cases where brain samples were presented to the Department of Veterinary Public Health and Preventive Medicine, Ahmadu Bello University, Zaria were studied noting the origin of dogs and their relationship to victims of bite.

3.5 Free Anti-rabies Vaccination Campaign

Free anti-rabies vaccination campaign was conducted through neightbourhood vaccination centres. Based on the result of the population study, information on rabies status and vaccination in Samaru, a one day free vaccination programme against dog rabies was

announced for residents of Samaru village. The planning and implementation involved local institutions (WHO, 1989). The Sarkin Samaru, the traditional leader of the community, chose a suitable date, time and venue from suggestions. Mobilization of local residents to bring their dogs and identification of fellow Samaru residents was mainly carried out on the behest of the Sarkin Samaru. The campaign was also publicised in Ahmadu Bello University Bulletin stating eligibility, venue, date and time (Appendix 3).

Samaru residents brought their dogs and lined up for free vaccination on the agreed date and time at the chosen centres. The Low Egg Passage (LEP) Flury strain vaccine purchased from the National Veterinary Research Institute (NVRI), Vom was used for the programme. Vaccinated dogs were issued anti-rabies vaccination certificates (Appendix 4). The vaccinated dogs had their ears marked with gentian violet and their foreheads marked with a coloured ink marker.

3.6 Estimation of Household Dogs Accessible to Vaccination

One hundred household that owned dogs during the initial survey but indicated that the dogs had not been vaccinated against rabies were surveyed. Respondents were asked if their dogs were now vaccinated against rabies and when. If their dogs were not vaccinated, they were requested to state reasons for not vaccinating their dogs.

3.7 Estimation of Street Dog Population and Visual Recapture

Following the vaccination campaign with the marking of vaccinated dogs, direct street counting was once again carried out, watching for marked dogs (WHO, 1987). Marked dogs were indicated while entering the information on the proforma. This constituted visual recapture (Okoh, 1986).

3.8 Statistical Analysis

This was carried out using standard software to obtain frequency distributions, chi-square and cross-tabulations.

Data from the pre-vaccination survey was decoded and transferred to fotran coding sheets. This was analysed using standard software to obtain frequency distributions, chi-squares and cross-tabulations. Pie charts showing the various distributions were worked out and plotted using statistical software.

Data from the vaccinated dogs, post-vaccination survey, animals vaccinated at the Veterinary Teaching Hospital and reported rabies cases at Veterinary Public Health & Preventive Medicine, Ahmadu Bello University, Zaria were summarized by obtaining frequency distributions and graphs to show trends.

Chapter 4

DOG POPULATION AND ACCESSIBILITY OF THE DOGS TO ANTI-RABIES VACCINATION:

4.0 RESULTS

4.1 Estimation of Dog Population

4.1.1 Compound Questionnaire

The estimated number of household dogs in Samaru before the pre-vaccination campaign was 527. Estimation of the dog population in Samaru by the compound questionnaire method is summarized in (Table 4.1). The extrapolation is based on the population of 8486 for Samaru. This figure has been calculated from the 1963 census figure of 4147 for Samaru and a growth rate of 2.5% for villages and towns in Kaduna State.

4.1.2 Direct Street Counts

The estimated street dog population in Samaru by the direct street count technique was 120 (Table 4.2).

4.2 Demographic Factors

A total of 510 households sheltering 3772 people were sampled in Samaru. Only 3(0.6%) of pre-selected households refused to respond to the questionnaire.

Table 4.1: **Dog Population Estimated by Compound Surveys, Samaru, Zaria, 1992**

Total Human Population in Households	Total dog Population in Households	Dog/Human Ratio
3772	234	16:1

Estimated dog population = 527*

*Estimate based on the human population figure of 8486 (NPC 1963) for Samaru in 1992 and the estimated dog-to-human ratio of 16:1

Table 4.2: Dog Population in Streets of Samaru, Zaria Estimated by Direct Street Counts in 1992

Stratum	Street Counts: No of Streets counted	Street Counts: Average Count on streets*	Street Counts: Estimated No. of dogs in stratum
1. BZ, C & G	6	8±1.4	40
2. Samaru Market Area	1	2±2.1	10
3. Area III	1	4±1.5	20
4. Danraka/Bomo Estate	2	4±0.6	20
5. Hayin Dogo	4	6±1.2	30
Total			120

* Average number of dogs on 20% of the streets in the stratum.

Figure 4.1 shows the distribution of households in Samaru, Zaria, sampled during the pre-vaccination dog population study according to the number of inhabitants. Households with 1-10 people were highest in frequency 432(84.7%); followed by households with 11-20 people which were 69(13.5%); 21-30 people which were 8(1.6%); and 31-40 being 1(0.2%).

Of the 510 households sampled, 138(27.1%) owned dogs while 372(72.9%) owned no dogs at the time of the survey. Household dog ownership was dependent on religion ($P<0.01$, X^2). Christian households were most likely to own dogs, than Moslem or Hindu households. Christian households that owned dogs were 123(24.1%); Moslem households 13(2.6%) and Hindu households 2(0.4%). Christian households that did not own dogs were 228(44.7%) Moslem households 14(27.7%) and Hindu households 0(0%). Three households were unclassified.

Respondents gave various reasons why they owned dogs. The most common reason was for security and as a pet 79(57.3%), for providing security only, 47(34.1%); as a pet only, 6(4.4%); for security/food 1(0.7%); for food only, 1(0.7%) (Figure 4.2). Four respondents (2.9%) did not give any specific reason for keeping dogs.

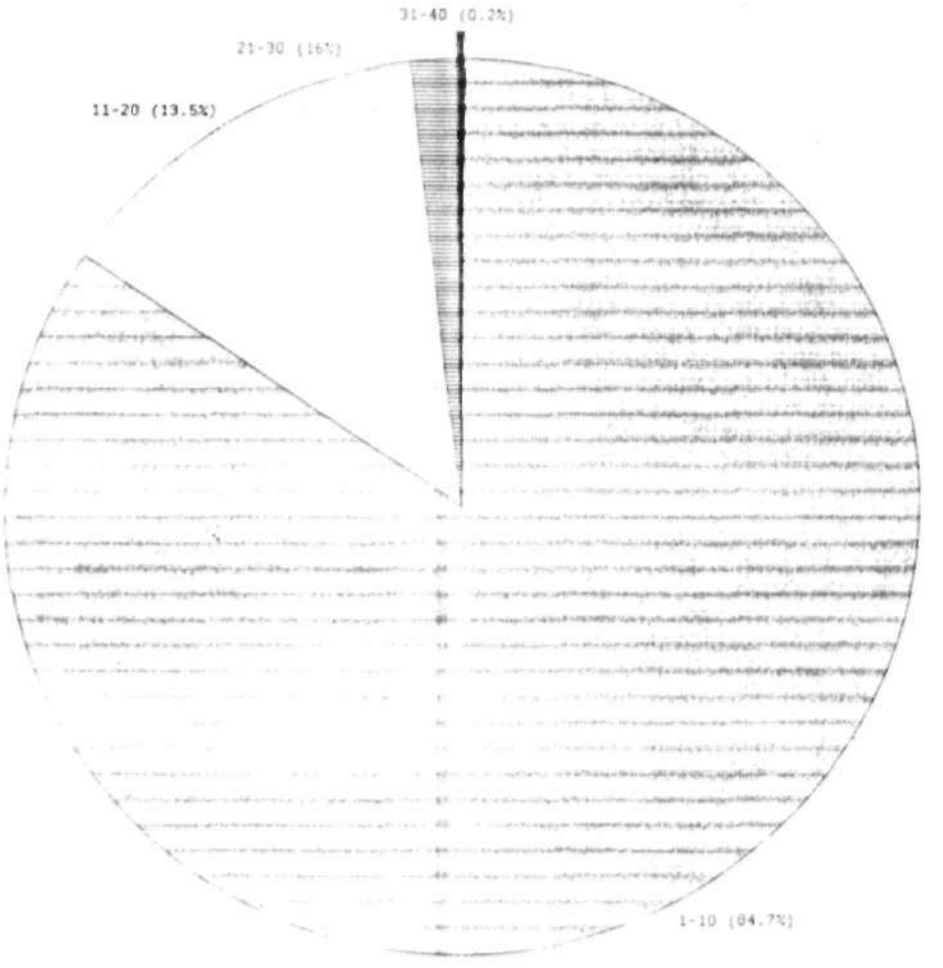


Fig. 4.1. Distribution of households in Samaru, Zaria, sampled during the log population study according to the number of inhabitants.

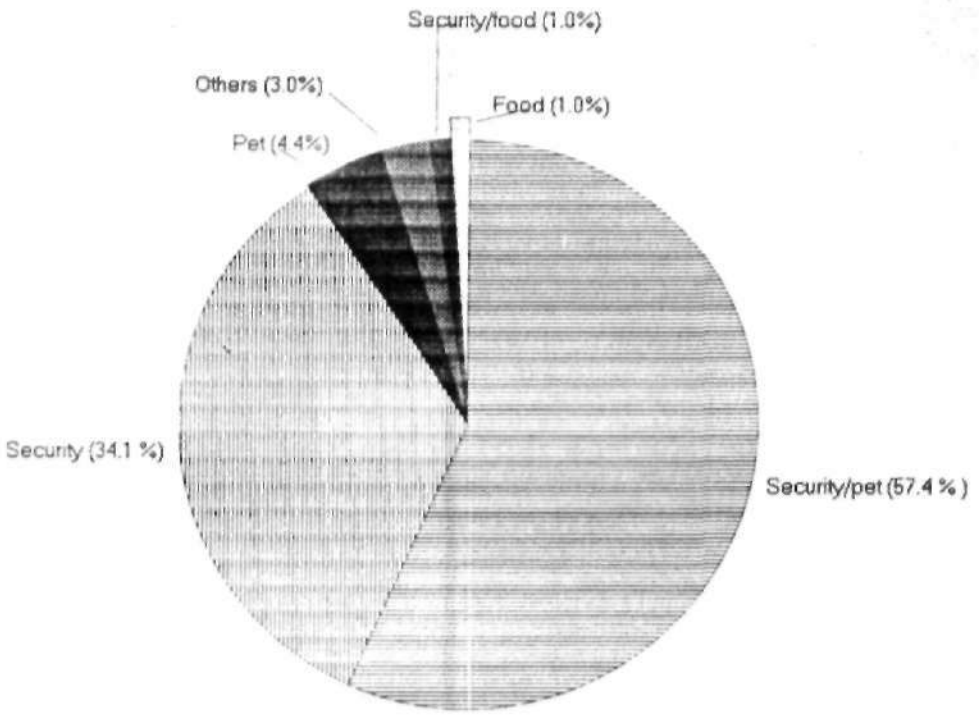


Fig. 4.2: Reasons for owning dogs as stated by respondents in in a dog population study in Samaru, Zaria.

The reasons given for not owning a dog were: dislike for dogs, 151(40.6%); lack of interest, 71(19.1%); economic hardship, 43(11.6%); death of the fomer dog, 33(88.4%); dog ownership being against religious belief 24(6.4%); the former dog had been stolen, 12(3.2%); fear of rabies, 11(3.0%); dog ownership being against culture, 4(1.1%); other reasons, 23(6.2%) (Figure 4.3).

The type of housing occupied by respondents were: western styled housing type such as bungalows and flats 333 (65.3%); local styles, 176(34.5%); and unclassified, 1(0.2%). Most of the households were fenced or walled 335(65.7%); while, 174(34.1%) households were not fenced or walled. Only 1(0.2%) household could not be classified.

Of the fenced households, only 89(26.6%) fences were effective in restricting the entry of street dogs into the fenced households. Dog owning households in stratified residential areas are shown in (Table 4.3). Hayin Dogo showed the highest dog owning households with a dog to household ratio of 1:1; followed by Areas BZ, C and G with a dog to household ratio of 1:2; then Area III, 1:2; Danraka/Sarkin Bomo Estate, 1:3; and Samaru Market Area, 1:7.

Variation of dog numbers according to households is shown in (Figure 4.4). Households with one dog were 76(56.5%); with two dogs were 37(26.8%); with three dogs were 7(5.1%); with four dogs were 6(4.4%); with five dogs were 6(4.5%); and with six dogs were 4(2.9%).

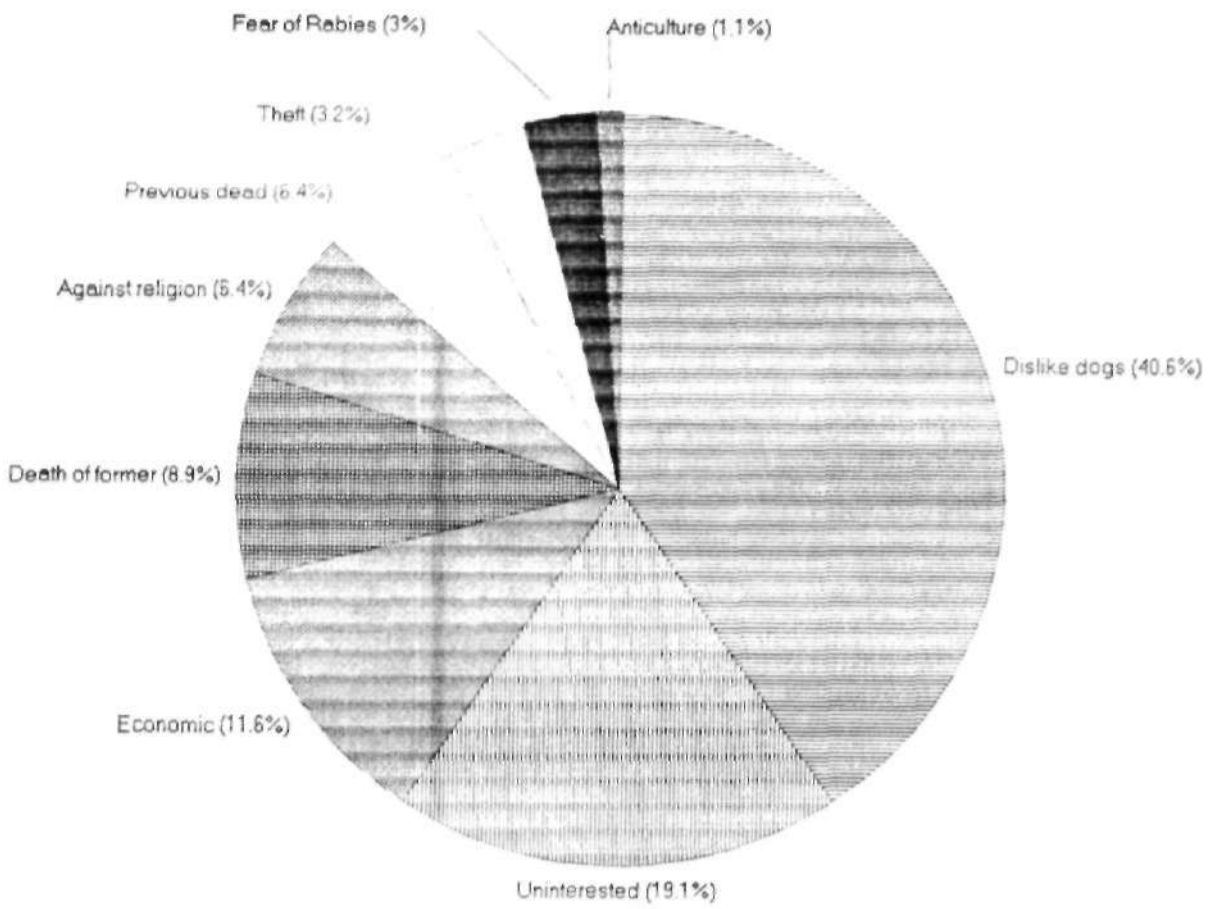


Fig. 4.3: Relative distribution of the for not owning a dog as stated by non-dog owning respondents in a dog population study, Samaru, Zaria.

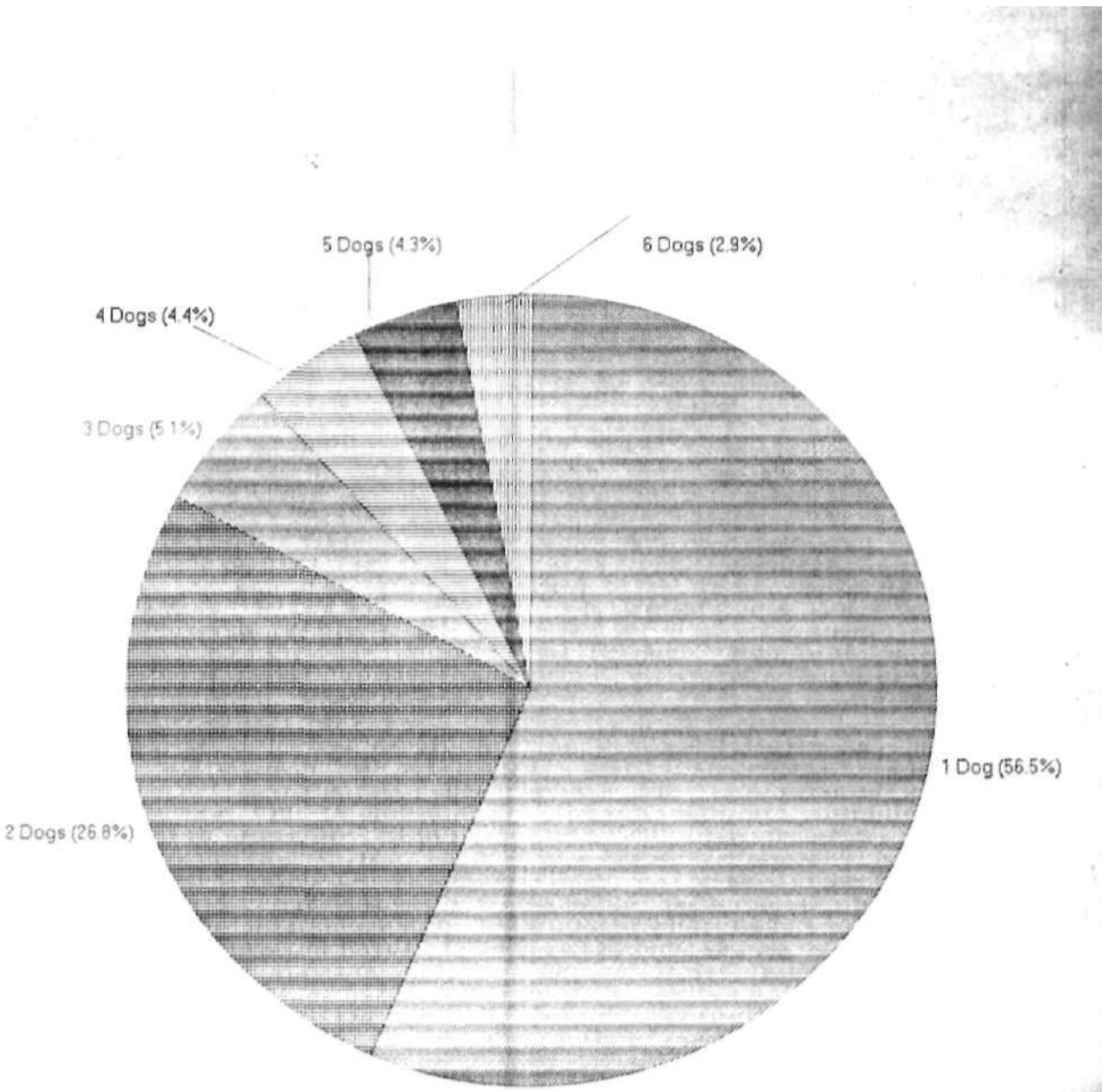


Fig. 4.4: Distribution of number of dogs per household sampled in the dog population study, Samaru, Zaria.

Table 4.3: **Estimated Dog to Household Ratio in Samaru, Zaria, 1992**

Stratum	No. of Dogs	No. of Households Sampled	Dog to household Ratio	
			General	Dog owning Households
BZ, C & G	90	137	1:1.5	1:0.5
Samaru Market Area	13	92	1:7.1	1:10
Area III	44	96	1:2.1	1:0.6
Danraka/Bomo Estates	38	124	1:3.3	1:0.7
Hayin-dogo	49	61	1:1.2	1:0.5
	234	510	1:2.2	1:0.6

Family owned dogs or dogs that were said to belong to no particular member but generally belonged to the family were more frequently encountered 129 (95%); than dogs pointed out to be owned by a particular members of the family 7(5%).

The weighted mean number of dogs encounted per household was 1.8.

Figure 4.5 shows the religions of household heads. Christian households predominated, being 351(68.8%) followed by Moslem households 154(30.2%), then Hindu 2(0.4%) and others, 3(0.6%).

4.3 Zoographic Factors

The weighted mean number of dogs per stratum was 50 (Appendix 6). Mongrels were the dominant breed encountered in both the household survey and during the vaccination campaign, accounting for 215(91.9%) and 100(100%) in the two surveys respectively. There were 19(8.2%) mixed breed dogs among the household dogs.

The most common sex of household dogs was the male 121(52.2%). A similar observation was made during the vaccination campaign with males being 76(72.4%). Female dogs were 111(47.8%) and 29(27.6%) respectively (Figure 4.6a,b). No respondent indicated that their dog had been neutered in both censusing procedures. Only 3

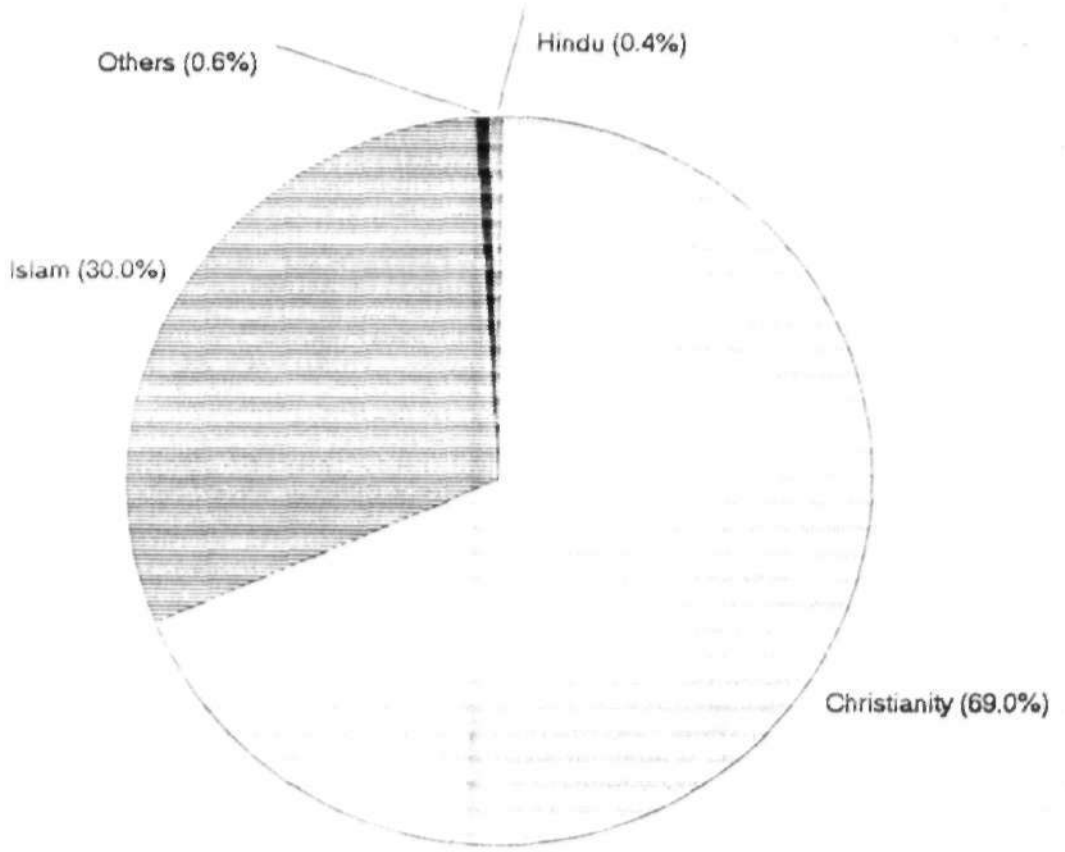


Fig. 4.5: Distribution of number of dogs according to the religion of household owner in the dog population study, Samaru, Zaria.

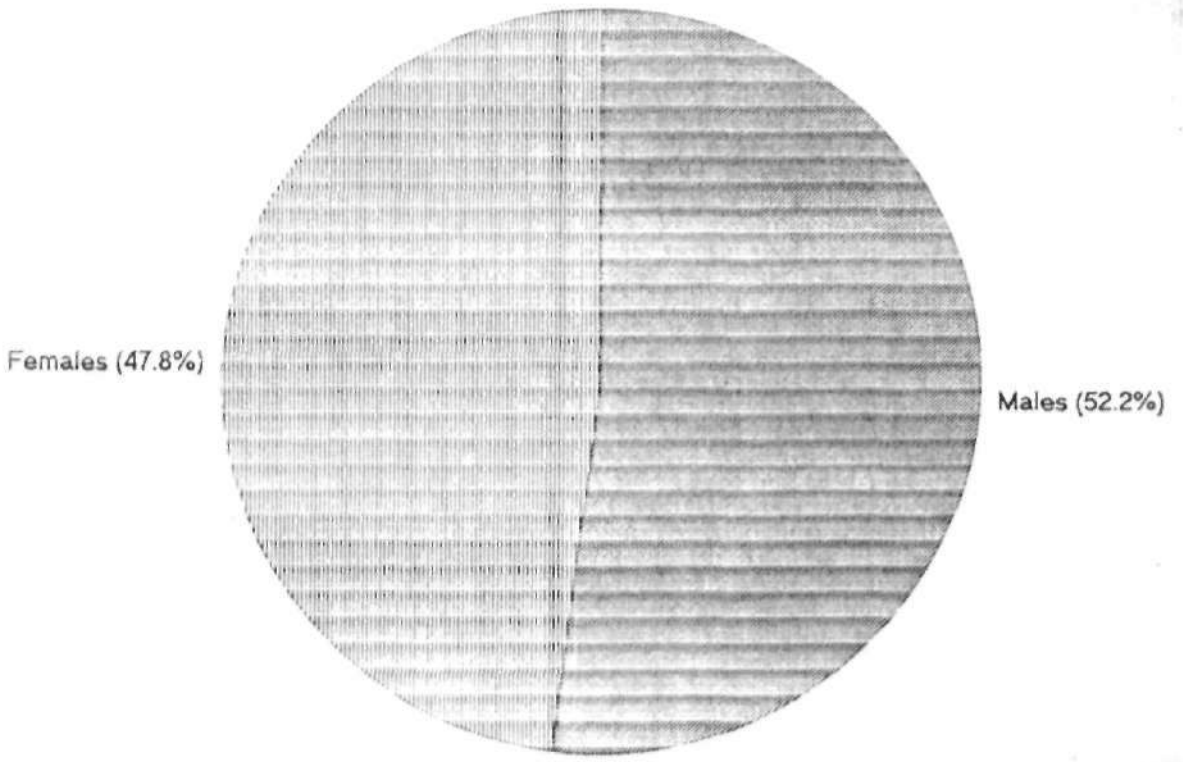


Fig. 4.6a: Distribution of dogs according to sex during the compound survey in Samaru, Zaria.

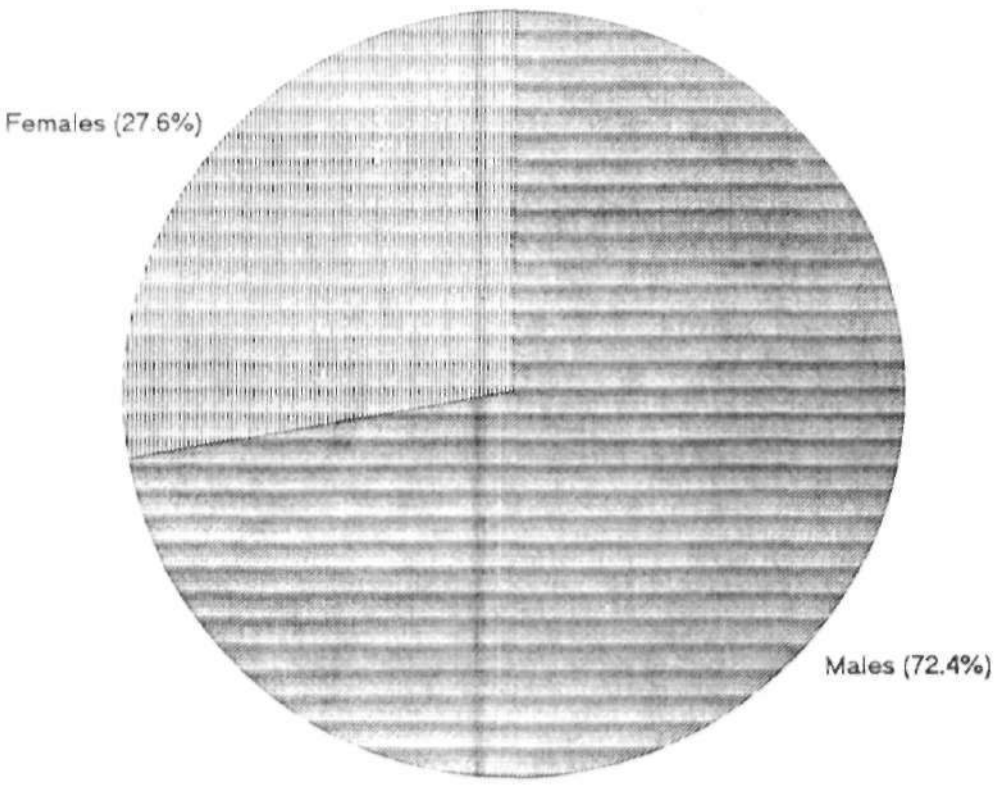


Fig. 4.6b: Distribution of dogs according to sex during the vaccination campaign in Samaru, Zaria.

respondents could not provide information about the sex of their dogs and the dogs were not available for proper identification in the household survey.

The sex ratios were 1.1:1 or 52% males in the household survey and 2.5:1 or 72% males during the vaccination survey. In the household survey, dogs 1-3 months in age were 47(20.4%); 4-6 months 28(12.1%); 7-12 months 34(14.7%); 13-24 months 55(23.8%); 25-36 months 31(13.4%); 37-48 months 14(6.1%); and above 48 up to 240 months 22(9.5%). The distribution of the age of dogs encountered during the campaign was: dogs 3-6 months of age 48(45.7%); 7-12 months 19(18.1%); 13-24 months 17(16.2%); 25-36 months 13(12.4%) and above 36 months 8(7.6%). In both the household and campaign surveys, dogs one year and below of age predominated accounting for 109(47.2%) in the questionnaire survey and 67(63.8%) in the vaccination campaign survey (Figure 4.7a, b).

The weighted mean age of dogs encountered during the household survey was 26-7 months or 2.2 years. The weighted mean number of whelpings per bitch encountered was 2.8 (Appendix 9).

Bitches that had whelped once were most frequently encountered being 20(48.5%); bitches that had whelped twice were 10(21.7%); bitches that had whelped thrice were 5(10.9%); bitches that had whelped four times were 2(4.4%) and more than four whelpings up to nine times 9(19.6%) (Figure 4.8).

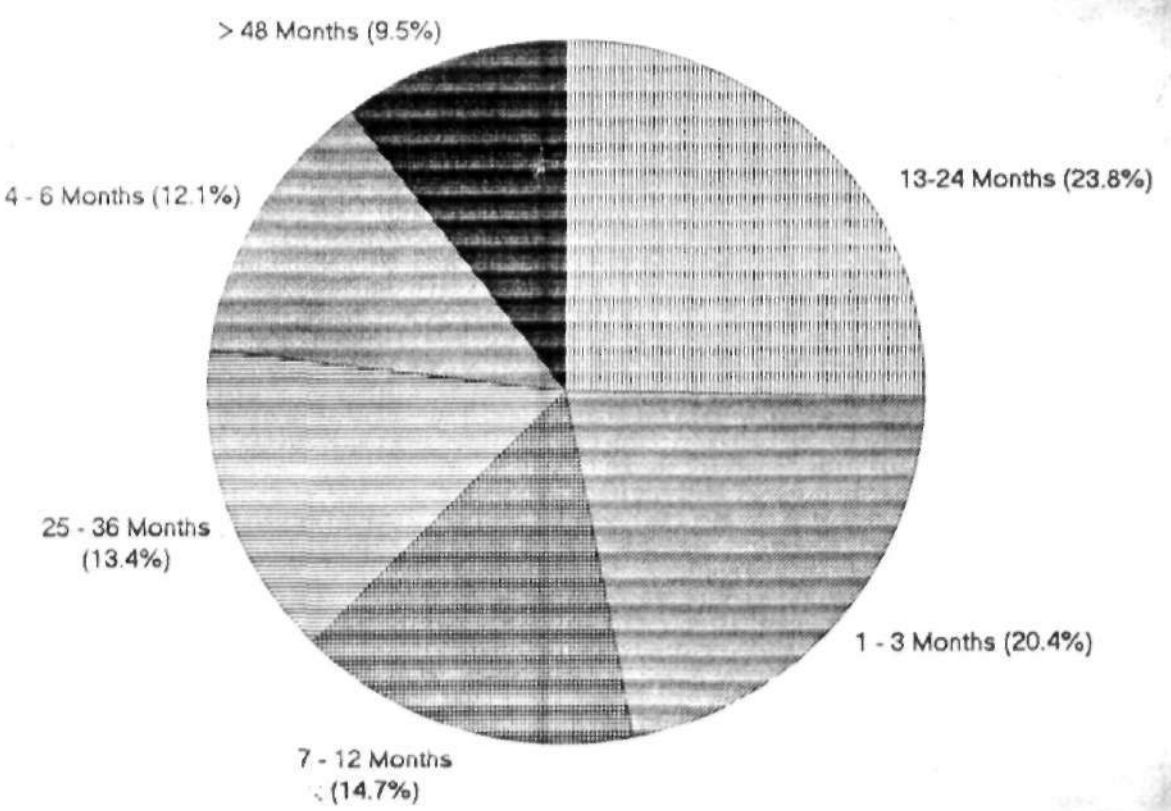


Fig. 4.7a: Age distribution of dogs as revealed by compound survey in Samaru, Zaria.

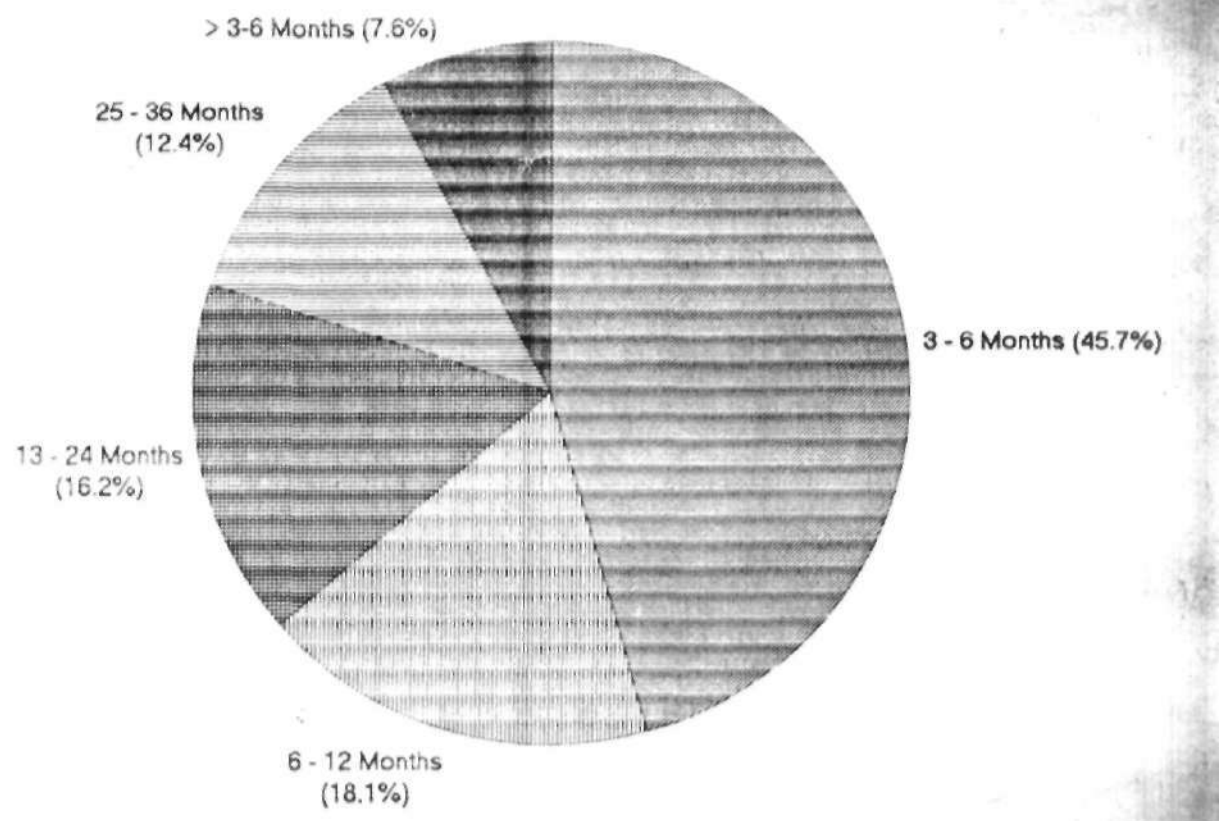


Fig. 4.7b: Age distribution of dogs as observed during the vaccination campaign in Samaru, Zaria.

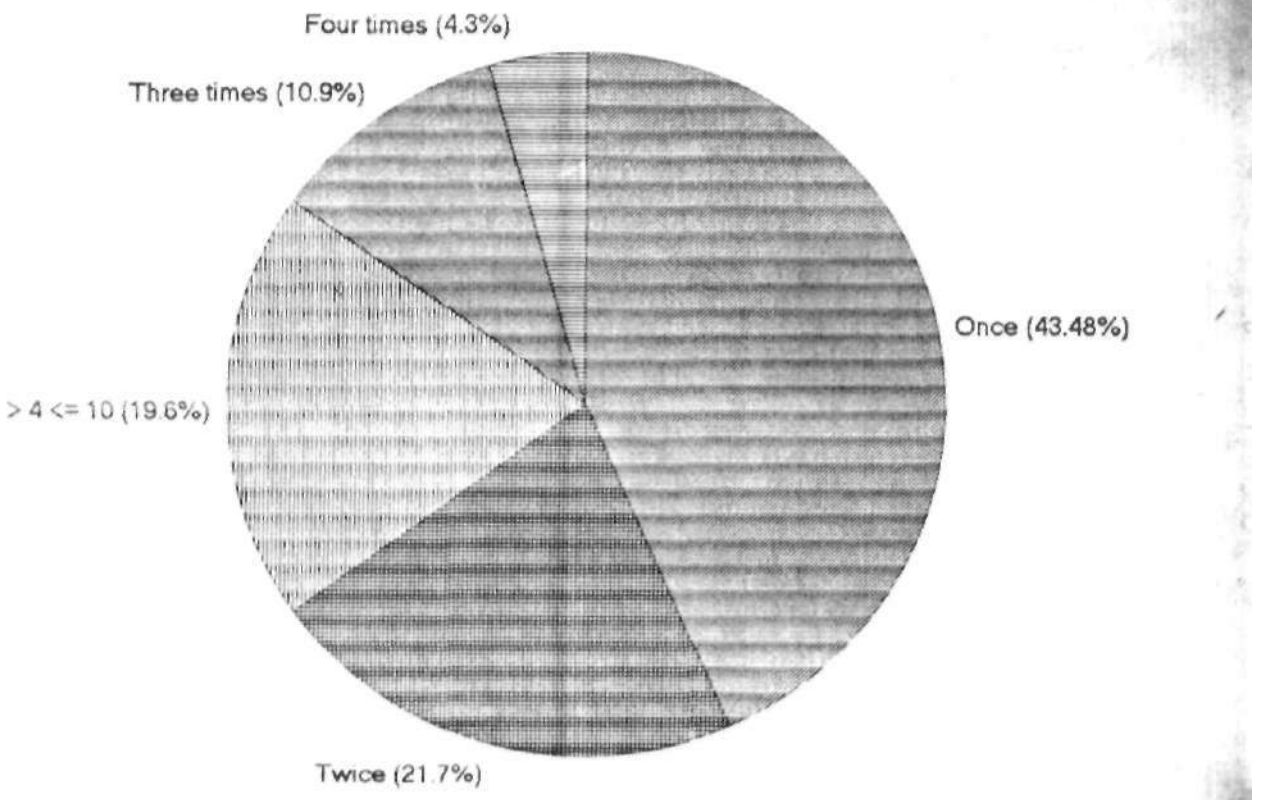


Fig. 4.8: Distribution of bitches as revealed by the number of whelpings in the dog's life, Samaru, Zaria.

Almost all respondents (99.2%) had noticed street dogs in their area. Only 44(13.2%) would not permit a street dog to feed from their household or trash cans intentionally. A large proportion 289(86.8%) could intentionally allow street dogs access to their trash cans occasionally giving out food handouts to dogs.

The presence of street dogs was independent of area of study or strata ($P<0.05, X^2$) up to 64.7% of respondents indicated that they support street dogs by allowing them access to their households, to obtain food and shelter. Feeding of street dogs was independent of type of household ($P<0.05$, x^2).

Dog owning households indicated that up to 106(79.1%) of them allowed their dogs to be fed by neighbours also. Only 28(20.9%) fed their dogs by their own household food handouts only. Four households (2.9%) were unclassified.

Dog owning households also indicated that 22(16.5%) confined their dogs while 111(83.5%) did not confine their dogs. Few respondents 5(3.8%) did not indicate whether they confine their dogs or not.

Dog bites were said to have taken place in 41(8.0%) of sampled households. One respondent could not say if a dog had bitten any of his household members in the year preceeding the survey.

The origin of the biting dog was: neighbour's dog, 21(51.2%); their own or family dog, 8(19.5%); street dog, 7(17.1%); friend's dog 4(9.8%) and by client's dog 1(2.4%) (Figure 4.9).

Post-exposure prophylaxis was carried out in 11(26.8%) of the exposures. The distribution of the prophylaxis in relation to the biting dog was as follows: client's dog 1(100%); friend's dog 3(75%); street dog 4(57%); neighbour's dog 1(9%) and own dog 0(0%).

4.4 Community Willingness to Participate in Rabies Control Programmes

4.4.1 Dog Identification

Up to 280(54.9%) respondents would participate if requested; 227(44.5%) would not, 3(0.6%) said they would make up their minds when the campaign is initiated. Of the 280 respondents that would participate 105(37.5%) were dog owners and 175(62.5%) were not dog owners, and of the 227 that would not participate, only 30(5.9%) were dog owners while 197(38.6%) were not dog owners. The three respondents who could not respond to the questionnaire were all dog owners.

Willingness to participate in a dog identification campaign in Samaru if requested was not however significantly associated with dog ownership ($P>0.05$, X^2).

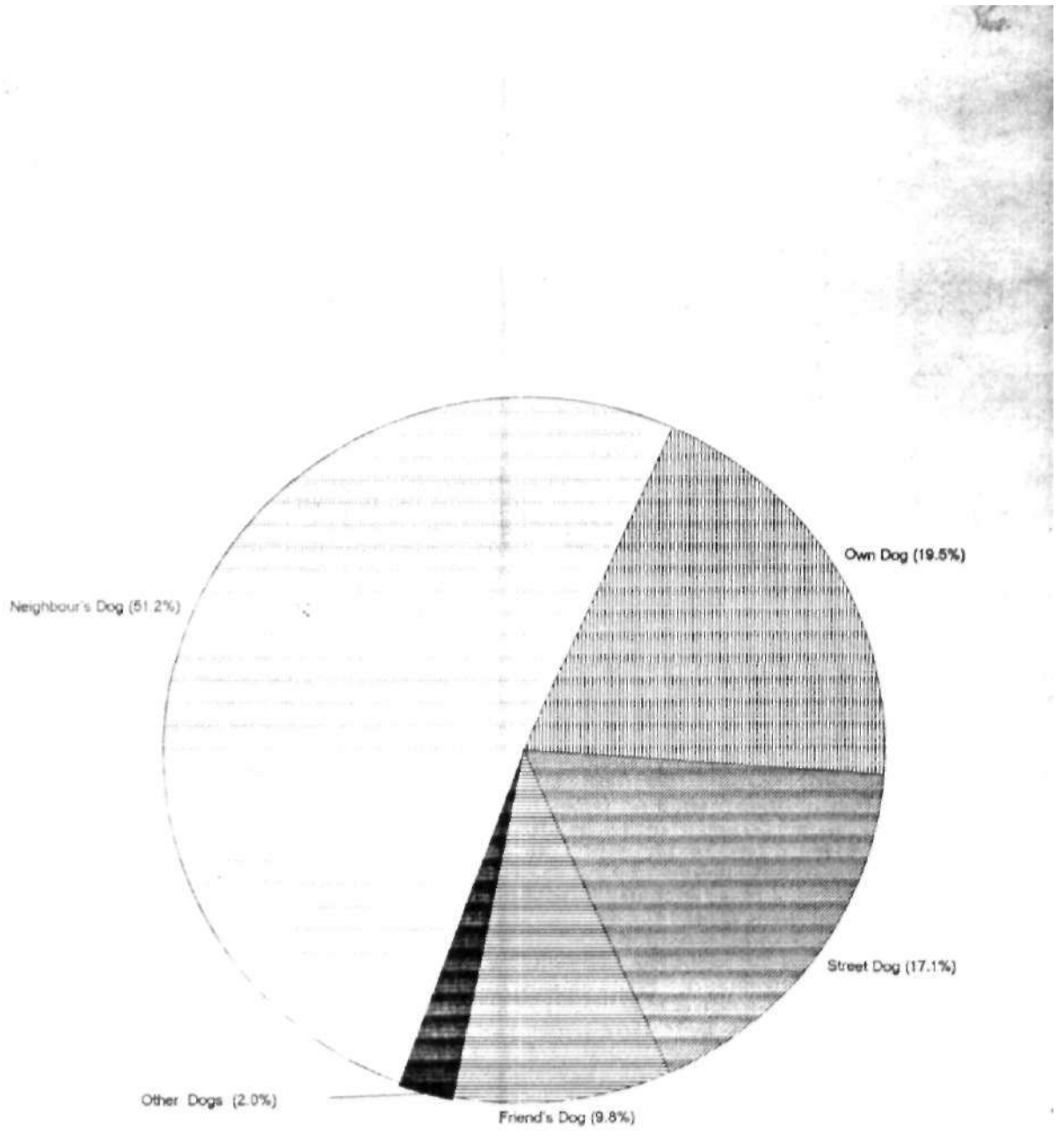


Fig. 4.9: Origin of dogs involved bite cases as revealed by the dog population survey, Samaru, Zaria.

4.4.2 Willingness to Carry a Dog for Vaccination

The respondents that affirmed were 349(68.4%). Of these 118(21.1%) were dog owners while 231(45.3%) were not dog owners. However, 161(31.6%) would not carry a dog to a Veterinary Surgeon for vaccination. Of these, 20(3.9%) were dog owners while 141(27.6%) were not dog owners.

Willingness to carry a dog for vaccination was dependent on area of study or strata ($P<0.01$, x^2). Willingness also depended on religion ($P<0.01$, X^2). Christians were more likely to carry a dog for vaccination than other religions.

4.4.3 Public Enlightment Campaign

Up to 319(62.5%) said they would participate. Of these 125(24.5%) were dog owners while 194(38%) were not dog owners. The respondents that would not participate in a public enlighment campaign about rabies were 191(37.5%). Almost all were not dog owners 178(34.9%). Only 13(2.5%) were dog owners.

Willingness to participate in public enlightment campaigns including calls for vaccination of dogs and the danger of rabies was independent of dog ownership ($P>0.05$, X^2).

4.4.4 Knowledge About Dog Rabies

As many as 442(86.7%) knew about dog rabies; 93(18.2%) of them being dog owners while 349(68.4%) were not dog owners. Only 68(13.3%) respondents had no knowledge of dog rabies; 45 (8.8%) of them were dog owners with only 23(4.5%) were not dog owners.

Knowledge about dog rabies was independent of dog ownership ($P>0.05$, X^2).

4.4.5 Knowledge About Dog Rabies Transmission

Most respondents 446(87.5%) knew that dog bite is responsible mostly for the transmission of rabies to man and other animals. Of these, 88(17.3%) of them were dog owners while 358(70.2%) were not dog owners. Only 64(12.5%) had no idea about the mode of transmission of the disease, 50(9.8%) were dog owners while only 14(2.7%) were not dog owners.

Knowledge about rabies transmission was independent of dog ownership ($P>0.05$, X^2).

4.5 Vaccination Status

In the pre-campaign survey, 68(37.4%) dogs were vaccinated against rabies. A survey of one hundred respondents who had

indicated during the pre-campaign survey that their dogs had not been vaccinated against rabies indicated that up to 69(69%) of the dogs were vaccinated against rabies after the campaign. Of these only 59(59%) had benefited from the campaign.

Vaccination of dogs was dependent on religion ($P<0.01, X2$), and was also dependent on the housing style ($P<0.01$, X^2) Christian households vaccinated their dogs more than households of other religions; and people living in western styled households were more likely to vaccinate their dogs.

Households with unvaccinated dogs had various reasons why their dogs could not benefit from the campaign: inability to restrain dogs and bring them to the vaccination centres 12(12%); no child at home to carry the dog to the centres 9(9%); no reason given and evasive and/or apprehensive to cross examination 6(6%). Only 4(4%) respondents said they had not heard about the vaccination campaign.

4.6 Dog Human Interaction Ratios

The dog to human ratio was 1:16.1 (Table 4.1). The dog to household ratio was 1:2.2 (Table 4.3). Dog bite/human ratio was 1:92; the bite/dog ratio was 1:5.7 and the bite/household ratio was 1:12.4 (Table 4.4).

Table 4.4: **Bite-to-person and Bite-to-household Ratios in Samaru, Zaria 1992**

Categories		No. of bites	Ratio
1. No. of people in households sampled:	3772	41	1:92
2. No. of households sampled:	510	41	1:12

4.7 Characteristics of Dogs Vaccinated Against Rabies at the V.T.H., ABU, Zaria in 1991

A total of 138 dogs were vaccinated. The distribution by origin was as follows: 63(45.7%) of the dogs were from residential areas of Ahmadu Bello University; 13(9.4%) were from Samaru village; 7(5.1%) from G.R.A., Zaria; 17(12.3%) from Sabon Gari, Zaria; 11(7.9%) from Wusasa, Zaria; 10(7.3%) from Aviation area in Zaria; 6(4.4%) from Kongo, Zaria; 4(2.9%) from Jaji and 7(5.0%) from Tudun Wada, Zaria (Table 4.5).

Distribution of the ages of the dogs was as follows: dogs 3 months old 7(5.1%); 4-6 months old 23(16.6%); 7-9 months old 17(12.3%); 10-12 months 17(12.3%); 13-15 months 6(4.4%); 16-18 months 7(5.1%); 19-21 months 9(6.5%); 22-24 months 13(9.4%); and greater than 24 months 39(28.3%) (Table 4.6).

Based on the breed, the dogs were distributed as follows: Mongrels were 103(74.6%); cross-breed dogs were 22(15.9%) and foreign or exotic dogs were 13(9.4%). The distribution of dogs based on sex was male dogs were 75(54.3%) while female dogs were 63(45.7%).

4.8 Rabies in Samaru

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The situation of rabies (from 1985-1989) based on brain samples of dogs submitted to the Department of Veterinary Public

Table 4.5: The Distrubiton of Dogs Vaccinated Against Rabies at the Veterinary Teaching Hospital, ABU, Zaria in 1991 According to Origin of the Dogs

Area	No. of dogs
ABU Residential areas	63(45.7)
Samaru village	13(9.4)
GRA, Zaria	7(5.1)
Sabo, Zaria	17(12.3)
Wusasa	11(7.9)
Aviation Area	10(7.3)
Kongo	6(4.4)
Jaji	4(2.9)
Tudun Wada	7(5.0)
	138

The figures in parenthesis are percentages

Table 4.6: The Age Distribution of Dogs Vaccinated at the Veterinary Teaching Hospital, ABU, Zaria 1991 According to Age

Age(months)	Frequency
3	7(5.1)
4-6	23(16.6)
7-9	17(12.3)
10-12	17(12.3)
13-15	6(4.4)
16-18	7(5.1)
19-21	9(6.5)
22-24	13(9.4)
>24	39(28.3)

The figures in parenthesis are percentages

Health and Preventive Medicine, A.B.U., Zaria was as follows. The number of samples examined was 58 and number of samples positive 36(62.0%).

The relationship of the biting dog to its victims was: number of bites 26(100%); bite from own dog 15(57.7%), bite from stray dog 10(30.5%) and bite from clients dog 1(3.8%).

4.9 Coverage of the Free Antirabies Vaccination Campaign in Dogs

The campaign was designed for Samaru residents and up to 105 household dogs were vaccinated against rabies during the campaign.

4.9.1 Household Dogs Accessible to the Campaign

A post-vaccination survey of 100 households revealed that 59(59%) were reached by the campaign; up to 10(10%) had previously vaccinated their dogs after the initial survey and before the campaign. Household dogs accessible to anti-rabies vaccination was 69(69%) (Table 4.7).

4.10 Estimation of Free-roaming Dog Population and Accessibility to the Campaign by the Optical Re-capture Method

The estimated number of free-roaming dogs post-campaign was 450. Based on re-capture records, the street dogs reached by the campaign were 35(23.3%) (Table 4.8)

Table 4.7: Accessibility of Dogs to Vaccination as Observed During the Vaccination Campaign in Samaru, Zaria

Dog Category	No. of dogs
Accessibility identified by:	
Vaccinated household dogs	69(28.2)
Vaccinated street dogs	35(14.3)
SUBTOTAL	104(42.5)
Unaccessibility identified by:	
Unvaccinated household dogs	31(12.7)
Unvaccinated street dogs	110(44.8)
Total	245(100)

Figures in parenthesis are percentages

Table 4.8: Post-campaign Street Survey for Dogs in Samaru, Zaria

Stratum	Direct Count (Average)I	Director Count (Estimate)II	Marked Dogs (Average)III	Marked Dogs (Estimate)IV
BZ, C, G	-	-	-	-
Samaru Market Area	5	25	1	5
Area III	17	35	2	10
Danraka/Bomo Estates	8	40	2	10
Hayindogo	10	50	2	10
	30	150	7	35

i. Average number of dogs on 20% of streets per stratum.
ii. Total estimate per stratum.
iii. Average number of marked dogs per stratum.
iv. Total number of marked dogs per stratum.

Chapter 5

DOG POPULATION AND ACCESSIBILITY OF THE DOGS TO ANTI-RABIES VACCINATION:

5.0 DISCUSSION

5.1 Dog to Human Ratio

The dog to human ratio of 1:16 for this study on the surface appears to contradict the ratio 1:1000 reported by Ezeokoli *et al.* (1981). However, the ratio illustrates the mixed human population of Samaru, with various cultures and religions. This is unlike rural Kaduna State where Ezeokoli and his co-workers surveyed. The predominant religion of the rural people of southern Kaduna State is Christianity while the predominant religion of rural northern Kaduna State is Islam. This explains the ratios since this study has shown that dog ownership is dependent on religion ($P<0.01$, Chi-square). The study therefore supports the observation by Ezeokoli *et al.* (1981) that the Chritian culture in Kaduna State encourages the keeping of dogs in households than other cultures in Kaduna State.

Dog to human ratio has been used by other workers. Okoh (1986) used it to estimate the population of household dogs in Jos. This study used the method to estimate the number of household dogs

since dogs are not often licensed and many are often not vaccinated, hence it does not make sense to rely on licensing or records of vaccination to estimate household dog numbers (WHO, 1987).

Reliable estimates for dog populations in localities are rare (WHO, 1984). Even where such estimates have been reported in a given geographical area, variations could make any control measure based on such estimates to fail or not to achieve the desired objective. Ezeokoli *et al.* (1981) illustrates this point for Kaduna State, reporting a variation from 1:1000 to 1:27 and 1:30 in different parts of the state. Dog to human ratios have also been reported from other parts of Nigeria. Oboegbulem and Nwakonobi (1989) and Okoh (1986) reported dog to human ratios of 1:21 and 1:4 in Lagos and Jos respectively.

5.2 Street Dog Population

The result of this study completely agrees with the observation that terms widely used in literature such as "owned dog", "stray dog" are not generally suitable for comparism of conditions between different ecosystems since these terms lack clear definition and delineation (WHO, 1988). Marked household dogs were seen at locations far away from residences with no sign such as collars on them to indicate ownership. Street dog is hereby used to mean a dog that was observed from the street during

the direct street counting. The term does not indicate whether a dog is "owned" or "unowned" but generally included stray, owned and possibly feral dogs, that were free-roaming.

To attain a high population immunity, the street dog population must be known and reached by vaccination. Street dog populations are often unknown, although in rural and sub-urban study sites in Turkey and Tunisia, it did not exceed 10% of the total dog population (Matter, 1989, WHO, 1992). In this study it was 46% of the dog population.

The classification of street dogs above is in contrast with our ecosystem and this study. The estimated number of street dogs in Samaru was 1:1 in ratio to household dogs. It was observed that household and street dogs sectors are not mutually exclusive in Samaru.

5.3 Demographic Factors

WHO (1987) recommends that in estimating the population of household dogs, not less than 500 households should be surveyed. The study sample size of 510 met this condition; and the strata were based on socio-economic and cultural backgrounds of people in Samaru.

Okoh (1986) reported household ownership of dogs as 54.8% with a dog/household ratio of 1:4. Household ownership of dogs in Samaru was lower; being 27.1% with a dog/household ratio of 1:2. This implies that fewer households owned dogs in Samaru than in Jos but dog owning households in Samaru had more dogs per household.

The reasons for keeping dogs by man or dog functions are numerous. Frank (1965) cited close to 600 publications in her review of the role of the dog in African cultures.

In this study, most people kept dogs as pets and to provide security. This is understandable because of the general socio-economic problems of the society. The reasons for not keeping dogs too were numerous. Okoh (1986) reported dissatisfaction with dogs as the chief reason. Most people in this study did not keep dogs because they dislike dogs. This agrees with the work of Okoh (1986).

In this study it was observed that people living in bungalow type households were most likely to own dogs than people living in local styled households. This may likely have to do with the security needs of non-natives living in Samaru.

Dog categorization terms used in (WHO, 1988) do not fit the local situation in Samaru. The terms include: "restricted dog"; the dog is given all of its essential needs intentionally by

humans, and the dog is physically separated from the rest of the population on a permanent basis. "Family dog"; all the dog's needs are intentionally met by humans, but the dog has access to the rest of the population some of the time. "Neighbourhood dog"; the dog is given a proportion of its essential needs intentionally by humans and has access to the population. "Feral dog"; the dog is given none of its essential needs intentionally by humans and has free access at all times to the dog population.

The study, in identifying the reasons that encourage dog wandering categorises, dogs as family owned dogs and individually owned dogs, within the general category of household dogs. The other category is wandering or street dogs. The categories overlap and it was observed that dogs were categorised as such in the society. Family owned dogs were more (95%) than individually owned dogs (5%) within household dogs. This fact and the observation that the different categories overlapped is indicative of a very low level of dog supervision and that mobility of the dogs is high.

Almost all respondents (99.2%) had noticed street dogs parading their areas. Mobility was encouraged and supported by the fact that 64.7% of respondents indicated that they allow street dogs access to their households, to obtain food and shelter.

Dog owning households also indicated that up to 79.1% of them

allow their dogs to be fed by neighbour. The study also noted that only 16.5% of dog owning households confine their dogs at any one time. All these point to a high dog mobility which leads to an unstable dog population.

The unstableness of the dog population is supported by the low average age of household dogs which was 2.2 years. The mean age of populations of owned and well supervised dogs in the United States of America was approximately 4.5 years (Schnurrenberger *et al.*, 1961; Beck, 1973; 1981; Nasser and Mosier, 1980). The U.S. study reported a stable dog population ideal for planning rabies control measures.

5.4 Zoographic Factors

This study has a figure of 9.5% for dogs four years and above of age and 7.6% for dogs three years and above in the post-vaccination survey. In both surveys, dogs one year and below of age were predominant accounting for 79.7% and 63.8% of the population in the pre and post-campaign surveys. Moreover, in the pre-campaign survey, dogs below three months were 20.4% of the population. The number of dogs that are five years and above often predominate in developed countries (WHO, 1987). In a study in Mexico, a developing country, only 12% of the dogs were above five years (Rangel *et al.*, 1981).

Oboegbulem and Nwakonobi (1989) reported that 34% of sampled dogs were mongrels while 49% were foreign or exotic breeds of dogs, in a study in the Lagos area. In this study, mongrels were the predominant breed in both the pre-campaign and post-campaign surveys accounting for 91.9% and 100% respectively of the dog populations. The reason for this great disparity could be due to the large number of foreigners in Lagos who introduce exotic breeds into the dog population of Lagos. It may also have to do with the socio-economic status of Lagos residents. Exotic dogs are expensive to purchase and even more expensive to maintain. They are, therefore, mostly kept by the rich. This explains the near absence of exotic dogs in the Samaru dog population.

The sex ratio at birth has been observed to be generally 1:1 in dogs (WHO, 1987). Beran (1982) in a survey in the central Philippines observed the sex ratio of sub-adult and adult dogs to be close to 1:1. However, in many surveys on predominantly owned dogs, there was a preponderance of males. The ratio of females to males in five areas was found to be as follows: Mexico City 1:2.3 (Rangel *et al.*, 1981); Sacramento country, California 1:2.4 (Westbrood and Allen, 1979); Rural Ohio 1:1.7 (Schnurrenberger *et al.*, 1961); Newark, New Jersey 1:3 (Daniels, 1980).

This study had a ratio of females to males of 1:1.1 and 1:2.6 in the pre-campaign and post-campaign surveys. These ratios agree with general observations and with the fact observed by (WHO, 1987)

that the ratio varies directly with the average age of the dog population.

The weighted mean number of whelpings per bitch of 2.8 and the observation that bitches that had whelped only once predominated is indicative again of the young character of the dog population.

About 8% of households had cases of dog bite occuring in them within the past year. People showed little or no concern when they were bitten by their own or their household dogs, with a post-exposure prophylaxis of 0% in this category of dog bites. Prophylaxis was administered in 9% of bites from neighbours dogs; prophylaxis was also administered in 50% of dog bites by friends' dogs. This shows a basic flaw in understanding the behaviour of dogs. This flaw can be addressed in public enlightment campaigns, because a dog that bites its owner has demonstrated a change in disposition and could actually be rabid.

Dog bite depended on the presence of street dogs ($P<0.05$); it was observed that dog bites mostly occurred where the dogs had access to individuals unaccompanied. The bite/person ratio of the study at 1:92 was lower than the Okoh (1986) figure for Jos of 2-16 for every 100 people. The bite/dog ratio of 1:5.7 was within the Okoh (1986) figure of 13-58 for every 100 dogs.

5.5 Community Willingness to Participate in Rabies Control

Most of the respondents suspected the motive behind this question. However, 54.9% of the respondents said they would participate if it had nothing to do with dog removal or tax. This illustrates the weary nature of communities about strangers asking questions around. The reasoning points to the fact that rabies control programmes that include street dog removal or destruction could be unacceptable to Samaru residents.

The fact that 110(21.6%) households were willing in Area BZ, G and C while 27(5.3%) households were unwilling; 71(13.9%) were willing in Samaru market area while 21(4.1%) were unwilling; 50(9.9%) were willing in Area III while 46(9.0%) were unwilling; 76(14.9%) were willing in Danraka and Sarkin Bomo housing estates while 48(9.4%) were unwilling and 42(8.2%) were willing at Hayin Dogo and 19(3.7%) were unwilling indicates that education standard seems to influence willingness. Educational standard of the areas are in that order. Religious believes affect the willingness since Muslims view dogs as unwholesome.

Willingness to participate in public enlightment campaigns including call for vaccination of dogs and the danger of rabies was independent of dog ownership. This was expected since some members of the population would not own dogs because of the fear of rabies.

Knowledge about dog rabies was independent of dog ownership and this points to a lack of responsibility towards dogs by dog owners. All these indicate a low level of dog supervision.

Knowledge about rabies transmission was predictably independent of dog ownership since a large proportion of the community knew that a bite from a rabid animal results in the disease.

5.6 Vaccination Status of Dogs

With the knowledge of the existence and transmission of rabies and willingness to vaccinate dogs, the figure of 37.6% as the pre-campaign vaccination status for household dogs was disappointing.

The economic status of Samaru people is one reason that could explain this low figure. The cost of vaccination has increased geometrically recently. This fact against the background of poverty leaves many with no disposable income to vaccinate their dogs. The attitude of some dog owners also explains the situation. Some respondents use dogs but neglect its care, seeing it as unhygienic or below their dignity. It is the lack of care for dogs that explains the high percentage of household dogs that wander the streets.

5.7 Characteristics of Dogs Vaccinated Against Rabies at the VTH, ABU, Zaria in 1991

This aspect of the study confirmed that the origin of most unvaccinated dogs in Samaru were from settlements in Samaru village as Samaru village had only 9.4% compared to a figure of 45.7% by A.B.U. residential areas of dogs vaccinated for the year. This was against the background that Samaru village settlements such as Hayin Dogo showed the highest dog to household ratios. This demonstrated the need to increase the vaccination status of dogs in Samaru village.

The preponderance of young and juveniles in the dog population points to the unstable nature of the population with a high turnover. Rabies control programmes such as vaccination campaigns would have to be regularly carried out to raise the level of population immunity.

5.8 Rabies in Samaru

The situation of rabies in Samaru actually indicates that though the disease is a public health problem, it is undereported. The occurrence of more dog bites in Samaru than any locality within Zaria indicates that this area is a high risk zone for the propagation of rabies and efforts to control rabies in Samaru will greatly improve the health status of Samaru residents. This could also point to low level of dog supervision. There is also the need

to educate residents about the danger of dog bites especially bites from own dogs.

5.9 Free Anti-rabies Vaccination Campaign in Dogs

The post-campaign survey revelation that only 59% of household dogs benefited from the campaign is disturbing. However, 10% of the survey's respondents had vaccinated their dogs in the interval between the pre-vaccination survey and the campaign. Bogel and Joshi (1990) reported that 75-80% of the total dog population was reached in their vaccination campaign in Kathmandu valley, Nepal.

From an estimate of 450 free roaming dogs in Samaru, the visual recapture method also indicated that only 23.3% of these dogs were reached by the vaccination campaign. This figure although excluding dogs that had been vaccinated prior to the campaign is alarming because Samaru has been shown to have a low vaccination rate even among household dogs. The result also confirms the belief that free-roaming dogs are least reached by vaccination. Removing the cost of vaccination did not so much increase the proportion of free-roaming dogs that could be vaccinated.

The results of the two surveys when combined to produce an average figure for Samaru show that 42.5% of dogs were accessible to the campaign. This implies a high unowned dog population. The

study indicates that the unowned dog population, though high and important in the epidemiology of rabies, cannot be reached by routine vaccination methods. The study concludes that to attain a high level of herd immunity, the unowned dog proportion of street dogs in Samaru would have to be vaccinated extensively. A new rabies control method in dogs that offers hope is the vaccine-bait delivery techniques to vaccinate dogs orally against rabies. This method which has been adapted from vaccination of wild carnivores is under field evaluation by the World Health Organisation (WHO, 1993).

REFERENCES

Adeyanju, J. B. and Addo, P. B. (1977). Rabies in eight-week-old puppy. Veterinary Record, 101:38

Anonymous (1912). Annual Report of Souther Nigeria, Page. 36.

Beck, A. M. (1973). The ecology of stray dogs. A study of free-raning urban animals. York Press, Baltimore, 98 pages.

Beck, A. M. (1974). The ecology of urban dogs: In: J. N. Noyes and D. R. Progulske (eds) Wildlife in Urbanizing Environment. University of Massachusettes Cooperative Extension Service, Amhorst, U.S.A. 152 pages.

Beck, A. M. (1975). The ecology of feral and free-roving dogs in Baltimore. In: M. W. Fox (ed). The Wild Canids. Van Nostrad Reihold Co. New York, U.S.A. 26: 380-390.

Beck, A. M. (1981). Guidelines for planning for pets in urban areas. In B. Fogle (ed) Inter-relation between people and pets. C. C. Thomas Co. Springfield U.S.A. 13: 231-240.

Beran, G. W. (1981). Rabies and infections by rabies related viruses; In: CRC handbook Series in Zoonoses. (Steele, J. H. ed) Section B, Viral Zoonoses. Baca Raton Co. Florida, U.S.A. 2: 57-135.

Beran, G. W. (1982). Ecology of dogs in the central Philippines in relation to rabies control efforts. Comp. Immun. Microbiol. Infec. Dis. 5: 265-270.

Beran, G. W., Nocete, A. P., Elviva, O., Gregorio, S. N., Marero, R. R., Nakao, J. C., Burchett, G. A., Canizares, H. L. and Macasaet, F. F. (1972). Epidemiology and control studies on rabies in the Philippines. Southeast Asian Journal of Tropical Medicine and Public Health 3: 433-445.

Bogel, K. and Joshi, D. D. (1990). Accessibility of dog population for rabies control in Kathmandu Valley, Nepal. Bulletin of the World Health Organisation 68: 611-617.

Boulger, L. R. and Porterfield, S. S. (1956). Isolation of a virus from Nigerian fruit kbasts. Transactions of the Royal Society of Tropical Medicine and Hygiene, 52: 421-424.

Caughley, E. (1977). Analysis of vertebrate populations. J. Wiley and Sons, London, 280 pages.

Dada, B. J. O. and Belino, E. D. (1979). Prevalence and public health significance of helminth ova in dog faeces deposited on street in Zaria, Nigeria. Annals Tropical Medicine and Parasitology, 73: 495.

Daniels, T. J. (1980). The social behaviour of free-raning urban dogs. M.S. Thesis, Ohio State University, Columbus, Ohio 144 pages.

Davis, E. E. and Winstead (1980). Estimating the numbers of wildlife populations. In: S. D. Schemitz (ed) Wildlife Management Techniques Maual. The Wildlife Society, Washington D.C., U.S.A., 221-245.

Downes, R. M. (1971). Tiv Religion. U.I. Press Ibadan. 75PP.

Downing, R. L. (1980). Vital statistics of animal populations. In: S. D. Schemitz (ed) Wildlife Management Techniques Manual. The Wildlife Society, Washington D.C., U.S.A., 247-267.

Dupont, J. R. and Earle, K. M. (1965). Human rabies encephalitis. A study of forty-nine fatal cases with a review of the literature. Neurology. 15: 1023-1034.

Du-Sai, D. H. M. and Vakuru, C. T. (1991). Prevalence of *Toxocara canis* ova in residential and public places in Zaria. Tropical Vet. 10: 69-72.

Ezeokoli, C. D., Ogunkoya, A. B., Beran, G., Belino, E. D., Eze, E. K. and Barnes, H. J. (1981). The epidemiology of rabies in Kaduna State: Result of a survey. Nigerian Veterinary Journal 10: 97-98.

Ezeokoli, C. D. and Umoh, J. U. (1987). Epidemiology of rabies in northern Nigeria. Transactions of the Royal Society of Tropical Medicine and Hygiene, 81.

Fagbami, A. H., Anosa, V. O. and Ezebuiro, E. O. (1981). Hospital records of human rabies and anti-rabies prophylaxis in Nigeria 1969-78. Transactions of the Royal Society of Tropical Medicine and Hygiene, 95: 872-876.

Fox, M. W., Beck, A. M. and Blackman, E. (1975). Behaviour and ecology of a small group of urban dogs (*Canis familiaris*). Applied Animal Ethonogy, 1:119-137.

Frank, B. (1965). Die Rolle des Hundes in Afrikanschen Kulturen. Franz Steiner Verlag, Wiesbaden.

Franti, C. E., Kraus, J. F. and Borhani, M. O. (1974). Pet ownership in suburban rural area of California, 1970. Public Health Records, 89: 473-484.

Friedman, E., Katcher, A. H., Lynch, J. J. and Thomas, S. A. (1980). Animal companions and one-year survival of patients after discharge. Lione, a coronary care unit. Public Health Reports 95(4), 307-312.

Galadima, M., Dada, O. O., Ameh, J. B. and Hafiz (1989). A survey of ova of *Toxocara* species in soil samples in Zaria, Nigeria. Zariya Vet. 1, 66-69.

Graburn, N. H. H. and Strong, B. S. (1973). Circumpolar peoples: An anthropological perspective. Goodyear Publishing Co. Pacific Palisades, California, U.S.A.

Harris, S. (1981). An estimation of the number of foxes (*Vulpes vulpes*) in the city of Bristol and some possible factors affecting their distribution. Journal of Applied Econology, 18:455-456.

Heussner, J. C., Flowers, A. I., Williams, J. D. and Siloy, N. J. (1978). Dog and cat populations in an urban area. Animal Regulation Study 1: 203-212.

Institute of Agricultural Research (1992). Samaru Meterological observations in 1992 as compared to long-term means. IAR Records, Ahmadu Bello University, Zaria.

Jones, T. C. and Hunt, R. O. (1983). Vet. Pathology. 5th edit. Lea and Fabiger, Philadelphia.

Kasali, O. B. (1977). Rabies in a civet cat (*Vireta civetta*): case report. Veterinary Record. 100: 291.

Katcher, A. H. and Friedman, E. (1980). Potential health value of pet ownership. Compen Cont. Educ. Pract. Vet. 2(2), 117-121.

Kemp, G. E., Causey, O. R., Moore, D. L., Odetola, A. and Fabiyi, A. (1972). Further studies on IBAN 27377, a new rabies related etiological agent of zoonoses in Nigeria. American Journal of Tropical Medicine and Hygiene, 21: 356-359.

Lantis, M. (1980). Changes in the Alaskan Eskimo relation of man to dog and their effect on two human diseases. Arctic Anthropology 17(1), 2-25.

Luga, I. I. and Oduntan, A. N. (1991). Dog population and ecology in relation to rabies control: a study of two settlement areas in Samaru, Zaria. Paper presented at the 28th Annual Conference of the Nigerian Veterinary Medical Association at Port Harcourt, October, 29-31.

Matter, H. C. (1989). Population biologische untersuchungen an hundepopulationen in Tunesien. Ph.D. Thesis, University of Bern, Switzerland.

Marx, M. B. and Furcolow, M. L. (1969). What is the dog population? Archives of Environmental Health, 19: 217-219.

Meredith, O. D., Rossouw, A. P. and Van Praage-Koch, H. (1971). An unusual case of human rabies thought to be chiropteran origin. South African Medical Journal, 45: 767-769.

Nasser, R. and Mosier, U. (1980). Canine population dynamics: a study of the Manhattan Kansas. American Journal of Veterinary Research 41: 1798-1803.

Nigerian Population Commission (1963). Population census of 1963 and projections from 1984-1990 by local governments councils, districts and towns/villages units. Ministry of Finance and Economical Planning, Statistical Division Kaduna State Nigeria Government Printer, Kaduna.

Oboegbulem, S. I. and Nwakonobi (1989). Population density and ecology of dogs in Nigeria: a pilot study. Reviews of Science and Technology, Office of International Epizootics 8: 733-745.

Oboegbulem, S. I., Erojikwe, E. E. and Okolo, M. O. A. (1981). Rabies in a muturu cow in eastern Nigeria. Veterinary Record, 108: 380-381.

Oduntan, A. N. (1990). Population density and ecology of dogs in Area A and Silver Jubilee Estates of Ahmadu Bello University, Zaria. DVM Thesis, Ahmadu Bello University, Zaria. 57 pages.

Ogunkoya, A. B. (1986). Epidemiology of rabies in Kaduna, Oyo and Lagos States of Nigeria. M.Sc. Thesis, Ahmadu Bello University, Zaria, 134 pages

Okoh, A. E. J. (1976). A case of rabies in a captive caracal lynx (*Felis caraca*) in Jos, Nigeria. Journal of Nigerian Veterinary Medical Association, 5: 52-56.

Okoh, A. E. J. (1982). Canine rabies in Nigeria, 1970-1980 reported cases in vaccinated dogs. International Journal of Zoonoses, 9: 118-125.

Okoh, E.A.J. (1986). Dog ecology with reference to surveillance for rabies and characterization of rabies virus isolates in Plateau State, Nigeria. Ph.D. Thesis, Ahmadu Bello University, Zaria, 377 pages.

Onunkwo, O., Momoh, M. A. and Aderigbe, B. (1980). Rabies in a six-week-old puppy. Nigerian Vet. Journal. 9: 57-58.

Oppenheim, A. N. (1966). Questionnaire design and attitude measurement. Heinemann, London.

Owoludun, B. Y. (1968). Rabies in cattle in northern states of Nigeria. Bulletin of Epizootic Diseases of Africa, 16: 425-427.

Owoludun, B. Y. (1969). Rabies: present situation in Nigeria. West African Medical Journal 18: 143-144.

Payne, S. L. (1951). The art of asking questions. Princeton University Press Princeton.

Purvis, M. J. and Otto, D. M. (1976). Household dermand for pet food and the ownership of cats and dogs: an analysis of a neglected component of US food use. Staff paper, Department of Agriculture and Applied Economics, University of Minnesota, St. Paul, U.S.A. 47 pages.

Rangel, M. C. F., Cardenas, L. J. and De Aluja, A. S. (1981). The canine population of Mexico city: an estimative study. Animal Regulation Study. 3: 281-290.

Schnurreberger, P. R., Kangilaski, E. and Bashe, W. J. (1961). Characteristics of a rural Ohio dog population. Vet. Medicine, 56: 519-523.

Shope, R. E., Murphy, F. A., Harrison, A. K., Causey, O. R., Kemp, G. E., Simpson, D. I. H. and Moore, D. L. (1970). Two African viruses serologically and morphologically related to rabies virus. Journal of Virology, 6: 690-692.

Sikes, R. K. (1971). Evaluation of canine rabies vaccines. In: Nagano, Y. and Davenport, F. M. (eds). Rabies. University Park Press, Baltimore, page 343.

Sikes, R. K. (1975). Canine and feline vaccines-past and present. In: Baer, G. M. (ed) The Natural History of Rabies. Academic Press, New York, U.S.A., 2: 177.

Tignor, G. H., Shope, R. E., Bhatt, P. N. and Percy, D. H. (1973). Experimental infection of dogs and monkeys with two rabies serogroup viruses-Lagos bat, Mokola (Ib An 27388): Clinical serological, virologic and fluorescent antibody studies. Journal of Infectious Diseases, 128: 471-478.

Tomori, O. (1980). Wildlife rabies in Nigeria: experimental infection and transmission studies with the shrew (*Crocidura* sp). Annals of Tropical Medicine and Parasitology, 74: 151-156.

Tong, J. C., Umoh, J. U., Adeyanju, J. B. and Essien, E. E. (1994). Studies on dog population of Bamenda Town, Cameroun. Zaria Vet. In Press.

Umoh, J. U. and Belino, E. D. (1979). Rabies in Nigeria: a historical review. International Journal of Zoonoses, 6: 41-48.

Umoh, J. U. and Asake, T. T. (1982). Prevalence of parasites and cysts in dog faeces deposited on streets of staff quaters of Ahmadu Bello University, Zaria, Nigeria. Nigerian Vet. Journal. 2: 58-63.

University of Ibadan (1972). Annual Report of the Virus Research Laboratory.

Westbrood, W. H. and Allen, K. D. (1979). Citizen action techniques: attitude survey research. In: Allen, R. D. and Westbrook, W. H. (eds). The handbook of animal welfare. Garland Press, New York.

World Health Organisation (1984). Guidelines for Dog Rabies Control. WHO Unpublished Document, VPH/83. 43.

World Health Organisation (1987). Guidelines for Dog Rabies Control. WHO Unpublished Document, VPH/83. 43.

World Health Organisation (1988). Report of WHO Consultation on Dog Ecology Studies Related to Rabies Control. WHO Unpublished Document, WHO/Rab/Res/88.25.

World Health Organisation (1989). Health Systems Research and Intersectoral Collaboration in Rabies Control in Nigeria. WHO Unpublished Document, VPH/HSR/89.6.

World Health Organisation (1992). Report of the First Seminar on the Control of Rabies in English-speaking West African Countries, Kaduna, Nigeria. WHO Unpublished Document, WHO/Rab/Res/93.39.

World Health Organisation (1993). Suggestions for the Development of research Projects for the Field Evaluation of Several Vaccine-bait Delivery Techniques to Vaccinate Dogs Orally Against Rabies. WHO Unpublished Document, WHO/Rab/Res/93.40.

APPENDIX 1

DOG ECOLOGY AND POPULATION IN RELATION TO RABIES CONTROL QUESTIONNAIRE, ZARIA

PART A: HOUSEHOLD INFORMATION

Date:_____

1. Area and House No:_____

2. How many people live in your house?_____

3. Is your house fenced or walled?_____

   *Does fence or wall completely restrain dogs from entering your house?_____

4. Dog you own any dog?_____

   *If no, why not?_____

   *If yes, how many dogs?_____

5. Do you notice wandering dogs in your area?_____

6. Do dogs (other than yours) eat from your house?_____

   *Fed by your household_____)
   *Eat from your trash can_____) Mark as applicable
   *Scavenge your premises_____)

7. Has any member of your family been bitten by a dog in the past 12 months?_____

   *By your dog?_____)
   *By neigbour's dog?_____) Mark as applicable
   *By unknown dog?_____)
   *By client's dog?_____)

8. Would you participate in the following programmes of rabies control if requested?

*Stray dog identification in your area_____

*Carrying a dog to a Vet. for vaccination:_____

*Public education about rabies?_____

9. Do you know about dog rabies?_____

10. Do you know how it is transmitted?_____

11. Type of housing:_____

12. Religion of house-head:_____

PART B: INDIVIDUAL DOG INFORMATION

1. What is your dog's name?_____

2. Breed?_____

3. Sex?_____

4. Age?_____

5. Why do you keep the dog(s)?_____

6. Do you confine your dog(s):_____

*During the day:_____

*At night:_____

*Day and night:_____

7. Dog feeding:

*By household members only:_____

*By neighbours also:_____

8. Who owns the dog specifically?_____

9. Is the dog vaccinated against rabies?:_____

10. Date of vaccination:_____

11. How many litters has the bitch produced in her life?

_____

12. What was the last litter size?_____

APPENDIX 2

STREET DOG CENSUS DATA, SAMARU
(PROFORMA)

Street Number									
Dog No. (Serial									
Local Breed									
Mixed Breed									
Exotic Breed									
Male									
Female									
Special Feature									
Size									
Colour									

APPENDIX 3

FREE ANTIRABIES VACCINATION FOR DOGS OF SAMARU RESIDENTS

Calling on Samaru residents to take advantages of this golden opportunity to vaccinate their dogs.

ELIGIBILITY:

*Dogs three months and above in age that have never been vaccinated against rabies.

*Dogs with annual re-vaccination time in August.

*Dogs that have not been re-vaccinated for more than a year.

VENUE:

*Sarkin Samaru Residendence

*Mai Anwa Hayin Dogo Residence

TIME AND DATE:

9.00 a. m. - 12.00 Noon, 15th August, 1992

(Sgd.) Prof. J. U. Umoh
(Head of Department)

APPENDIX 4

(MASS VACCINATION CAMPAIGN IN SAMARU)

DATE:.....

TEMPORARY ANTIRABIES VACCINATION CERTIFICATE

This is to certify that I have this day vaccinated against RABIES:_____

Property of Mr/Mrs/Miss/Dr:_____

using the Vom prepared Flurry vaccine.

.....
(Dr. I. L. I. Luga)

Booster:.....

APPENDIX 5

WEIGHTED MEAN, DOG/HOUSEHOLD, SAMARU, ZARIA

No. of Dogs in Households (X)	Frequency (W)	XW
1.	78	78
2.	37	74
3.	7	21
4.	6	24
5.	6	30
6.	4	24
	EW138	EXW251

Weighted mean (XW) = $\frac{251}{138}$

= 1.8

APPENDIX 6

WEIGHTED MEAN DOG/STRATUM, SAMARU, ZARIA

Stratum	No. of Dogs per stratum (X)	Freqency of house-holds (W)	XW
1. BZ, C & G	90	137	12330
2. Samaru market	13	92	1196
3. Area III	44	96	4224
4. Daraka/ Bomo Estates	38	124	4712
5. Hayin Dogo	49	61	2989
		EW510	EXW25451

$$XW = \frac{25451}{510}$$

$$= 49.9$$

APPENDIX 7

Sex ratio

Samaru

Precampaign: 121 males: 111 females

or 1.09 : 1 or

121/232 = 52.16%

Males

Post campaign: 76 males: 29 females

or 2.62:1 or 76/105

= 72.38% Males.

APPENDIX 8

XW OF THE AGE OF DOGS, SAMARU

Age in months(X)	Frequency (W)	XW
1	38	38
2	6	12
3	3	9
4	9	36
5	1	5
6	18	108
7	4	28
9	6	54
10	3	30
12	21	252
14	2	28
18	27	486
20	2	40
24	24	576
28	3	84
30	4	120
36	24	864
48	14	672
60	4	240
84	1	84

APPENDIX 8 (Cont.)

Age in months(X)	Frequency (W)	XW
108	3	324
114	4	456
120	2	240
156	2	312
168	5	840
240	1	240
	EW231	EXW6178

$$XW = \frac{6178}{231} \text{ months}$$

$$= 26.7 \text{ months}$$

$$= 2.2 \text{ Years.}$$

APPENDIX 9

XW WHELPINGS/BITCH, SAMARU

No. of bitches	Frequency of whelpings (W)	XW
1.	20	20
2.	10	20
3.	5	15
4.	2	8
5.	2	10
6.	3	18
9.	2	18
10.	2	20
	EW46	EW129

APPENDIX 10

ESTIMATED FREE-ROAMING DOG POPULATION
POST-CAMPAIGN, SAMARU

$$\text{Estimated dog population} = \frac{\text{No. of dogs initially trapped marked and released} \times \text{Total No. of dogs caught}}{\text{No. Marked dog recaptured.}}$$

$$= \frac{105 \times 30}{7}$$

$$= 450 .$$