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THE DEMOGRAPHICS AND EPIDEMIOLOGY OF PET OWNERSHIP AND CANINE RELINQUISHMENT

by

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Thesis submitted for the Degree of Doctor of Philosophy in the Faculty of Veterinary Medicine, University of Glasgow

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Veterinary Informatics and Epidemiology
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ABSTRACT

Research was undertaken to investigate the demographics of the pet population in a local community. A sample of the general dog population and owners was then compared with a sample of relinquished dogs and their surrendering owners, to identify dog and household characteristics associated with canine relinquishment to an animal welfare centre (AWC). The investigation was carried out in Strathclyde Region, Scotland.

A cross-sectional telephone survey was conducted to establish the pet owning status of a randomly selected sample of households. The dog and cat populations were then estimated by extrapolation of results to local census data. Using an area based approach, the association between deprivation, community setting and pet ownership were assessed using available census data. A Geographical Information System approach was applied to the data to display the spatial distribution of pet ownership in Strathclyde Region. Dog owning households identified by the telephone survey were invited to participate in a second study. This case-control study compared information regarding dog and household characteristics of these successful owners (controls), with a sample of unsuccessful dog owners and their pets (cases). The control sample was assessed by mailed questionnaire. Case households were selected by AWC staff at the time of relinquishment and data collected using self-administered questionnaires.

Results revealed that 36.1% of households were pet owners, with dogs and cats being the most prevalent species owned. The canine population of Strathclyde Region was estimated to be 248,649 and the feline population estimated to be 170,044. These dogs and cats were owned by an estimated 185,589 and 121,235 households, respectively. Deprivation and urban communities were negatively associated with pet ownership. A sample of 360 of the dog owning households agreed to participate in the second study. Based on a response rate of 89.2%, 321 of these households returned usable questionnaires. Comparison of data from these questionnaires with data obtained from 49 case households revealed that several factors were associated with relinquishment. Although certain dog characteristics were identified as important, most of the predisposing characteristics were owner-related. Uneducated, inexperienced dog owners who impulsively acquired their dog for little cost, were more likely to relinquish their pet after a short duration of ownership because of inappropriate care expectations, lack of planning and the dog failing to meet their expectations. Surprisingly, dog behavioural problems were no more prevalent in relinquished animals. These data were entered into a multivariable logistic regression model. Variables retained in the final model associated with relinquishment included ownership of a small mammal pet, no history of previous pet ownership, young dogs, mixed breed dogs, lack of veterinary care, short duration of residence in the present home and absence of a garden.

The study identified several risk factors associated with canine relinquishment, many of which could potentially be modified to decrease the numbers of animals abandoned at AWCs. Use of the multivariable logistic regression model could enable the assessment of the likelihood of future relinquishment. In particular, application of the model in AWCs could decrease the number of adopted dogs that are subsequently relinquished.

DECLARATION

I, Fiona Gregory, declare that the work in this thesis is original, was carried out solely by myself or with due acknowledgements. It has not been submitted in any form for another degree or professional qualification.

FIONA GREGORY

Parts of this thesis have been accepted for publication or presentation elsewhere.

ABSTRACTS

Gregory, F. and Reid, S.W.J. (1999) Epidemiological investigation of the risk factors for canine relinquishment to an animal welfare centre. In: Proceedings of the 42nd British Small Animal Veterinary Association Congress, Birmingham. pp 264.

Gregory, F. and Reid, S.W.J. (1999) Risk factors for canine relinquishment to an animal welfare centre in the United kingdom. In: Proceedings of the 80th Annual Meeting of the Conference of Research Workers in Animal Diseases, Chicago, Iowa State University Press. pp 37.

Gregory, F. and Reid, S.W.J. (2000) The demographics of dog ownership in Strathclyde Region, Scotland. In: Proceedings of the 9th International Symposium on Veterinary Epidemiology and Economics, Colorado. In press.

PRESENTATIONS

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A considerable amount of the work load for this research project involved the use of computers; however, my computer knowledge at the outset left a lot to be desired. Unavoidable mistakes, hiccups and catastrophes were quickly rectified with the guidance from the Veterinary Informatics and Epidemiology group. Vicki Dale, David Irvine, Tom Irwin and Colin Naismith have all offered assistance, often at inconvenient times, to help unravel the complexity of computers, for which I am truly grateful.

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This thesis is dedicated to Esha, a dearly loved
and forever remembered, companion.

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LIST OF ACRONYMS

AWC	Animal welfare centre
BSAVA	British Small Animal Veterinary Association
BT	British Telecommunications PLC
BVA	British Veterinary Association
CI	Confidence interval
DF	Degrees of freedom
DV	Dummy variables
GIS	Geographical Information System
OR	Odds ratio
PDSA	People's Dispensary for Sick Animals
RCVS	Royal College of Veterinary Surgeons
RSPCA	The Royal Society for the Prevention of Cruelty to Animals
SD	Standard deviation
SSPCA	The Scottish Society for the Prevention of Cruelty to Animals
TDM	Total Design Method
UK	United Kingdom
USA	United States of America

CHAPTER I

GENERAL INTRODUCTION AND REVIEW OF THE LITERATURE

CHAPTER I

GENERAL INTRODUCTION AND REVIEW OF THE LITERATURE

1.1 INTRODUCTION

Pet overpopulation and the use of euthanasia to dispose of healthy but unwanted companion animals has become an issue of increasing concern (Patronek and Glickman, 1994; Patronek, Glickman and Moyer, 1995). A multitude of solutions have been offered to control populations of ownerless dogs and cats and reduce the numbers destroyed (Rowan and Williams, 1987; Nassar and Fluke, 1991). However, despite wide recognition of the problem and sincere efforts to alleviate it, there has been little focused research on this field and accurate data are necessary to characterise the pet surplus (Carding, 1969; Murray, 1992b; Murray, 1992c; Salman *et al.*, 1997). Attempts to solve a problem are more likely to fail if the background causal factors are not fully understood (Carter, 1990, Murray, 1992a). But is this a question of true overpopulation or simply one of casual ownership resulting in unwanted and abandoned pets?

1.2 PET POPULATIONS

1.2.1 Pet ownership

The domestication of dogs and cats and their subsequent adoption as companion animals began around ten to 12 and three to four thousand years ago, respectively (Fox, Beck and Blackman, 1974; Fox, 1975; Feldman, 1977; Young, 1985; Althaus, 1987; Serpell, 1987; Council for Science and Society, 1988; Jöchle, 1991; Sturla, 1993; Weiss and Greenberg, 1997). Since then, mankind has been a major force in the evolution and survival of these animals (Beck, 1975). With regard to dogs, domestication has involved selection for distinct physical and behavioural traits such that today, there are over 400 different breeds fulfilling a variety of human needs (Young, 1985; Serpell, 1987; Ledger, 1997; Weiss and Greenberg, 1997).

Throughout this period, growth in pet ownership has been dramatic, largely reflecting demographic and social changes in the human population (Carding, 1975; Council for Science and Society, 1988; Strand, 1993). The movement from rural to urban environments in particular, cultivated a less utilitarian and more sympathetic attitude to animals (Council for Science and Society, 1988). Urbanisation also concentrated more animals into relatively smaller areas, facilitating uncontrolled breeding (Moulton, Wright and Rindy, 1991). Compounding this was the establishment of preventive veterinary medicine such that major epidemics of infectious disease no longer decimated the population size (MacKay, 1993). With increasing affluence and leisure time, the demand for pets escalated resulting in an explosive growth in the population (Anvik, Hague and Rahaman, 1974; Beck, 1975; Schneider, 1975; Beck, 1979). A trend towards an increase in popularity of large breeds of dogs in the 1960s also contributed to the increased biomass of pets (Council for Science and Society, 1988). Unfortunately, excessive growth in the free-roaming, neglected pet population accompanied the increase in owned pets (Carding, 1975; Faulkner, 1975). This high density of pets exacerbated the negative interactions between humans and animals and as numbers continued to rise, pet overpopulation surfaced as a problem in the 1970s (Arkow, 1991).

In most developed countries, roughly half of all households now own companion animals (Council for Science and Society, 1988; Beck and Meyers, 1996; Dunmont, 1996). According to the Council for Science and Society (1988), pet keeping is one of the most popular leisure activities in the UK and encompasses a considerable body of industrial, commercial and recreational interests. The benefits provided by companion animals are voiced by pet owners, animal welfare organisations and veterinary surgeons, whereas some 'animal rights' supporters regard the concept of pet ownership as exploitative (Rollin, 1991). Man has always been a user of animals (Murray, 1992b). For centuries, dogs have helped humans work with their herding, hunting, guarding and vermin killing skills, amongst many others (Feldman, 1977; Beck, 1979; Beck, 1980; Kidd and Kidd, 1980; Brodie, 1981; Selby and Rhoades, 1981; Young, 1985; Weiss and Greenberg, 1997). More specifically, assistance dogs have been trained to aid people with physical handicaps to enhance their independence and mobility. Such service dogs include guide dogs for the blind and hearing dogs for the deaf. More recently, the uses of seizure alert dogs to predict human epilepsy attacks and of dogs which assist people

confined to wheelchairs are being explored (Beck, 1980; Gerstman, 1987; Edney, 1992; Edney, 1993; Weiss and Greenberg, 1997; Lane, McNicholas and Collis, 1998).

While many of these utilitarian purposes remain important today, the role of animals has changed considerably (Council for Science and Society,1988). The main objective of pet ownership for most is to make the animal an integral part of daily life, with household pets often perceived to be favoured family members (Kidd and Kidd, 1980; Selby *et al.*, 1980; Selby and Rhoades, 1981; Brodie, 1981; Katcher, 1985; Quackenbush, 1985; Voith, 1985; Rollin, 1991; Endenburg and Vorstenbosch, 1992; Voith, Wright and Danneman, 1992; Murray, 1992c; Beck and Meyers, 1996; Melson, Schwarz and Beck, 1997; Lane, McNicholas and Collis, 1998). Indeed the interaction between owners and pets shows many similarities to the relationship between humans themselves, particularly the adult-child relationship (Kidd and Kidd, 1980; Berryman, Howells and Lloyd-Evans, 1985; Quackenbush, 1985; Voith, 1985; Gerstman, 1987; Endenburg and Vorstenbosch, 1992). The strength of the human-companion animal bond that ensues is evident, particularly when ended by the animal's death or permanent separation which can result in a profound sense of bereavement (Leigh, 1966; Beck and Quackenbush, 1983; Quackenbush, 1985; Thornton, 1991; Edney, 1992; Endenburg, Hart and Baarda, 1991; Endenburg, 1996; Gorodetsky, 1997; Melson, Schwarz and Beck, 1997).

Research has shown that emotional factors, specifically companionship, followed by hobby or sport are the most common reasons for ownership (Rhoades and Selby, 1979; Selby *et al.*, 1980; Brodie, 1981; Endenburg and Vorstenbosch, 1992; Glickman, 1992; Kidd, Kidd and George, 1992a; Leslie, Meek, Kawash and McKeown, 1994; Beck and Meyers, 1996; Dumont, 1996). Pets fulfil roles such as companion, confidante, visual object and something to touch and feel. In addition, they provide a focus of attention to keep one busy, provide a sense of worth, facilitate social interaction, give an outlet for nurturant and care-giving behaviour, a stimulus to exercise, an opportunity for play and relaxation and a source of laughter. They are also viewed as protectors and providers of feelings of comfort, safety and security, as well as a variety of practical and recreational roles (Siegel, 1964; Heiman, 1965; Ryder, 1973; Levinson, 1975; Kidd and Kidd, 1980; Brodie, 1981; Selby and Rhoades, 1981; Katcher and Friedman, 1982; Beck and Quackenbush, 1983; Katcher, 1985; Voith, 1985; Gerstman, 1987; Council for Science and Society, 1988; Kidd, Kidd and George, 1992a; Berryman, Howells and Lloyd-

Evans, 1985; Beck and Meyers, 1996; Zasloff, 1996; Melson, Schwarz and Beck, 1997; Lane, McNicholas and Collis, 1998).

Despite being widespread, much remains unknown about the interactions between people and companion animals and the benefits which accrue from such relationships (Council for Science and Society, 1988; Arkow, 1991; Strand, 1993). In recent years, the human-companion animal relationship has attracted research in various disciplines, with a rapid expansion of the literature in this field (Council for Science and Society, 1988; Barba, 1995; Blackshaw, 1996; Paul and Serpell, 1996). Although most studies have focused on dogs, studies on the cat's natural behaviour and interaction with the human population have also appeared in the literature (Mertens and Turner, 1988). The main purpose of such studies has been to assess the beneficial effects of animals on human health, both physical and mental (Barba, 1995). Researchers have revealed that pet owners have significantly less contact with their doctor and a reduction in minor health problems after pet acquisition. Moreover, pet owners have a marked reduction in the risk factors for cardiac disease and a significantly higher survival rate after discharge from coronary care units than non-owners (Kidd and Kidd, 1980; Brodie, 1981; Katcher and Friedman, 1982; Katcher, 1985; Council for Science and Society, 1988; Edney, 1992; Glickman, 1992; Beck and Meyers, 1996; Blackshaw, 1996; Zasloff, 1996).

Animal interactions have also been reported to provide people with a variety of psychological benefits: they can facilitate relaxation, make people happier, calmer, more secure, affectionate and alert (Feldman, 1977; Katcher and Friedman, 1982; Katcher. 1985; Council for Science and Society,1988; Barba, 1995; Beck and Meyers, 1996). Interestingly, pets can alleviate the pathological effects of social isolation by enhancing social integration and acceptability and combating feelings of loneliness (Brodie, 1981; Messent, 1985; Council for Science and Society, 1988; Lane, McNicholas and Collis, 1998). It has also been reported that animals can play a role in the development of children's emotional, physical and social character. Pet keeping in childhood has been suggested to have important effects on children's self esteem and confidence, social skills and empathy, leisure activities and interests (Levinson, 1975; Bridger, 1976; Feldman, 1977; Kidd and Kidd, 1980; Messent, 1985; Gerstman, 1987; Council for Science and Society, 1988; Robertson, Edwards, Shaw and Clark, 1990; Barba, 1995; Beck and Meyers, 1996; Paul and Serpell, 1996; Melson, Schwarz and Beck, 1997).

Growing scientific evidence supports the role of companion animal ownership and attachment in improving the physical and emotional well-being of children, adults, the elderly, the socially isolated and those with disabilities (Mugford and McComisky, 1975; Feldman, 1977; Beck, 1980; Kidd and Kidd, 1980; Katcher and Friedman, 1982; Council for Science and Society, 1988; Netting, Wilson and Fruge, 1988; Stallones, Marx, Garrity and Johnson, 1988; Kidd and Kidd, 1989; Endenburg, 1992; Hart and Kidd, 1994; Beck and Meyers, 1996; Blackshaw, 1996; Melson, Schwarz and Beck, 1997). Consequently, Pet Facilitated Therapy has been promoted with the use of animals in various clinical, therapeutic and remedial contexts to help institutionalised people with a range of physical and psychological problems (Corson, Corson and Gwynne, 1975; Ryder, 1973; Kidd and Kidd, 1980; Beck, 1985; Council for Science and Society, 1988; Edney, 1992; Beck and Meyers, 1996). Although this concept is not new and the recreational value of such programmes is incontestable, the therapeutic use of animals requires further evaluation using critical research methodologies (Beck and Katcher, 1984; Beck, 1985). In addition, the underlying mechanisms that mediate the relationship between pet ownership, physical health and emotional well-being are poorly understood, and this could be the focus of future studies (Lane, McNicholas and Collis, 1998).

1.2.2 Dog and cat populations

Interest in animal populations results both from their relationship with humans and also from the need for pet population regulation and control (Heussner *et al.*, 1978). Concern over the welfare of unwanted, abandoned dogs and cats and awareness of potential pet associated problems such as dog bites, zoonoses, pollution and other animal nuisances, have increased this need (Anvik, Hague and Rahaman, 1974; Carding, 1975; Franti *et al.*, 1980; Nassar, Mosier and Williams, 1984; Leslie *et al.*, 1994). Knowledge of the size, structure and dynamics of the pet population is required to quantify the extent of any overpopulation problem and devise programmes to regulate further population growth (Nassar and Fluke, 1991; Nassar and Mosier, 1991; Patronek and Glickman, 1994). Likewise, an accurate estimate of the pet population is essential for quantification of the rates of disease in dogs and cats in population based epidemiological studies (Lengerich *et al.*, 1992; Teclaw, Mendlein, Garbe and Mariolis, 1992). Pet population studies could also provide information to estimate the demand for veterinary services

and other pet related industries (Dorn, 1970; Miller, Spangler and Dorn, 1987; Wise, 1987; Bonnet *et al.*, 1997; McCrindle, Cornelius and Schoeman, 1997; Wallrab, 1998).

Despite these considerations, reliable estimates of the canine and feline populations are not readily available, and companion animal demographic data are lacking for most countries (Carding, 1969; Dorn, 1970; Godwin, 1975; Schneider and Vaida, 1975; Griffiths and Brenner, 1977; Anderson, 1983; Rowan, 1986; Nassar and Mosier, 1991; Rowan, 1991; Murray, 1992a). Although a number of surveys are conducted for market purposes, results are invariably unpublished (Rowan, 1991). The majority of published pet ownership rates* and absolute dog and cat numbers have arisen from surveys conducted in North America, with occasional reports from the UK and other countries (Schnurrenberger *et al.*, 1961; Mills and Nielsen, 1967; Jordan, 1973; Anvik, Hague and Rahaman, 1974; Franti and Kraus, 1974; Beck, 1975; Carding, 1975; Fennell, 1975; Godwin, 1975; Mann, 1975; Schneider and Vaida, 1975; Griffiths and Brenner, 1977; Heussner, Flowers, Williams and Silvy, 1978; Heussner and Grant, 1978; Rhoades and Selby, 1979; Franti *et al.*, 1980; Charles, Charles Research Groups, 1983; Wise, 1984a; Wise, 1984b; Miller, Spangler and Dorn, 1987; Wise, 1987; Council for Science and Society, 1988; Troutman, 1988a; Troutman, 1988b; Troutman, 1988c; Troutman, 1988d; Troutman, 1988e; Thrusfield, 1989; Robertson *et al.*, 1990; Lengerich *et al.*, 1992; Manning and Rowan, 1992; Murray, 1992a; Rowan, 1992b; Teclaw *et al.*, 1992; Wise and Yang, 1992; Leslie *et al.*, 1994; Wise and Yang, 1994; Beck and Meyers, 1996; Dumont, 1996; Luke, 1996; Gehrke, 1997; Patronek, Beck and Glickman, 1997).

1.2.3 Pet population dynamics

Populations of dogs and cats are subject to changing structure due to variations in natality and mortality (Thrusfield, 1989). Studying the structure and dynamics of this population and its interaction with human demographic factors is also important and the use of statistical models developed specifically for this purpose has been reported (Heussner and Grant, 1978; Nassar and Mosier, 1980; Nassar and Mosier, 1982; Nassar, Mosier and Williams, 1984; Nassar and Mosier, 1986a; Nassar and Mosier, 1991; Patronek and Glickman, 1994; Patronek and Rowan, 1995). A community pet population

* The term rate(s) is used throughout this thesis to represent a 'prevalence' i.e. pet ownership rates, neutering rates, response rates. This is in order to avoid confusion, as such terminology is commonly used by other researchers who are referred to within this thesis.

structure is composed of owned, stray, feral and animal welfare centre animals. When neuter status is considered the population consists of eight subpopulations which constantly interact (Nassar and Fluke, 1991). Over time, each subpopulation may increase, decrease or remain unchanged in size. Previous researchers from the USA have indicated that dog and cat populations are in constant flux; within a one year period, 14 to 25% of owned pets are removed from their home and only one third remain in their original home for the duration of their lives (Schneider, 1975; Arkow, 1987; Rowan and Williams, 1987; Beaver, 1991; Murray, 1992b; Rowan, 1992b; Patronek and Glickman, 1994; Luke, 1996; Patronek, Beck and Glickman, 1997). This turnover in the owned subpopulation includes births, natural death and euthanasia, exchange of animals between owners and sale. Migration of pets into or out of a community owing to human movement and acquisition of pets from outside a community also contributes to this turnover (Nassar and Mosier, 1986b; Patronek and Glickman, 1994).

1.2.4 Neutering status and reproduction in the pet population.

High fertility in the canine and feline populations is widely accepted (Faulkner, 1973; Thrusfield, 1989; Mahlow and Slater, 1996). For effective pet population control, one must regulate this by neutering, especially if pets are allowed to roam and breed freely (Nassar and Mosier, 1980). Between 6 to 88% of the canine and feline populations in developed countries have been reported as neutered, with higher neutering rates reported in more recent years (Godwin, 1975; Schneider, 1975; Schneider and Vaida, 1975; Griffiths and Brenner, 1977; Heussner *et al.*, 1978; Rhoades and Selby, 1979; Franti *et al.*, 1980; Nassar and Mosier, 1980; Nassar, Mosier and Williams, 1984; Edney and Smith, 1986; Robertson *et al.*, 1990; Rowan, 1991; Manning and Rowan, 1992; Murray, 1992a; Rowan, 1992b; Teclaw *et al.*, 1992; Blackshaw and Day, 1994; Leslie *et al.*, 1994; Luke, 1996; Patronek, Beck and Glickman, 1997). Most authors report separate figures for male and female dogs, with estimates that females are neutered at twice the rate of males (Franti and Kraus, 1974; Schneider and Vaida, 1975; Heussner *et al.*, 1978; Rhoades and Selby, 1979; Franti *et al.*, 1980; Manning and Rowan, 1992; Patronek and Glickman, 1994). Such a difference has not been found in the feline population.

When investigating the dynamics of the dog population by considering reproduction rates, it is sufficient to study only the female population that is of reproductive age i.e.

ignore females that are prepubertal or greater than five to six years, as reproduction in the pet dog population is negligible after this age (Nassar and Mosier, 1980; Nassar, Mosier and Williams, 1984). Estimates of the female dog population that reproduce have been reported by several authors (Nassar and Mosier, 1980; Nassar, Mosier and Williams, 1984; Nassar and Mosier, 1986b; Robertson *et al.*, 1990, Manning and Rowan, 1992; Leslie *et al.*, 1994; Patronek and Glickman, 1994; Patronek, Beck and Glickman, 1997). In each case, reproducing dogs represent less than one fifth of the total reproduction pool. The figures are higher for cats, which may reflect the greater control dog owners have over their pets (Robertson *et al.*, 1990).

1.2.5 Human demographic factors and pet ownership

Research has shown a relationship between dog and cat ownership and household demographic factors, with results being consistent across many industrialised nations (Marx and Furcolow, 1969; Dorn, 1970; Franti and Kraus, 1974; Godwin, 1975; Griffiths and Brenner, 1977; Heussner *et al.*, 1978; Franti *et al.*, 1980; Selby *et al.*, 1980; Anderson, 1983; Wise, 1984a; Wise, 1984b; Wise and Kushman, 1984a; Wise, 1987; Troutman, 1988b; Troutman, 1988c; Troutman, 1988d; Troutman, 1988e; Nassar and Mosier, 1991; Teclaw *et al.*, 1992; Wise and Yang, 1992; Leslie *et al.*, 1994; Melson, Schwarz and Beck, 1997). Factors such as employment, age of household head, educational level, household income, family size, number and age of children, type of home, home ownership status and community setting, viz. urban, suburban, rural, all have an impact on pet ownership (Rowan and Williams, 1987). Variables found to be particularly important determinants of pet ownership included family structure, presence of school aged children, type of home, home ownership compared with rental and community setting. Clearly, many of these variables are inter-dependent.

Family structure has been shown to be an important variable influencing the probability of pet ownership and particularly, dog ownership, with the highest rates of ownership found in multimember households (Schnurrenberger *et al.*, 1961; Franti and Kraus, 1974; Godwin, 1975; Franti *et al.*, 1980; Wise, 1984a; Wise, 1984b; Wise and Kushman, 1984a; Troutman, 1988b; Troutman, 1988c; Nassar and Mosier, 1991; Teclaw *et al.*, 1992; Wise and Yang, 1992). More specifically, the presence of children is reported to be the most significant factor that increases pet ownership (Dorn, 1970;

Franti and Kraus, 1974; Godwin, 1975; Griffiths and Brenner, 1977; Heussner *et al.*, 1978; Franti *et al.*, 1980; Selby *et al.*, 1980; Beck, 1984; Wise, 1984a; Wise, 1984b; Wise and Kushman, 1984a; Wise, 1987; Troutman, 1988b; Troutman, 1988c; Troutman, 1988d; Troutman, 1988e; Rowan, 1992b; Teclaw *et al.*, 1992; Wise and Yang, 1992; Leslie *et al.*, 1994; Beck and Meyers, 1996; Paul and Serpell, 1996; Melson, Schwarz and Beck, 1997). The child's age must also be considered, with ownership being highest when children between five and 15 years of age are present (Dorn, 1970; Godwin, 1975; Wise and Kushman, 1984a; Wise, 1987; Teclaw *et al.*, 1992; Leslie *et al.*, 1994; Melson, Schwarz and Beck, 1997).

Home ownership status has been found to have considerable effect on the probability of owning a dog, with dramatically higher ownership rates amongst home owners compared to renters (Griffiths and Brenner, 1977; Wise and Kushman, 1984a; Troutman, 1988b; Troutman, 1988c; Nassar and Mosier, 1991; Wise and Yang, 1992; PFMA, 1999). Although important, this variable appears to have less effect on the probability of cat ownership (Wise and Kushman, 1984a). Lower prevalences of pet ownership in rented accommodation may partly reflect prohibition of pets by property owners. However, accurate estimates of the frequency of people foregoing pet ownership due to housing restrictions are unknown (Hart and Kidd, 1994). Considering type of home, pet owners are reported to be significantly more likely to live in larger single family dwellings as opposed to a building encompassing multiple flats (Dorn, 1970; Franti and Kraus, 1974; Franti *et al.*, 1980; Anderson, 1983; Wise and Kushman, 1984a; Netting, Wilson and Fruge, 1988; Nassar and Mosier, 1991; Teclaw *et al.*, 1992; Melson, Schwarz and Beck, 1997). With respect to community setting, Leslie *et al.* (1994) reported a significant difference in ownership rate between urban (45%) and rural (81%) areas in Canada. Such higher pet ownership rates in communities with smaller population densities has been reported previously (Marx and Furcolow, 1969; Franti and Kraus, 1974; Griffiths and Brenner, 1977; Wise and Kushman, 1984a; Troutman, 1988b; Troutman, 1988c; Troutman, 1988d; Brooks, 1990; Melson, Schwarz and Beck, 1997).

The influence of social class in predicting pet ownership has been variably reported. Some researchers have found that dog ownership is more likely in households with higher incomes (Dorn, 1970; Franti and Kraus, 1974; Beck, 1975; Beck, 1980; Franti *et al.*, 1980; Wise, 1984a; Troutman, 1988b; Teclaw *et al.*, 1992; Wise and Yang, 1992).

Similarly, cat ownership is higher in the upper class, or at least cats have been reported to be the most popular pet in this class (Dorn, 1970; Franti and Kraus, 1974; Godwin, 1975; Anderson, 1983; Wise, 1984b; Troutman, 1988c; Robertson *et al.*, 1990; Teclaw *et al.*, 1992). However, many have found this variable to be less influential than other demographic factors, with similar ownership rates in all social classes (Anderson, 1983; Godwin, 1975; Wise and Kushman, 1984a; Robertson *et al.*, 1990; Leslie *et al.*, 1994).

Besides these observable human demographic factors, human attitudes and individual preferences will affect pet ownership rates (Kidd and Kidd, 1980; Selby *et al.*, 1980; Selby and Rhoades, 1981; Kidd and Kidd, 1989; Leslie *et al.*, 1994). In particular, childhood pet ownership has important effects, with early relationships with companion animals increasing one's desire to own pets in adulthood (Kidd and Kidd, 1980; Council for Science and Society, 1988; Netting, Wilson and Fruge, 1988; Kidd and Kidd, 1989; Paul and Serpell, 1993). Health status has also been reported to influence the propensity for pet ownership, especially among the elderly (Netting, Wilson and Fruge, 1988). Overall, these variable human factors induce considerable differences in pet populations from place to place (Anderson, 1983). Moreover, as certain household characteristics are important determinants of pet ownership, the use of statistical models which relate the probability of pet ownership to household predictor variables have been reported (Wise, 1987; Nassar and Mosier, 1991; Wise and Yang, 1994). These models are then used to estimate the future number of dogs and cats, using projected human census data.

1.2.6 Community pet populations

Results from different surveys of pet populations are often inconsistent, with significant variations identified in ownership patterns (Marx and Furcolow, 1969; Dorn, 1970; Schneider and Vaida, 1975; Anderson, 1983; Nassar and Mosier, 1986a; Rowan and Williams, 1987; Rowan, 1991; Rowan, 1992b Patronek and Rowan, 1995). Researchers frequently use any available pet population studies to estimate dog and cat populations in their own community (Rowan, 1991). Study results may be stated as the proportion of households that own pets, the number of pets per household, or the ratio of pets to humans. Local communities then estimate their own figures from raw data on the human population in the area. However, due to significant temporal and regional variations in pet ownership patterns, it may be inappropriate to extrapolate pet population estimates

from one geographical region or from one period to another (Lengerich *et al.*, 1992; Teclaw *et al.*, 1992; Patronek and Glickman, 1994). Consequently, it is important that the dog and cat population size, structure and dynamics in any given area is determined by a comprehensive local survey (Robertson *et al.*, 1990; Lengerich *et al.*, 1992).

1.3 PET OVERPOPULATION

1.3.1 Animal abuse and the humane movement

Since its inception, the humane movement has been concerned with propagating society's moral obligation to prevent cruelty to creatures (Arkow, 1985). The origin of the movement was in England in 1824 when Richard Martin, an Irish lawyer, founded an animal protection group that came to be known as the Royal Society for the Prevention of Cruelty to Animals (Carter, 1989). Since then, the movement has continued to grow such that today, concern for animals is regarded as a major social issue throughout the western world (Rollin, 1991; Arkow, 1998). This status has encouraged the formation of an array of independent groups charged with investigating perceived animal abuse and scrutinising the treatment of animals by humans (Arkow, 1985)

The treatment of some companion animals constitutes a major area of animal abuse (Rollin, 1991; Kahler, 1993a). There is an obvious and regrettable surplus of healthy but unwanted animals, that is managed by killing of the excess (Carding, 1975; Carter, 1990). In addition, there are unknown numbers abandoned and left to fend for themselves at risk of exposure, illness or injury, and animals that are routinely ill-treated, abused or severely neglected (Faulkner, 1973; Higgins and Pineda, 1980; Olson, 1990; Caras, 1993; Sturla, 1993; Howe, 1997). In one study concerning animal cruelty, 74% of cases involved companion animals (Watt and Waran, 1996). However, this abuse and mass euthanasia has not been the focus of major criticism or reform and continues with minimum objection from the public at large (Carding, 1969; Avanzino, 1991). For years, it has been accepted that painless death for millions of unwanted pets is preferable to permitting both the animal suffering and human dangers inherent in free-living neglected animals (Carding, 1969). However, a growing number of people are hesitating to define the destruction of homeless animals as 'euthanasia' and are questioning its acceptability (Arkow, 1985; Endenburg and Vorstenbosch, 1992). 'Euthanasia' is defined as 'the bringing about of a gentle and kind death in the case of

incurable and painful disease' (Concise Oxford Dictionary, 1990) which is not consistent with taking the lives of healthy young pets (Sturla, 1993). Contemporary society has become less tolerant of this perceived animal cruelty, leading to pressure to resolve the problem of unwanted animals and pet overpopulation (Murray, 1992c; Rowan, 1992a).

1.3.2 Impact on society and public health implications

Besides the distress and suffering to the surplus companion animals, the public health, public nuisance and economic implications of a large surplus animal population are considerable, particularly when these animals are allowed to roam (Carding, 1969; Mann, 1975; Carter, 1990; Beaver, 1991; Slater, 1999). Unfortunately, roaming dogs in all communities are common place (Carding, 1975; Young, 1975; Heussner *et al.*, 1978; Rhoades and Selby, 1979; Wong and Lee, 1985; Murray, 1992b; Margawani and Robertson, 1995). In 1969, Carding reported that a stray dog population of considerable numbers was present in the UK. The stray animal problem can be even more devastating in developing countries where animal control programmes are lacking and most dogs are rarely confined (Rangel, Lara and de Aluja, 1981; Brooks, 1990; Carter, 1990).

Despite the general impression that these free-roaming animals are feral, the majority of roaming dogs show evidence of being owned (Anonymous, 1971; Olson *et al.*, 1986a; Arkow, 1991; Beaver, 1991; Anderson, 1992; Patronek and Rowan, 1995). Feral dogs are virtually unknown in the UK (Carding, 1969). Likewise, reports from the USA indicate that the feral dog population is very small (Patronek and Rowan, 1995). In contrast, colonies of feral cats are common in urban environments. Data from the USA indicate that the stray and feral cat population is similar in size to the owned population (Natoli, 1994; Anonymous, 1995; Patronek and Rowan, 1995; Luke, 1996; Mahlow and Slater, 1996; Patronek, 1998). Researchers have examined feral cat colonies in the UK and estimated that the feral cat population represented just under 20% of the total feline population in 1982 (Dard, 1978; UFAW, 1982; Neville, 1983; Neville and Remfry, 1984; Neville 1989; Passanisi and MacDonald, 1990; Page *et al.*, 1993; Remfry, 1996).

Truly feral animals which avoid human contact arise originally and continually from the domestic pet population after reverting to a wild state. Once feral, only the most resourceful survive for long periods, litter mortality exceeds natality and the population is unable to sustain itself without external recruitment (Carding, 1969; Fox, Beck and

Blackman, 1974; Beck, 1979; Neville, 1989; Mahlow and Slater, 1996; Remfry, 1996; Patronek, 1998). Differentiating between free-roaming owned cats and unowned strays is difficult. Individual cats can change from owned to unowned and confined to free-roaming during short periods, with arbitrary distinctions between these subpopulations (Mahlow and Slater, 1996; Patronek, 1998; Slater, 1999). In the UK, a stray dog is defined by the Dog Act of 1906 as a dog impounded by the police as a result of being found straying (Young, 1975). Carding (1969) defined a stray as 'one whose freedom is not restricted by an owner', encompassing so called 'latch key' dogs whose delinquent owners intentionally allow unrestricted freedom, owned dogs that have escaped and are lost and abandoned dogs not allowed to return home. In combination with the expanding urban influence in society, these strays jeopardise the health, welfare and safety of people and animals living in a congested environment (Carding, 1969; Arkow, 1991).

Although communicable zoonotic diseases are inevitable consequences of the close association between humans and animals, any stray or feral animal is an additional reservoir of zoonoses (Carding, 1969; Anonymous, 1971; Beck, 1975; Carding, 1975; Faulkner, 1975; Beck, 1979; Arkow, 1987; Carter, 1990; Glickman, 1992; Patronek, 1998; Hoff, Brawley and Johnson, 1999). Rabies, which has not been endemic in the UK since 1922, is the most greatly feared zoonotic infection and accounts for much of the impetus to control strays (Council for Science and Society, 1988). The incidence of bites from stray and uncontrolled dogs and feral cats is significant, resulting in medical costs and considerable suffering for the victims (Carding, 1969; Anonymous, 1971; Faulkner, 1973; Beck, 1975; Carding, 1975; Faulkner, 1975; Heussner and Grant, 1978; Beck, 1979; Beck, 1980; Rangel, Lara and de Aluja, 1981; Olson *et al.*, 1986a; Council for Science and Society, 1988; Szpakowski, Bonnett and Martin, 1989; Carter, 1990; Beaver, 1991; Anderson, 1992; Podberscek, 1994; Cornwell, 1997; Lockwood, 1997; Patronek, 1998; Hoff, Brawley and Johnson, 1999). Unrestricted animals are responsible for road traffic accidents, noise complaints, overturning litter, damaging property, environmental pollution, livestock and wildlife harassment and generally disturbing the peace (Carding, 1969; Anonymous, 1971; Faulkner, 1973; Beck, 1975; Carding, 1975; Faulkner, 1975; Mann, 1975; Senn and Lewin, 1975; Feldman, 1977; Heussner *et al.*, 1978; Heussner and Grant, 1978; Beck, 1979; Rhoades and Selby, 1979; Beck, 1980; Higgins and Pineda, 1980; Rangel, Lara and de Aluja, 1981; Council for Science and

Society, 1988; Moulton *et al.*, 1991; Thornton, 1991; Anderson, 1992; Murray, 1992c; Sturla, 1993; Margawani and Robertson, 1995; Dumont, 1996; Slater, 1999).

Economic concerns include the heavy commitment of resources to control the problem, the financial burden of which is borne by non-government organisations and the total costs of which have never been estimated (Carding, 1969). Injured strays also cause an economic dilemma with regards to who is responsible for bearing the cost incurred in their treatment (Wells, 1976). In 1974, Alan Beck described how 'dogs changed from being man's best friend to a source of social, political and medical concern'. Fortunately, it is possible to minimise many of these dangers and nuisances by responsible human behaviour (McKenzie, 1977; Edney, 1992; Beck and Meyers, 1996; Hoff, Brawley and Johnson, 1999).

1.3.3 Animal control and animal welfare societies

The problem of surplus animals is by no means new (Arkow, 1985). Battersea Dog's Home, the first humane shelter for the care of stray dogs, was established in 1860 and by 1880 was caring for nearly 19,000 dogs annually (Vonesch, 1975). The need for dog control was first recognised in the UK with the Licensing of Dogs Act 1878 (Carding, 1975). In earlier years, control of the surplus animal population was established in the form of 'dog pounds' with stereotypical 'dog catchers'. Unfortunately, priorities were not directed at the welfare of animals and brutal methods were used to capture and deal with these roaming dogs (Arkow, 1991). After the second world war, these inhumane methods became apparent and the destruction of unwanted animals aroused public concern (Jöchle, 1991). At this time, animal welfare societies began to take over animal control, contracting their services to local government (Arkow, 1991) Private AWCs were also established to receive lost and unwanted animals (Moulton *et al.*, 1991).

In the 1970s, the dramatic increase in stray and unwanted animals inundating AWCs, together with mounting euthanasia rates, gained widespread attention (Beck, 1975; Carding, 1975; Beck, 1980; Arkow, 1991; Digiacomo, Arluke and Patronek, 1998). As a result, many animal control programmes were reorganised and expanded between 1970 and 1980. A new programme was launched in North America, referred to as LES - legislation, education and sterilisation - and evolved as the cornerstone of the campaign against overpopulation worldwide (Rowan and Williams, 1987). At this time, AWCs

were inundated with litters of unwanted puppies and kittens (Digiacomo, Arluke and Patronek, 1998). Consequently, although all three areas of LES were promoted, emphasis was on pet reproduction and new ways were sought to encourage neutering.

During the 1980s, concern over high euthanasia rates and the fact that animal welfare societies were reluctant to continue the 'catch and euthanatise' technique, government resumed involvement in animal control (MacKay, 1993). The term 'animal control' refers to the regulation of companion animals to protect health, ensure safety and abate nuisance, and continues to operate under government authority (Arkow, 1987). In contrast, animal welfare societies are non-profit organisations run by those interested in the welfare of animals (Anderson, 1992). Any individual or group can form a society to protect animals, and these societies seldom experience external regulations from national associations (Arkow, 1987; Patronek, 1993). A large number of independent animal welfare groups operate in communities worldwide (Anderson, 1992). Animal welfare societies in the UK include the RSPCA, the SSPCA, the Blue Cross, the National Canine Defence League, the Cats Protection League, the PDSA, the Wood Green Animal Shelters, Battersea Dogs Home, the Animal Health Trust, the International League for the Protection of Horses and the Donkey Sanctuary.

Animal control and animal welfare societies work together against the problem of unwanted and abandoned animals (Arkow, 1991). They are often based in AWCs which represent the main response to pet overpopulation (Moulton *et al.*, 1991). A wide range exists in the size of AWCs, each operating independently in response to the interest, needs and demands of a local community (Rowan, 1991; Patronek, 1993; Luke, 1996). In the UK, the Dog Act of 1906 gave responsibility for the capture, custody and disposal of stray dogs to the police, who discharge their duties on behalf of the home office. Stray cats and other companion animals are not covered by the law (Young, 1975) and the public demand for feline population control has been less rigorous than that for canine control (Mahlow and Slater, 1996). Animal welfare groups are subcontracted to accommodate, rehome or destroy unwanted pets (Carding, 1969). Government activity in the UK is almost insignificant since a satisfactory service is provided by animal welfare groups (Carding, 1969; Young, 1975). Many AWCs exist throughout the country, provided and run by animal welfare societies, private individuals and trusts. The provisions and running of these homes rely entirely on voluntary donations.

1.3.4 Neutering

The prevention of unnecessary breeding was hailed as the best solution to pet overpopulation and methods designed to solve the problem were based on neutering of dogs and cats (Carding, 1969, Woodrow, 1975; Arkow, 1991; Digiacomo, Arluke and Patronek, 1998). Due to early sexual maturity, short gestation periods and multiple offspring per litter, if pets were not supervised and reproduced freely, their populations could escalate to epidemic proportions (Carding, 1975; Olson *et al.*, 1986a; Anderson, 1992; MacKay, 1993). Pregnancy intervention and prevention are necessary for control.

1.3.4.1 Surgical neutering

Researchers have been studying oestrus prevention and termination of pregnancy in dogs and cats for many years (Weissinger and McRae, 1991). However, the options available remain limited. Surgical neutering is the obvious approach when permanent sterility is desired. Ovariohysterectomy and orchidectomy are the recommended techniques and are accepted throughout the world as the most reliable means of pet population control (Concannon and Meyers-Wallen, 1991; Stubbs, Salmeri and Bloomberg, 1996). The RSPCA, RCVS, BVA and BSAVA unanimously advocate surgical neutering of pets not intended for breeding (Council for Science and Society, 1988). Benefits of the surgery on population control and individual animal health should be weighed against surgical/anaesthetic risks and any undesirable side effects encountered (Johnston, 1991).

The obvious advantage of surgical neutering is that irreversible infertility is attained immediately, precluding any unwanted offspring (Carter, 1990; Sturla, 1993). Prevention or minimisation of disease of the reproductive organs and associated glands and diseases mediated by gonadal hormones benefits the neutered pet (Cooper, 1984; Sanders, 1984; Evans, 1988; Concannon and Meyers-Wallen, 1991; Johnston, 1991; Anderson, 1992; Murray, 1992a; Nagakura and Clark, 1992; Bloomberg, 1996). Disorders of pregnancy and parturition are also avoided. Speying eliminates oestrus behaviour, attraction of male dogs and other related behavioural problems (Woodrow, 1975; Rowan and Williams, 1987). Castration attenuates many male behaviours including urine marking, mounting, aggression and roaming and is often used as a form of treatment for these objectionable behaviours (Olson *et al.*, 1986a; Hart, 1991; Anderson, 1992; Alexander

and Shane, 1994; Root, Johnston and Olson, 1997). Neutered dogs have also been reported to be one third as likely to bite as unneutered animals (Cornwell, 1997).

One disadvantage of surgical neutering is the expense and labour requirement involved (Rowan and Williams, 1987). Potential peri-operative complications also exist, the incidences of which vary with the experience of the surgeon and the pre-operative patient risk factors (Olson *et al.*, 1986a; Concannon and Meyers-Wallen, 1991; Johnston, 1991; Bloomberg, 1996). Despite these, neutering is a routine procedure with low morbidity and mortality in healthy animals. Unfortunately, several undesirable side effects have been reported. Most frequently encountered is urethral sphincter mechanism incontinence, the most common cause of urinary incontinence in bitches and this has been reported also in male dogs (Thrusfield, 1985; Lieberman, 1987; Evans, 1988; Johnston, 1991; Salmeri, Olson and Bloomberg, 1991; Romatowski, 1993; Atalan, Holt and Barr, 1997; Power *et al.*, 1998; Thrusfield, Holt and Muirhead, 1998). Other possible side effects include weight gain, inactivity, feline urological syndrome, endocrine alopecia, perivulval dermatitis and atrophic vaginitis (Herron, 1972; Jackson, 1984a; Edney and Smith, 1986; Evans, 1988; Jagoe and Serpell, 1988; Concannon and Meyers-Wallen, 1991; Johnston, 1991; Salmeri, Olson and Bloomberg, 1991; Salmeri, Bloomberg, Scruggs and Shille, 1991a; Romatowski, 1993).

Surgical neutering programs have also been employed on free-roaming cat populations. Trapping, neutering and return to site is considered to be the method of choice to control pre-existing feral cat colonies, replacing alternatives methods such as trapping and elimination or oral contraceptives (Remfry, 1978; McDonald, 1980a; McDonald, 1980b; RCVS, 1980; Cuffe *et al.*, 1983; Neville and Remfry, 1984; Neville, 1989; Smith and Shane, 1988; Zaunbrecher and Smith, 1993; Natoli, 1994; Mahlow and Slater, 1996; Remfry, 1996; Goeree, 1998; Patronek, 1998; Hughes and Slater, 1999). Although the method has gained official approval from the RSPCA, the use of what is known in the USA as TTVAR (trap-test-vaccinate-alter-release) remains a highly controversial issue (Mahlow and Slater, 1996). Concerns relate to the welfare of cats, use of limited resources to vaccinate and neuter unowned cats, the ecological disturbances on wildlife due to predation and disease introduction and concerns about zoonoses and sanitation (Mahlow and Slater, 1996; Patronek, 1998; Hughes and Slater, 1999; Slater, 1999).

1.3.4.2 Subsidised neutering schemes

For any contraceptive to be effective in controlling the pet population, the method must be readily used by all non-breeding pet owners and used prior to the birth of any litters (Olson and Johnston, 1993). However, many owners are reluctant to consider surgical neutering for their animals before reaching sexual maturity (Stockner, 1991; Murray, 1992a). Although an increase in the frequency of neutering began in the 1970s, over the proceeding years, data indicated that there was still a reasonable proportion of society that was not neutering its animals (Nassar and Mosier, 1980; Moulton *et al.*, 1991). Moreover, the issue of pet overpopulation was not resolving. Consequently, lack of neutering was viewed as the main contributor to the problem and methods to encourage surgery were sought. At that time, animal welfare associations deduced that pets were not being neutered as a result of the surgical fee charged by veterinary surgeons (Feldman and Carding, 1973; Samuelson, 1973; Staff Report, 1973a; Kahler, 1993a; MacKay, 1993). Consequently, many low cost neuter clinics were established by animal welfare societies during the 1970s and 1980s (Anonymous, 1971; Staff Report, 1973a; Staff Report, 1973b; Beck, 1975; Faulkner, 1975; Moulton *et al.*, 1991). Veterinary surgeons were often opposed to such schemes as they were considered to compete unfairly with private veterinary practice, due to the cost advantage of tax exemption (Anonymous, 1971; Samuelson, 1973; Staff Report, 1973a; Olson *et al.*, 1991; Robinson, 1991; Anderson, 1992). Subsidised neutering then became a focus of debate and arguments between veterinary and animals welfare associations were unresolved (Faulkner, 1973; Feldman and Carding, 1973; Staff Report, 1973a; Staff Report, 1973b; Beck, 1975; Arkow, 1987; Rowan and Williams, 1987; MacKay, 1993; Arkow, 1998).

Subsidised neuter schemes were introduced with the expectation that they would cause a significant increase in the proportion of the pet population that was neutered (Carding, 1969; Heussner and Grant, 1978; Murray, 1992a; Murray, 1992b). These schemes manifest in the form of 'neuter clinics' which are established, maintained and operated at public expense. Private veterinary surgeons are obliged under the schemes, to reduce the cost of neutering procedures for eligible animals. Alternatively, vouchers are used to facilitate payment, the voucher representing money contributed by someone other than the owner. People that qualify for subsidised neutering include all owners of newly

adopted pets from AWCs, regardless of their financial resources, and certain pet owners deemed to be financially needy (Woodrow, 1975; Staff Report, 1973b; Murray, 1992a).

The efficacy of low cost neutering programmes in causing a significant reduction of breeding in the total pet population has been questioned. This is due to reports that only a small percentage of the pet population comes from AWCs (Staff Report, 1973a; Staff Report, 1973b; Nassar, Mosier and Williams, 1984; Rowan and Williams, 1987; Murray, 1992a). Further pessimism stems from the believe that while some owners may be reluctant to pay for the procedure due to genuine financial hardship, these schemes mainly attract those who can afford standard surgical fees (Staff Report, 1973a; Rowan and Williams, 1987; Murray, 1992a). This opinion is supported by reports that only a small percentage of owners are in the lower income brackets (Schneider, 1975; Murray, 1984; Arkow, 1985; Rowan and Williams, 1987; Beaver, 1991; Wise and Yang, 1992). There is also concern that subsidised neutering may downgrade the concept of 'owner onus' and personal obligation and tend to undermine the corner stone of responsible pet ownership (Koltveit, 1973; Murray, 1984; Murray, 1992a). Unfortunately, debate over the efficacy of these schemes still continues (Patronek and Glickman, 1994).

1.3.4.3 Non-surgical neutering

Although cost has been promoted as the reason for many owners failing to neuter their pets, this theory has not been supported by any survey (Rowan and Williams, 1987; Manning and Rowan, 1992; Murray, 1992a; MacKay, 1993; Patronek and Glickman, 1994). Instead factors reported to be more important include procrastination, pet health concerns and owners who hold religious, philosophical or psychological beliefs that favour sexually intact pets over neutered ones (Samuelson, 1973; Rhoades and Selby, 1979; Avanzino, 1991; Olson and Johnston, 1993; Blackshaw and Day, 1994; Patronek, Beck and Glickman, 1997). Consequently, many researchers have advocated the development of non-surgical methods of preventing and terminating pregnancy as a means of pet population control, with a strong impetus to develop contraceptive 'pills' for pets (Samuelson, 1973; Staff Report, 1973b; Higgins and Pineda, 1980; Jöchle, 1991). Pharmacological approaches to non-surgical neutering that have been investigated include use of the natural steroid hormones, synthetic steroid analogues, hormone implants, intrauterine or intravaginal devices, immunocontraception and

permanent chemical sterilisation including the use of tissue specific cytotoxins (Koltveit, 1973; Higgins and Pineda, 1980; Jöchle, 1980; Olson *et al.*, 1986a; Olson *et al.*, 1986b; Olson *et al.*, 1989; Concannon and Meyers-Wallen, 1991; Jöchle, 1991; Anderson, 1992; Olson and Johnston, 1993; Bloomberg, 1996). The most widely developed and used are the synthetic progesterone analogues (Jöchle, 1980; Jackson, 1984a; Jöchle, 1991). Other methods have been mainly experimental in nature and research continues to assess these fully (Carter, 1990; Concannon and Meyers-Wallen, 1991; Olson and Johnston, 1993). Unfortunately, numerous adverse effects have been reported in association with all of the above, making these products unpopular with veterinary surgeons (Olson *et al.*, 1986b; Olson *et al.*, 1989; Carter, 1990; Concannon and Meyers-Wallen, 1991; Jöchle, 1991; Anderson, 1992; Olson and Johnston, 1993).

Together with the development of chemical neutering, reliable abortifacients have also been in demand (Olson *et al.*, 1986c; Olson and Johnston, 1993). Historically, the termination of canine and feline pregnancies has been fraught with difficulties (Onclin and Verstegen, 1999). Traditional methods include ovariohysterectomy or surgical removal of the foetus during pregnancy and post-coital oestrogen administration (Jöchle, 1980; Olson *et al.*, 1986c; Concannon and Meyers-Wallen, 1991; Anderson, 1992; Olson *et al.*, 1992). Prostaglandins ($PGF_{2\alpha}$ and its analogues) have also been efficacious when used for misalliance treatment or termination of pregnancy in dogs and cats (Concannon and Meyers-Wallen, 1991; Jöchle, 1991; Anderson, 1992; Onclin and Verstegen, 1999). Severe side effects and toxicity have been reported after use of the above drugs such that they cannot be recommended (Copestake, 1986; Olson *et al.*, 1986c; Concannon and Meyers-Wallen, 1991; Olson *et al.*, 1992; Olson and Johnston,1993; Onclin and Verstegen, 1999). Other methods of chemical termination of pregnancy in companion animals are limited to experimental protocols including anti-oestrogens, prostagens and androgens, gonadotrophin releasing hormone antagonists and superagonists, competitive inhibitors of progesterone synthesis, glucocorticosteroids selective embryotoxic agents and immuno-therapy (Jöchle, 1980; Olson *et al.*, 1986d; Concannon and Meyers-Wallen, 1991; Jöchle, 1991; Olson *et al.*, 1992; Olson and Johnston, 1993). The most recent advance has involved the use of dopamine agonists which act as anti-prolactin drugs (Jöchle, 1991; Olson *et al.*, 1992; Olson and Johnston, 1993; Onclin and Verstegen, 1999). Cabergoline is the latest drug developed exclusively

for use in dogs and cats. It is safe and effective if used either alone or in combination with a low dose, synthetic $PGF_{2\alpha}$ analogue (Jöchle, 1991; Onclin and Verstegen, 1999).

1.3.4.4 Early-age neutering

The conventional age for surgical neutering in companion animals is six months or older and in bitches, it is often recommended to delay surgery until after the first season (Lieberman, 1988b; Salmeri *et al.*, 1991). However, objective information to support this 'optimal' age is lacking within the scientific literature (Kluth, 1984; Gourley, 1987; Olson *et al.*, 1986a; Lieberman, 1987; Lieberman, 1988a; Aronsohn and Faggella, 1993a; Romatowski, 1993; Stubbs, and Bloomberg, 1995; Stubbs *et al.*, 1996; Stubbs, Salmeri and Bloomberg, 1996). Neutering at this age poses a problem for AWCs. Large numbers of unaltered puppies and kittens are adopted and become potential sources of additional unwanted litters (Lieberman, 1988a). This has led to the mandatory neuter policy practiced in most AWCs. Either people adopting animals are held to a contract requiring that the newly acquired pet is neutered at an older age or the animals are neutered before they leave (Woodrow, 1975; Council for Science and Society, 1988; Carter, 1990; Anderson, 1992; Phillips, 1992; Sturla, 1993; Bailey, Hetherington and Sellors, 1998). Unfortunately, despite these contracts in combination with careful pre-adoption screening, neutering deposits and intensive follow up procedures, compliance is poor and many owners fail to fulfill the agreement (Samuelson, 1973; Lieberman, 1988a; Lieberman, 1988b; Salmeri, Olson and Bloomberg, 1991; Phillips, 1992; Aronsohn and Faggella, 1993; Alexander and Shane, 1994; Crenshaw and Carter, 1995; Stubbs and Bloomberg, 1995; Bloomberg, 1996; Stubbs *et al.*, 1996; Stubbs, Salmeri and Bloomberg, 1996; Howe, 1997; Johnston, 1998).

Early-age (8 to 16 weeks) neutering has thus been evaluated as a solution that might alleviate this problem and enhance the efficiency of population control programmes (Lieberman, 1987; Kahler, 1993b; Stubbs, Salmeri and Bloomberg, 1996; Howe, 1997; Johnston, 1998). However, neutering during the infantile period when gonadal hormones are low may have different physiological effects to neutering during the pubertal period, causing immediate concerns about the potential for serious side effects (Salmeri *et al.*, 1991). Stunted growth and poor bone formation, obesity, urinary incontinence, feline lower urinary tract disease including urethral obstruction and defective formation of the

preputial cavity, ovarian imbalance type two alopecia, perivulval dermatitis, vaginitis, persistent juvenile behaviour and lack of trainability, increased surgical and anaesthetic risk and increased susceptibility to infectious disease, diabetes mellitus and adrenal gland disease have been cited as possible complications (Herron, 1972; Chalifoux *et al.*, 1980; Cooper, 1984; Gourley, 1984; Kluth, 1984; Copestake, 1986; Olson *et al.*, 1986a; Jagoe and Serpell, 1988; Carter, 1990; Salmeri *et al.*, 1991; Salmeri, Olson and Bloomberg, 1991; Nagakura and Clark, 1992; Phillips, 1992; Johnston, 1993; Romatowski, 1993; Stubbs and Bloomberg, 1995; Root *et al.*, 1996; Stubbs *et al.*, 1996; Stubbs, Salmeri and Bloomberg, 1996; Howe, 1997; Root-Kustritz, 1999). While some of these conditions may be related to neutering, there is no objective data to substantiate claims that early-age neutering increases their development. Moreover, mounting clinical and research data suggests that most of these concerns are unfounded, although some remain to be addressed (Herron, 1972; Aronsohn, 1993; Bloomberg, 1996; Mahlow and Slater, 1996; Stubbs, Salmeri and Bloomberg, 1996; Root, Johnston and Olson, 1997).

In the USA, early-age neutering has been implemented as a population control program for many years, with no undesirable side effects reported (Lieberman, 1982; Lieberman, 1987; Lieberman, 1988a; Phillips, 1992; Aronsohn, 1993; Kahler, 1993a; Kahler, 1993b; Theran, 1993; Howe, 1997; Goeree, 1998). Early-age neutering of an abundant number of puppies and kittens has also been reported from the UK (Robinson, 1984; Edwards, 1986; Robinson, 1988; Poole, 1997). Despite this, the concept of neutering pets at six to eight weeks of age has engendered controversy and debates, thoroughly documented in the correspondence columns of veterinary journals (Lieberman, 1982; Cooper, 1984; Gourley, 1984; Hollands, 1984; Hurst, 1984; Kluth, 1984; Jackson, 1984a; Jackson, 1984b; Robinson, 1984a; Robinson, 1984b; Sanders, 1984; Thomas, 1984; Chambers, 1986; Copestake, 1986; Edwards, 1986; Gourley, 1986; Thomas, 1986; Gourley, 1987; Hannaford, 1987; Thompson, 1987; Campbell, 1988a; Campbell, 1988b; Coffey, 1988; Evans, 1988; Gourley, 1988; Jagoe and Serpell, 1988; Lieberman, 1988a; Lieberman, 1988b; Robinson, 1988; Thomas, 1988; Viner, 1988; Gourley, 1990; Aronsohn, 1993; Johnston, 1993; Kahler, 1993b; Romatowski, 1993; Gourley, 1997; Poole, 1997; May, 1998; Thornton, 1998; Yeatts, 1998).

Published studies into the effects of pediatric neutering on skeletal, physical and behavioural development have looked comparatively at dogs and cats neutered at seven

weeks versus seven months. From these studies, researchers have concluded that the effect of neutering pets at either age is similar, the most striking difference being the immaturity of the secondary sex characteristics and penile extrusion ability in cats, the significance of which are unknown (Salmeri and Bloomberg, 1989; Salmeri, Olson and Bloomberg, 1991; Stubbs *et al.*, 1993; Crenshaw and Carter, 1995; Root *et al.*, 1996; Root, Johnston and Olson, 1996; Stubbs *et al.*, 1996; Root, Johnston and Olson, 1997; Johnston, 1998). Interestingly, the implication that stunted growth results from early-age neutering has been disputed, as a delay in physeal closure resulted in greater final radial and ulnar length in dogs neutered at seven weeks (Salmeri, Olson and Bloomberg, 1991). Delay in growth plate closure has generated concern about an increased susceptibility to Salter-Harris fractures (May, Bennett and Downham, 1991; Houlton and McGlennon, 1992; May, 1998). Anaesthetic protocols and surgical techniques have also been described, with the safety of neutering pups and kittens in a clinical setting well established (Mackie, 1992; Aronsohn and Faggella, 1993; Faggella and Aronsohn, 1993; Theran, 1993; Faggella and Aronsohn, 1994; Stubbs, Salmeri and Bloomberg, 1996; Howe, 1997; Root-Kustritz, 1999). Providing that optimum precautions and techniques are used, short-term morbidity and mortality is negligible, comparing favourably with pediatric death rates reported from pet stores and other sources (Hird *et al.*, 1992; Scarlett, Saidla and Pollock, 1994; Howe, 1997). However, further research on the long term effects of this procedure is necessary, together with educating veterinary practitioners and the general public about early-age neutering (Thompson, 1987; Salmeri *et al.*, 1991; Salmeri, Olson and Bloomberg, 1991; Phillips, 1992; Aronsohn, 1993; Theran, 1993; Crenshaw and Carter, 1995; Bloomberg, 1996; Stubbs *et al.*, 1996; Howe, 1997; Root, Johnston and Olson, 1997).

While neutering programmes constitute an important tool in the fight against pet overpopulation, this approach is nowhere near the complete solution (Carding, 1975; Caras, 1993; Thornton, 1998). Enactment and enforcement of animal control laws and educational programmes for pet owners are also important (Koltveit, 1973; Faulkner, 1975; Council for Science and Society, 1988). As early as 1974, Beck was of the opinion that 'neutered animals can still run free, bite, turn over litter, bark, defecate and get hit by cars. If leash laws were enforced in the first place, pets would not get pregnant'.

1.3.5 Law and enforcement

In the early 1970s, government intervention via enactment and enforcement of laws that restrict irresponsible pet ownership was in demand (Samuelson, 1973; Carding, 1975; Faulkner, 1975; Young, 1975; Heussner and Grant, 1978; Arkow, 1991). Despite this, there are still few legislative or educational controls that ensure committed and qualified care, restraint and understanding of companion animals (Arkow, 1985). The legal aspects of companion animal ownership are complex, with current UK legislation dispersed across a wide range of different parliamentary Acts (Council for Science and Society, 1988). Historically, most laws have focused on dogs, ignoring the problems associated with unwanted, free-roaming cats, (Mahlow and Slater, 1996). It is for good reason, however, that every community has animal control laws which are, in effect, enforceable codes of responsible pet ownership (Porter, 1975; Murray, 1992b). New laws should extend enforcement from dog catching to include more professional regulation of diverse species and include a public safety, public health, nuisance abatement and cruelty to animals provision (Arkow, 1991; Hoff, Brawley and Johnson, 1999). No single law would be suitable for all communities and 'model' laws should be adapted to local needs (Moulton *et al.*, 1991). Consolidation of all existing and future UK legislation into a single Companion Animal Act would also be beneficial (Council for Science and Society, 1988).

1.3.5.1 Laws regarding stray animals and animal registration

The importance of leash, fencing and general restraint laws is mentioned by most authors on the subject of urban animal management (Carding, 1969; Carding, 1975; Beck, 1979; Council for Science and Society, 1988; Murray, 1992b). Properly restrained animals are prevented from all form of misadventure, including indiscriminate breeding. Laws concerning stray animals should define appropriate supervision on public property, with no animal being permitted to stray (Carding, 1975; Beck, 1979; Arkow, 1991; Hoff, Brawley and Johnson, 1999). In the UK, the Dog Act of 1906 defines a stray dog as one that is impounded by the police as a result of being found straying (Young, 1975). This Act gives statutory responsibility for the capture, care and disposal of strays to the police. Stray cats and other pets are not covered by this law. The Abandonment of Animals Act 1960 makes it an offence to abandon animals in the UK

in circumstances likely to cause suffering (Council for Science and Society, 1988). Prohibition of abandonment is facilitated by a network of AWCs which accept unwanted animals (Carding, 1969).

A major obstacle in controlling problems associated with abandoned and stray animals, is the difficulty in establishing ownership of the pet (Mann, 1975) Consequently, animal registration on a national level should also be incorporated (Carding, 1969; Carding, 1975; Murray, 1984). Registration involves paying a fee to license animals which are then identified by use of collars, tattoos or implanted microchips (Jöchle, 1991). Upon evidence of competence to keep an animal, a licence would establish ownership of the pet with certain responsibilities conferred (Carding, 1969). The fee applicable and the conditions of grant should be stringent enough to acquaint potential owners with the seriousness of the undertaking, and the licence be withdrawn from violators (Council for Science and Society, 1988). Legislation ensuring that all dogs and possibly cats are registered at the point of acquisition, for a reasonable fee, would also create a 'stop and think' effect, deterring impulsive acquisition and casual ownership (Carding, 1975; Woodrow, 1975; Council for Science and Society, 1988; Murray, 1992b). Such legislation would also benefit AWCs by increasing the number of identifiable strays that can be returned home (Moulton *et al.*, 1991). Voluntary registration systems exist in the UK in the form of Kennel Club registration for pure-bred dogs and 'Pet Log', a national pet identification scheme utilising identichips. These schemes are no longer compulsory after licensing legislation, first introduced in 1878, was abolished in Parliament in 1990.

1.3.5.2 Laws on neutering

Continual opposition from owners to surgical neutering of their pets has meant that some researchers have promoted the need for breeding regulation laws (Sturla, 1993). One such law which has gained global acceptance is the mandatory neutering of all pets adopted from an AWC (Avanzino, 1991; Mahlow and Slater, 1996). Other approaches have included breeding licenses for professional breeders and private owners wishing to engage in incidental pet breeding, compulsory neutering in the absence of a breeding permit and compulsory neutering of all free-roaming cats. Higher impoundment fees for entire animals, with owners paying a neuter deposit which is refunded once the animal is neutered, have also been suggested (Kahler, 1993a; MacKay, 1993; Sturla, 1993;

Mahlow and Slater, 1996). Many such breeding regulation laws are being promoted in the USA, amidst however, much controversy, especially from professional breeders (Woodrow, 1975; Avanzino, 1991; Strand, 1993). In the UK, the Breeding of Dogs Act 1973 states that any establishments with two or more bitches kept for breeding must be licensed by local authority and be available for regular inspection. The provision of animal welfare is secured by ensuring that certain standards are fulfilled according to the Animal Boarding Establishments Act 1963. This Act covers premises used for housing dogs and cats, including pet shops, commercial boarding and breeding establishments (Mann, 1975; Woodrow, 1975; Council for Science and Society, 1988).

Cheaper licenses for neutered animals have also been promoted as a means of encouraging neutering (Staff Report, 1973b; Carding, 1975; Woodrow, 1975; Heussner and Grant, 1978; Council for Science and Society, 1988; Mahlow and Slater, 1996). However, this kind of incentive would only be successful if registration was properly enforced in the first place (Murray, 1984; Murray, 1992b). The additional amount paid could be deducted from the neutering surgery fee, with the resultant effect of subsidised neutering paid for by owners themselves (Carding, 1969). Some people have felt it inappropriate to impose a fine that indiscriminately punishes owners, regardless of the responsibility exercised by them for their pets (Rowan and Williams, 1987). Nevertheless, such differential fees are not unusual in other areas of public activity and are a legitimate means of promoting desirable public behaviour (Sturla, 1993).

Advancement of the quality of urban animal management not only requires devising new laws, but also requires adequate policing and enforcement of laws (Carding, 1969; Samuelson, 1973; Carding, 1975; Feldman, 1977; Heussner and Grant, 1978; Murray, 1984; Rowan and Williams, 1987; Murray, 1992b). Weak laws, with poor compliance and insignificant penalties for offenders should be eliminated (Moulton *et al.*, 1991). Other efforts to improve law enforcement include shifting punishment for violations from the animal to the owner, to reinforce that pet ownership is a responsibility rather than a right (Arkow, 1991). These have included replacing impoundment with owner summons, imposing stiffer fines on irresponsible owners, especially persistent offenders and reserving specific court dates for violators of laws to ensure that priority is given to animal control issues (Murray, 1984; Rowan and Williams, 1987; Council for Science and Society, 1988; Mahlow and Slater, 1996; Hoff, Brawley and Johnson, 1999).

1.3.6 Education

Many of the problems created by companion animals arise through an owner's ignorance of an animal's basic needs and the effort and financial commitment necessary to provide these needs. Information and understanding about normal canine and feline behaviour and training is also lacking. Providing the information requisite to responsible pet ownership, together with guidance and counselling in the selection and location of a suitable pet in advance of ownership, is therefore necessary (Fredrickson, 1975; Joshua, 1975; Mann, 1975; Woodrow, 1975; Heussner and Grant, 1978; Rhoades and Selby, 1979; Council for Science and Society, 1988; Rollin, 1991; Bailey, 1992; Mahlow and Slater, 1996). Arkow (1991) suggested that if more owners supervised and adequately confined their pet, identified them with permanent traceable methods and made life long commitments, fewer pets would become abandoned, thereby reducing overpopulation.

Public education about responsible pet ownership and the enormity of the surplus pet problem could be carried out throughout the community, placing greater emphasis on prevention as a method of population control (Samuelson, 1973; Fredrickson, 1975; Rowan and Williams, 1987; Avanzino, 1991; Moulton *et al.*, 1991; Olson *et al.*, 1991; Murray, 1992b Mahlow and Slater, 1996). Education techniques have included newspaper columns, magazine articles, posters on buses, trains, in veterinary clinics and schools, television or radio broadcasts, leaflets, brochures and annual campaigns (Fredrickson, 1975; Woodrow, 1975; Council for Science and Society, 1988; Avanzino, 1991; Sturla, 1993). Child education involving school visits by professional animal carers, free distribution of a health care, welfare and responsible pet ownership booklet and accommodation by veterinary clinics of visits from schools and organised youth groups, have been recommended (Woodrow, 1975; Rollin, 1991; Murray, 1992b; Caras, 1993). Educating children may be the most profitable investment. Children form a captive, impressionable audience with a natural adoration for animals and what they learn will be passed to family, friends and their own children (Avanzino, 1991; Caras, 1993).

Animal welfare organisations have released public education material for many years, with most groups implementing educational programs geared towards solving pet overpopulation. People are encouraged to have their pets neutered and identified, to comply with leash laws and not let their pets roam at large or pollute public recreational

areas. Furthermore, local humane societies have initiated various approaches to raise the public awareness of the overpopulation issue and the humane treatment of animals in general (Carter, 1990; Moulton *et al.*, 1991). Counselling of potential owners before pet adoption is also an important part of their educational outreach (Moulton *et al.*, 1991). Furthermore, the RSPCA have, for some time, produced propaganda advising the public to surrender unwanted pets to AWCs as opposed to abandoning them (Carding, 1969). Reaching people who have no contact with an AWC could involve co-operation between veterinary associations, animal welfare societies, kennel clubs and breeders, the pet industry, schools and community groups in a widely supported combined effort (Mann, 1975; Woodrow, 1975; Higgins and Pineda, 1980; Avanzino, 1991; Beaver, 1991).

1.3.7 Animal welfare centre statistics

In view of the meagre and unreliable statistics concerning owned pets, accurate judgement of the size of the unwanted pet population is often precluded. Although the exact magnitude of the problem is unknown, estimates of the numbers of dogs and cats euthanatised in the USA range between four to 25 million annually, with recent surveys supporting lower figures (Jordan, 1973; Staff Report, 1973a; Faulkner, 1975; Rowan, 1986; Rowan and Williams, 1987; Carter, 1990; Olson, 1990; Moulton *et al*, 1991; Nassar and Fluke, 1991; Thornton, 1991; Anderson, 1992; Kahler, 1992; Olson *et al.*, 1992; Rowan, 1992a; Rowan, 1992b; Thornton, 1992; Caras, 1993; Olson and Johnston, 1993; Sturla, 1993; Alexander and Shane, 1994; Arkow, 1994; Hart and Kidd, 1994; Patronek and Glickman, 1994; Patronek and Rowan, 1995; Patronek *et al.*, 1995; Mahlow and Slater, 1996; Patronek, 1996; White and Shawhan, 1996; Howe, 1997). Various estimates of the number of stray or abandoned pets in the UK have been derived by extrapolation of data available from individual AWCs (Carding, 1969; Carding, 1975; Woodrow, 1975; Young, 1975; Hollands, 1984; Council for Science and Society, 1988; Bailey, 1992; Hubrecht and Serpell, 1993; RSPCA, 1994; Ledger, 1995), with recent figures suggesting that 500,000 companion animals are abandoned each year.

Although AWCs are responsible for euthanasia performed for population control, there is no national regulatory agency (Patronek, 1993). Moreover, AWCs are not always required to declare their existence or even maintain records of animal intake and disposal (Patronek and Glickman, 1994; Anonymous, 1997). The number of centres that

deal with stray and unwanted animals is unknown for most countries and overpopulation and euthanasia statistics tend to be unqualified estimates (Young, 1975; Rowan, 1991; Murray, 1992a; Patronek, 1993; Digiacomo, Arluke and Patronek, 1998). Besides private individuals and small groups, it has been estimated that approximately 200 registered charities run AWCs for homeless animals in the UK (Council for Science and Society, 1988). Without accurate data on the total numbers handled and euthanatised, population management methods cannot be evaluated and new programmes designed to combat the problem cannot be devised. Lack of reliable baseline data also makes it hard to assess changes that may have occurred regarding the overpopulation issue (Rowan, 1991). Although large sums of money have been spent on control programmes, there have been few attempts to determine local pet population dynamics, the dynamics of the AWC population or even identify the factors responsible for pet overpopulation, pet roaming, relinquishment and abandonment (Nassar and Fluke, 1991).

Despite this lack of accuracy, comparison of recent AWC estimates with figures reported in previous years indicate that progress has been made in reducing the number of animals entering AWCs and those euthanatised (Rowan, 1992a; Anonymous, 1995a; Digiacomo, Arluke and Patronek, 1998). Reports from the USA suggested that the proportion of the pet population received by AWCs in the 1970s and 1980s was 13 to 20% (Heussner and Grant, 1978; Nassar and Mosier, 1980; Nassar, Mosier and Williams, 1984) whereas recent surveys have reported figures between 6 to 8% (Rowan, 1993; Patronek and Glickman, 1994). To gauge what success has occurred, other researchers have assessed the percentage of the population that are euthanatised. The proportion of AWC animals that is euthanatised appears to have changed little, with 43 to 53% estimated over the last 20 years throughout the western world (Griffiths, 1975; Nassar and Mosier, 1987; Rowan, 1992a; Patronek and Glickman, 1994; Anonymous, 1995a). However, if the numbers euthanatised are related to the total pet population, considerable change has occurred. In the 1970s, 12 to 20% of the canine population in the USA were estimated to be euthanatised, whereas in the 1990s, this figure had fallen to 4 to 5% (Anonymous, 1971; Jordan, 1973; Beck, 1975; Rowan, 1992a; Arkow, 1994; Patronek and Glickman 1994; Patronek, 1996). Lack of data has impeded critical evaluation of various population control programs. It remains unknown therefore, which of the legislative, educational or birth control incentives have been responsible for this

success (Arkow, 1991; Patronek and Glickman, 1994). Before any problem can be approached on a scientific basis, its dimensions must be defined as accurately as possible. Future attempts to control pet overpopulation will therefore, depend on collection of accurate AWC data that describes the numbers of animals handled and the demographics of this population. Data relating to persons redeeming, adopting or relinquishing a pet will also provide crucial information (Nassar and Mosier, 1986b).

1.3.8 Animal welfare centre dynamics

Researchers have investigated the AWC population, describing its dynamics and the characteristics and fate of pets handled, with several studies reported from the USA and Australia (Nassar and Mosier, 1980; Arkow and Dow, 1984; Nassar, Mosier and Williams, 1984; Rowan, 1993; Patronek and Glickman, 1994; Murray and Speare, 1995; Patronek *et al.*, 1995; Miller *et al.*, 1996, Patronek *et al.*, 1996a, Salman *et al.*, 1997). Available data for the UK are more limited (Griffiths 1975; Young, 1975; Council for Science and Society, 1988; Bailey, 1992; Wells and Hepper, 1992; Wells and Hepper, 1999a). The most substantial change noted in the past 40 years, is the shift from being largely a dog problem to one that is worse in cats, which now outnumber dogs in most AWCs throughout the western world (Bailey, 1992; Thornton, 1992; Anonymous, 1995b; Digiacomo, Arluke and Patronek, 1998). Murray and Speare (1995) suggested a basic difference in the epidemiology of the unwanted cat and unwanted dog problem. However, studies that have addressed the feline population are more limited (Neville and Remfry, 1984; Neville, 1989; Smith and Shane, 1988; Jackson and Hutchison, 1993; Zaunbrecher and Smith, 1993; Natoli, 1994; Luke, 1996; Patronek *et al.*, 1996b; Remfry, 1996; Goeree, 1998; Hughes and Slater, 1999; Slater, 1999).

AWCs derive their intake from two major sources; impounded strays and relinquished animals. During the 1970s and early 1980s it was reported that only a small percentage of dogs handled were surrendered by their owners, the majority being impounded strays (Griffiths, 1975; Nassar and Mosier, 1980, Nassar, Mosier and Williams, 1984). Today, these proportions have dramatically changed, with reports that up to 44 to 48% of dogs received in the USA are relinquished (Anonymous, 1995a; Patronek *et al.*, 1995). From the UK, Bailey (1992) reported that only 6% of dogs handled by a Blue Cross Animal Rescue Centre were strays. Likewise, only 12% of dogs received at the Wood Green

Animal Shelter were reported to be strays (Council for Science and Society, 1988). In contrast, Wells and Hepper (1992) reported that twice as many strays as opposed to relinquished dogs are accepted in Northern Ireland. The fate of animals received can be placed in the following categories: reclaimed by their original owner, adopted by a new owner or euthanatised. The donation of AWC animals to research institutes also occurs in the USA. However, this practice is a contentious issue and is prohibited in the UK (Rowan, 1986). Recently, the use of dogs from AWCs to assist people with mental and physical handicaps has also been explored (Weiss and Greenberg, 1997).

1.3.8.1 Reclaimed strays

By law, impounded strays are held for a minimum of seven days in an AWC to provide owners time to redeem them (Council for Science and Society, 1988; Wells and Hepper, 1992; Patronek *et al.*, 1995). Most AWCs report that few impounded strays are reclaimed. In earlier years, a 10 to 25% reclaim rate was reported for impounded dogs in the UK (Griffiths, 1975; Young, 1975; Council for Science and Society, 1988). Since then, this figure has gradually increased with recent North American investigators reporting that up to 54% of strays are reunited with their owners (Anonymous, 1995a; Patronek *et al.*, 1995). Despite this improvement, the fact that about half of all strays impounded remain unclaimed indicates that further progress is desirable. While some owners fail to search for a lost pet, for those who do, there are many reasons why pets may not be found. Patronek *et al.* (1995) reported that the likelihood of a stray dog being reclaimed increased with the dog's age and was higher in pure breeds compared to mixed breeds. Younger, mixed breed dogs may represent pets that are not as highly valued by owners. Alternatively, these dogs may be more difficult to describe accurately compared to older, pure-bred dogs (Patronek *et al.*, 1995). This highlights the point that permanent identification is desirable, to ensure the return of a lost pet (Moulton *et al.*, 1991).

1.3.8.2 Adoption

The decision to hold an animal for adoption is influenced by the space available in the AWC and involves a subjective assessment of the suitability of that animal based on its age, breed, health and temperament (Patronek *et al.*, 1995; Bailey, Hetherington and Sellors, 1998). Considering the age and breed of the animal, Patronek *et al.* (1995) reported a preferential adoption of pure-bred dogs less than one year of age. If this latter

point is examined in relation to the probability of a stray dog being reclaimed, it can be seen that although older strays are more likely to be reclaimed, younger dogs are more likely to be adopted (Patronek *et al.*, 1995). This supports the findings of Griffiths (1975) who found similar age related adoption and redemption rates. Carding (1969) reported that male dogs are in much greater demand than females. However, this suggestion of a gender bias has not been supported by later work. A surprising finding by Wells and Hepper (1992) was the preferential adoption of surrendered dogs over strays, possibly reflecting some pre-conceived notion of a reduced desirability of strays.

When considering physical health, ill health is a reported to be a common reason why dogs are returned to their source of acquisition, with minor ailments being as important as life threatening conditions (Scarlett, Saidla and Pollock, 1994; Wells and Hepper, 1999b). Unfortunately, the requirement to handle a large number of animals, most of which have no medical history, means that AWCs fight a constant battle against epidemic disease, together with limited financial resources for disease treatment and prevention (Vonesch, 1975; Levine, 1984a; Levine, 1984b; Council for Science and Society, 1988; RSPCA, 1994). The young and old are particularly susceptible and disease undoubtedly accounts for a significant proportion of animals which die or are destroyed in AWCs or are subsequently returned.

Besides these inherent physical traits affecting the desirability and ultimate success of re-homing dogs, the animals environment and observed behaviour significantly influence the likelihood of adoption (Wells and Hepper, 1992). Within the AWC environment, various factors directly impact on the welfare of impounded animals and the resultant behaviour of captive animals is a useful indicator of their well being (Wells and Hepper, 1998). An animal confined in an unfamiliar environment experiences a wide array of stressors and methods to ameliorate the distress of impoundment have been investigated (Wells and Hepper, 1992; Hubrecht and Serpell, 1993; Sonderegger and Turner, 1996; Hennessy *et al.*, 1997; Hennessy *et al.*, 1998; Wells and Hepper, 1998; Kessler and Turner, 1999; Wells and Hepper, 1999a). Besides separation from former companions, the impounded animal is assailed with novelty in terms of the physical surroundings, exposure to unfamiliar animals, unpredictable and excessively high noise levels and disruption of regular routines (Sonderegger and Turner, 1996; Hennessy *et al.*, 1997; Sales *et al.*, 1997; Weiss and Greenberg, 1997; Hennessy *et al.*, 1998). While the effect

of such stressful environments on the behaviour of animals remains poorly understood, any adverse effects could decrease the animals desirability for adoption (Hubrecht, 1991; Wells and Hepper, 1992; Sonderegger and Turner, 1996; Hennessy *et al.*, 1997; Hennessy *et al.*, 1998; Wells and Hepper, 1998; Wells and Hepper, 1999a).

The policy of rehoming companion animals is sometimes criticised for simply recycling problem animals (Arkow, 1985; Council for Science and Society, 1988). Temperament of the animal is particularly important in this respect and is usually subjectively assessed by AWC staff. A new trend is to conduct validated temperament and behavioural tests which provide an objective method of assessing the general temperament of dogs and help predict problem behaviour (Van der Borg, Netto and Planta, 1991; Netto, Van der Borg and Planta, 1993; Ledger, 1995; Ledger, 1997; Ledger and Baxter, 1997a; Ledger and Baxter, 1997b; Bailey, Hetherington and Sellors, 1998). However, the difficulty in predicting both problem and desirable behaviours within a stressful AWC environment, has been recognised (Weiss and Greenberg, 1997). Unfortunately, the trauma associated with abandonment may contribute to the behavioural problems commonly encountered in adopted dogs (Wells and Hepper, 1992; Hennessy *et al.*, 1997; Hennessy *et al.*, 1998). In the absence of conditions precluding adoption, unclaimed strays are made available for adoption at the end of their holding period, whereas surrendered animals are available immediately upon relinquishment (Wells and Hepper, 1992; Patronek *et al.*, 1995). Besides the physical and psychological well being of the animal, the degree of owner suitability for such an undertaking and the environment in which the animal will be housed is taken into account, to ensure a successful match (Griffiths, 1975; Council for Science and Society, 1988; Van der Borg, Netto and Planta, 1991; Netto, Van der Borg and Planta, 1993; Ledger, 1997; Ledger and Baxter, 1997b). An objective way of assessing new owners has not yet been explored. However, many AWCs have elaborate screening procedures to attempt to ensure that all applicants will assume the lifetime responsibility involved in pet ownership and have the facilities and time to provide them (Woodrow, 1975; Arkow, 1985). As discussed previously (Section 1.3.4) most AWCs also incorporate mandatory neutering into their centre programmes.

1.3.8.3 Euthanasia

As incoming numbers are high and space and funding limited, euthanasia of healthy dogs and cats occurs frequently in AWCs (Moulton *et al.*, 1991; Wells and Hepper, 1992). It has been reported from the USA and UK that as many as half of the animals received are killed (Carding, 1969; Griffiths, 1975; Woodrow, 1975; Nassar, Mosier and Williams, 1984; Rowan, 1992a; Patronek and Glickman, 1994; White and Shawhan, 1996; Anonymous, 1997; Gorodetsky, 1997). However, the proportion destroyed in the UK varies enormously, with reports that few healthy animals are euthanatised in rural AWCs, whereas as many as two thirds are killed in AWCs located in cities (Council for Science and Society, 1988). Cats are reported to be euthanatised more frequently than dogs due to the lower reclaim and adoption rates for cats (Alexander and Shane, 1994; Anonymous, 1997; Gorodetsky, 1997). Although these figures are assumed to indicate healthy adoptable animals that are euthanatised, it has been reported from the USA that nearly a fifth of surrendered dogs are brought in specifically for euthanasia (Wells and Hepper, 1992; Patronek *et al.*, 1995; Patronek, Beck and Glickman, 1997). Animals may also be deemed unsuitable for adoption due to ill health, old age or temperament problems (Council for Science and Society, 1988; Murray and Speare, 1995; White and Shawhan, 1996; Anonymous, 1997). Failure to account for these, will artificially raise estimates of the number of adoptable dogs killed.

It is not known why owners select an AWC instead of a veterinary practice for elective euthanasia of their pets (Patronek *et al.*, 1995). Given that surrendering a pet to an AWC is often free of charge is probably significant (Murray, 1992b). In addition, personal identity is unlikely to occur, causing less anguish to the owner. Perhaps most important is that while a number of owners make an active decision to euthanatise their pet, many do not (Digiacomo, Arluke and Patronek, 1998). Leaving unwanted pets at an AWC is an easy option for uncommitted owners, especially if the owners perceive that the pet will be re-homed (Murray and Speare, 1995; Digiacomo, Arluke and Patronek, 1998). Such naïve expectations are not unreasonable considering that some people applying for work at AWC are shocked when they discover that euthanasia occurs (Arluke, 1991).

Euthanasia is a central and consuming aspect of AWC culture that is a source of personal stress and emotional anguish for many workers (Rowan, 1992a; Arluke, 1994; White

and Shawhan, 1996). Especially for new employees, euthanasia represents a moral conflict between their care and concern for animals and rationalisation of euthanasia as a way to deal with pet overpopulation (Arluke, 1991; Arluke, 1994; White and Shawhan, 1996). Due to this, there has been an emergence of centres that do not euthanatise animals (Arkow, 1987; Moulton *et al.*, 1991). In addition, AWCs have successfully expanded their work beyond the typical role of sheltering, adopting and killing (Arkow, 1985). Subsequent activities have included community education, adoption screening policies, animal rescue and rehabilitation, cruelty investigations and prosecutions, veterinary services and law enforcement. Furthermore, obedience training and behavioural therapy, behavioural advice and the sale of pet supplies are other programmes now provided (Arkow, 1987; Parmer, 1987; Arkow, 1991; Moulton *et al.*, 1991; Robinson, 1991; Anderson, 1992; Patronek, 1993; Sturla, 1993; Bailey, Hetherington and Sellors, 1998).

1.3.9 Demographics of the animal welfare centre population

Previous studies from the USA have indicated that the average age of the AWC population is lower than the general pet population (Beck, 1975; Nassar, Mosier and Williams, 1984; Rowan and Williams, 1987). Historically, this was presumed to reflect the disproportionate representation of unwanted litters of puppies and kittens. However, the population dynamics of companion animals has been changing (Digiacomo, Arluke and Patronek, 1998). Recent studies from the USA and Australia have found that most of these animals are not neonates, with reports that under half of the AWC population are animals less than one year (Patronek and Glickman, 1994; Murray and Speare, 1995; Patronek *et al.*, 1995). Today, most animals euthanatised are young adult and adult pets (Patronek *et al.*, 1995; Patronek, 1996). Considering relinquished pets only, the risk of relinquishment has been reported to be higher for younger dogs in the USA, with approximately half being under one year (Miller *et al.*, 1996; Patronek *et al.*, 1996a). However, Bailey (1992) reported that the commonest age that dogs were given up in the UK was six to nine months followed by one to two years. Moreover, although young dogs are at an increased risk of relinquishment, they tend to be quickly adopted, spending short periods in the AWC (Patronek and Glickman, 1994).

In 1984, Nassar, Mosier and Williams made the observation that most of the dogs that roamed were large breeds. Today, this still appears to be the case with toy breeds being under represented in the AWC population (Patronek *et al.*, 1995), whilst larger dogs predominate (Council for Science and Society, 1988; Bailey, 1992). Over representation of mixed breeds compared to pure breeds has been consistently reported for relinquished and stray dogs (Council for Science and Society, 1988; Bailey, 1992; Murray and Speare, 1995; Patronek *et al.*, 1995; Patronek *et al.*, 1996a; Salman *et al.*, 1997). These data could indicate that some intrinsic characteristics of large and mixed breed dogs make them unsatisfactory pets. For example, Patronek *et al.* (1996a) reported that mixed breed dogs were at an increased risk of chewing and aggressive behaviour compared to pure breeds. However, it has been suggested that owner characteristics probably have a more important bearing on breed related disposal rates (Murray and Speare, 1995).

In earlier years, when most dogs handled were impounded strays, the AWC population showed a distinct bias to males (Griffiths, 1975; Young, 1975; Nassar, Mosier and Williams, 1984). Recently, this population has shown no sex predilection (Murray and Speare, 1995; Patronek *et al.*, 1995). Similarly, gender of the dog has not been found to be a significant risk factor for relinquishment (Patronek *et al.*, 1996a; Salman *et al.*, 1997). Considering neutering status, the proportion of the AWC population reported to be neutered is markedly lower than in the general canine population (Nassar, Mosier and Williams, 1984; Murray and Speare, 1995; Patronek *et al.*, 1996a). A propensity to sexual entirety has also been reported when assessing relinquished animals only (Patronek *et al.*, 1995; Patronek *et al.*, 1996a; Salman *et al.*, 1997). In addition, it has been reported that up to 7% of bitches received in the UK are pregnant (Young, 1975). Why sexually entire animals are over represented in the AWC population is not known, but may simply reflect the young age of these animals. Sexually intact animals have been associated with an increased frequency of behavioural problems including unwanted chewing, inappropriate micturition and aggression, and this may contribute to the desire to surrender a sexually entire pet (Patronek, 1996; Patronek *et al.*, 1996a; Patronek *et al.*, 1996b). Other researchers have stressed the human factors involved. Murray and Speare (1995) were of the opinion that investment in pet care i.e. neutering, is unlikely to be a priority for irresponsible owners who will probably surrender or abandon their pet.

From the above, the 'profile' of the abandoned and relinquished pet can begin to be established. This information alone does not explain why the age, breed and neutering status of a dog is associated with becoming part of the AWC population. Recognition that certain owner factors influence pet selection and disposal means that the human side to pet overpopulation warrants research (Murray and Speare, 1995). Analyses of factors associated with pet acquisition, the reasons for relinquishment and demographic characteristics of households abandoning their pets could lead to a better understanding of the complex interaction between people, pets and AWCs (Patronek *et al.*, 1995).

1.3.10 Relinquishment

1.3.10.1 Reasons for relinquishment

Relinquishing a pet to an AWC can be a complicated issue and many owners struggle with the decision, procrastinating before doing so (Digiacomo, Arluke and Patronek, 1998). The reasons underlying relinquishment are often difficult to determine as individuals may not be aware of or may decline to reveal their true motives (Olson *et al.*, 1991). When investigating factors associated with the desire to give up ownership of a pet, Arkow and Dow (1984) identified two predominant reasons as lifestyle changes and behavioural problems. In more recent years, these two factors are still identified as important throughout the western world (Council for Science and Society, 1988; Bailey, 1992; Scarlett, Saidla and Pollock, 1994; Miller *et al.*,1996; Patronek *et al.*, 1996a; Ledger, 1997; National Council on Pet Population Study and Policy; 1997; Salman *et al.*, 1997; Digiacomo, Arluke and Patronek, 1998). Life complications identified as factors involved in relinquishment include: owner moving, divorce, landlord prohibiting pets, health problems, owner having a baby or addition of another new member to the household, too many pets, not enough room, personal problems, financial constraints and time constraints (Council for Science and Society, 1988; Bailey, 1992; Alexander and Shane, 1994; Hart and Kidd, 1994; Scarlett, Saidla and Pollock, 1994; Houpt, Honig and Reisner, 1996; Miller *et al.*, 1996; National Council on Pet Population Study and Policy; 1997; Salman *et al.*, 1997; Digiacomo, Arluke and Patronek, 1998).

Reports from the UK and USA have indicated that between 12 to 70% of owners complain that they are parting with their pet because of behavioural problems and some AWC animals are considered unadoptable due to their behaviour (Stead, 1982; Arkow

and Dow, 1984; Rowan and Williams, 1987; Council for Science and Society, 1988; Van der Borg, Netto and Planta, 1991; Bailey, 1992; Ledger *et al.*, 1995; Houpt *et al.*, 1996; Miller *et al.*, 1996; Ledger, 1997; Ledger and Baxter, 1997a; Gorodetsky, 1997; National Council on Pet Population Study and Policy, 1997; Digiacomo, Arluke and Patronek, 1998; Bailey, Hetherington and Sellors, 1998; Edney, 1998). Since unacceptable behaviour, rather than disease, has been reported as the main cause of premature pet death (Edney, 1998), an understanding of the factors leading to development of problem behaviour is particularly important.

Although genetic predispositions are clearly involved, the environment in which a dog grows up and its early experiences have a pronounced effect on adult temperament and behaviour (Fox, 1975; Serpell, 1987; Council for Science and Society, 1988; Ledger, 1997; Ledger and Baxter, 1997a). With respect to this, the sensitive period for puppies is between three to 12 weeks old, with the degree of contact with humans and other dogs and the behaviour of the nursing mother all shown to be important (Fox, 1975; Markwell and Thorne, 1987; Serpell, 1987; Slabbert and Rasa, 1993; Ledger, 1997; Weiss and Greenberg, 1997). The presence of an eliciting stimulus within a dog's environment may influence the incidence of behavioural problems (Ledger, 1997; Ledger and Baxter, 1997a). For example, Miller *et al.* (1996) found that behavioural problems were more prevalent in households with children, reflecting the excitement and stimulatory behaviour in such homes. It has also been reported that the behaviour, personality and attitude of owners can be reflected in the behaviour of their dog (Heiman, 1965; Fox, 1975; Brodie, 1981; O'Farrell, 1987; Council for Science and Society, 1998; Serpell and Jagoe, 1995; Jagoe and Serpell, 1996; Ledger, 1997; Ledger and Baxter, 1997a). However, contrary to common belief, 'spoiling' activities or pet anthropomorphism do not necessarily lead to behavioural problems (Voith, Wright and Danneman, 1992). With regard to owner attachment levels, Serpell (1996) found that owners with weak attachment to their dog were consistently less satisfied with its behaviour compared with those with strong attachment, even after controlling for source of dog and length of ownership. Voith (1985) also reported that many owners keep their pet despite behavioural problems due to strong attachment.

Frequently reported behavioural problems in abandoned dogs include hyperactivity, destructive chewing, housetraining problems, fearfulness, barking, aggression to people

or other dogs, boisterousness and escape from confinement (Council for Science and Society, 1988; Bailey, 1992; Miller *et al.*, 1996; Patronek, 1996; Patronek *et al.*, 1996a; Patronek *et al.*, 1996b; Gorodetsky, 1997; Ledger, 1997; Ledger and Baxter, 1997a; Salman *et al.*, 1997). Considering the young age of many surrendered pets, most of these reported problems may be attributable to an animal's normal expected behaviour (Miller *et al.*, 1996). The context within which the behaviour is performed and its frequency may define the problem (Houpt, Honig and Reisner, 1996; Melson, Schwarz and Beck, 1997). Similar behaviour may also be judged differently by individual owners, with their perception of a behaviour dictating whether or not it is a problem. Ledger and Baxter (1997b) found that while owners consistently considered certain behaviours as desirable or problematic, some behavioural characteristics were perceived differently by different individuals. More important is an owner's tolerance to such behaviour, with intolerance frequently ending in abandonment of the dog (Ledger, 1997; Ledger and Baxter, 1997a).

Much of the effect of pet behaviour on relinquishment thus appears to have more to do with owners than the pet. Cases of truly abnormal companion animal behaviour are reported to be rare and only a small percentage of rescue dogs must be euthanatised for behavioural reasons (Houpt, Honig and Reisner, 1996; Miller *et al.*, 1996; Bailey, Hetherington and Sellors, 1998). Animal behaviour consultants also report high success in dealing with most companion animal behavioural problems (Council for Science and Society, 1988). In 1975, Griffiths reported that the risks for rejection of puppies adopted from Birmingham's Dog Home suggested a degree of owner unsuitability. Such owners commonly lack reasonable expectations and understanding of normal canine behaviour and temperament. Such people may transfer normal human behaviour to their dogs resulting in misinterpretation or overinterpretation of aspects of dog behaviour (Council for Science and Society, 1988; Endenburg and Vorstenbosch, 1992; Endenberg and Knol, 1994). Knowledgeable owners expect these types of behaviour and are also prepared to seek ways to deal with them and raise a suitable pet (Miller *et al.*, 1996). This point was emphasised by Patronek *et al.* (1996a) who found that an owner requiring advice about canine behaviour increased the risk of relinquishment.

1.3.10.2 Factors associated with acquiring a pet

Studies from North America have indicated that animals born at home, acquired from an AWC or other pet owners are disproportionately represented in the AWC population, with the supply of pets by breeders and pet shops representing only 10 to 17% of surplus animals (Arkow and Dow, 1984; Nassar, Mosier and Williams, 1984; Patronek and Glickman, 1994). If considering relinquished animals only, this also appears to be the case, with the typical relinquished dog being obtained from a friend, neighbour or AWC (Miller *et al.*, 1996; Patronek *et al.*, 1996a; Digiacomo, Arluke and Patronek, 1998). The amount of money invested in the acquisition process also directly correlates to an owner's future commitment, with many unwanted animals being acquired without monetary exchange (Arkow and Dow, 1984). Patronek *et al.* (1996a) identified that dogs acquired at no cost, such as those born at home, found as strays or given away by a friend or neighbour were at an increased risk of relinquishment, with an inverse relationship between the price paid and risk.

1.3.10.3 Post acquisition related factors

An important factor to consider about abandoned animals is the length of time owners have devoted to developing the ideal relationship with their pet. Arkow and Dow (1984) reported that almost half of the animals relinquished in the USA have been owned for less than six months. The authors suggested that 'in too many cases the unique bond between people and animals never has a chance to develop and mature'. Obtaining a puppy to amuse children and then eliminating the pet once it has lost much of its charm and become less diverting, more of a responsibility and often a nuisance, is an example (Carding, 1969). Patronek *et al.* (1996a) found that the degree of owner-dog attachment increased with increasing length of ownership and lack of attachment was associated with an increased risk of relinquishment. Specific research has found that sex, marital status, the presence of children in the home, childhood pet contact, species of animal and for children, their parents attachment to the pet, are salient variables influencing human attitudes and attachment to pets (Netting, Wilson and Fruge, 1988; Stallones *et al.*, 1988; Kidd and Kidd, 1989; Kidd and Kidd, 1990; Paul and Serpell, 1993).

Many cases of poor attachment have been attributed to the owners' expectations of the animal versus their view of normal pet behaviour and pet keeping responsibilities

(Arkow and Dow, 1984; Kidd *et al.*, 1992a; Miller *et al.*, 1996). Kidd *et al.* (1992a) found that people who retained their pets had fewer unreasonable expectations regarding the pet's role in the home compared to those who relinquished their pet. Besides unreasonable expectations, many owners lack awareness of the responsibilities and work involved in pet ownership (Miller *et al.*, 1996). Kidd *et al.* (1992a) reported that subjects who already had or previously had pets and therefore were educated and experienced in pet owning, relinquished significantly fewer pets than first time adopters. This was supported by Patronek *et al.* (1996a) who found that nearly a third of dogs were relinquished due to the belief that the work involved was more than expected. Caring for a pet, particularly the larger dog breeds, is a major responsibility and failure to recognise this can jeopardise the welfare of the animal (Council for Science and Society, 1988).

Another point to consider is that although a companion animal is often chosen for its behaviour, pets do not instinctively acquire appropriate behaviour and owners are capable of shaping this behaviour with interaction and training (Ledger, 1997). Appropriate and positive interaction between an owner and their pet during obedience training classes has been shown to improve the human-canine relationship significantly, improve obedience behaviour in dogs and decrease the risk of relinquishment (Clark and Boyer, 1993; Patronek *et al.*, 1996a). Despite these observations, many owners appear to assume that pet ownership is synonymous with a companion animal bond, implying that one merely needs to own a pet to form a quality relationship (Clark and Boyer, 1993).

1.3.10.4 Household demographic characteristics

Household demographic characteristics have been studied to identify factors associated with pet relinquishment. Preliminary results from the USA have indicated that lower household income, renting or living in an apartment or mobile home and fewer years in the present accommodation are all factors that increase the risk of relinquishment (Patronek *et al.*, 1996a). Considering the characteristics of household members, it has been found that owners who relinquish pets are significantly younger than those who retain their pet; men relinquish a higher percentage of pets than women, and married couples and parents relinquish more pets than single people and non-parents (Kidd *et al.*, 1992a; Miller *et al.*, 1996; Patronek *et al.*, 1996a). Not all researchers have found an

association between relinquishment and these household characteristics, indicating that further research is needed in this area.

1.3.11 Role of veterinary surgeons

Professional health care for companion animals now constitutes a large proportion of work within the veterinary profession. In this field, besides improvement of animal health, the needs to pursue animal welfare and promote the positive effects of pet keeping on the welfare of the community, are recognised (Jordan, 1973; Mann, 1975; Cloud, 1993; Arkow, 1998). Pet overpopulation is one of the most important animal welfare issues today. Although veterinary surgeons have always been involved with the problem, participation has been reluctant to surface, with criticism that they have not contributed enough (Staff Report, 1973a; Olson, 1990; Beaver, 1991; Thornton, 1991; Murray, 1992b; Thornton, 1992; Kahler, 1993a; Sturla, 1993). The veterinary surgeon's main role stems from the co-operation needed by animal welfare groups on pet birth control. Historically there has been conflict on this point (Anonymous, 1971; Staff Report, 1973a; Staff Report, 1973b; Robinson, 1991; Thornton, 1991; Anderson, 1992; Patronek, 1993). Veterinary surgeons can be powerful colleagues for AWCs. However, such collaboration will only succeed with positive communication, respect for the priorities of each profession, recognition of a common goal and co-operative participation in animal control programmes (Arkow, 1987; Thornton, 1992; Strand, 1993; Mahlow and Slater, 1996; Lane, 1998).

By law, only veterinary surgeons can perform surgery or dispense drugs for birth control in companion animals (Anderson, 1992; Howe, 1997). It would be advantageous if they continued to provide neutering services to the public at the lowest rate compatible with safe surgery and practice viability (Samuelson, 1973; Higgins and Pineda, 1980; Murray, 1992b). More importantly, veterinary surgeons could increase pet owner education about the benefits of the surgery and encourage them to neuter their pets or restrict breeding by other means (Carding, 1969; Feldman and Carding, 1973; Higgins and Pineda, 1980; Avanzino, 1991; Council for Science and Society, 1988; Murray, 1992b; Thornton, 1992; Kahler, 1993a; Bloomberg, 1996; Remfry, 1996; Patronek, Beck and Glickman, 1997). Perceived by the public as trustworthy and knowledgeable, veterinary surgeons, with their unique access to pet owners, play crucial roles in the

overall education programme (Feldman and Carding, 1973; Mann, 1975; Arkow, 1987; Council for Science and Society, 1988; Arkow, 1991; Patronek, 1996; Arkow, 1998). Advising prospective new owners which type of pet to acquire and where to acquire it from, preparing new owners to anticipate the time, work and money involved in rearing a young pet, including prophylactic veterinary care, and offering guidance about the prevention and treatment of behavioural problems, are all examples of veterinary input (Fredrickson, 1975; Council for Science and Society, 1988; Bailey, 1992; Thornton, 1992; Hart and Kidd, 1994; Houpt, Honig and Reisner, 1996; Mahlow and Slater, 1996; Miller *et al.*, 1996; Patronek, 1996; Ledger, 1997; Melson, Schwarz and Beck, 1997; Hoff, Brawley and Johnson, 1999). Although many veterinary surgeons are already educating their clients, it would be plausible for the veterinary profession to place greater emphasis on public education (Rollin, 1991).

It has been suggested that veterinary schools should also be involved in addressing the surplus dog and cat problem. For example, departments which are knowledgeable in all areas relevant to pet overpopulation and the human-companion animal relationship could be established, with appropriate subjects included in the teaching curriculum (Beck and Quackenbush, 1983; Council for Science and Society, 1988; Beaver, 1991). Initiating programmes where veterinary students neuter adoptees at AWCs or become involved with neutering of feral cat colonies would provide low cost neutering and surgical experience for students (Rowan, 1986; Arkow, 1991; Howe and Slater, 1997; Hughes and Slater, 1999). Before advances can be made to resolve pet abandonment and neglect, more information is desperately needed (Mann, 1975; Murray, 1992b). With its objective, science based philosophies, the veterinary profession has much to offer in this field (Arkow, 1991; Murray, 1992a; Murray, 1992c). Companion animal epidemiologists may be instrumental in standardising data collection procedures and initiating research projects designed to investigate subjects relevant to pet overpopulation (Patronek, 1993). Veterinary schools could use full time research fellows or students could be involved in summer projects (Beaver, 1991). Once specialist knowledge has been gained, veterinary surgeons will be uniquely qualified to provide services to local government to promote better methods of urban animal management (Murray, 1984; Murray, 1992c).

1.4 SUMMARY

When pet overpopulation was first recognised as a cause for concern, management of the problem focused on pet reproductivity and the active encouragement of owners to neuter their pets (Murray, 1992a; Murray, 1992b; Alexander and Shane, 1994; Digiacomo, Arluke and Patronek, 1998). Traditional solutions included surgical neutering, subsidised neutering clinics, mandatory neutering for AWC adoptees and newer initiatives such as laws designed to prohibit breeding (Patronek and Glickman, 1994; Digiacomo, Arluke and Patronek, 1998). The desire to sterilise animals in simple and ingenious ways also led to the search for advanced non-surgical methods to prevent or terminate pet pregnancy (Olson *et al.*, 1991). Neutering of pets has now become routine for many owners, with consequent success in decreasing pet breeding (Patronek, 1996). Unfortunately, the impact of neutering programs on animal euthanasia is uncertain, with no evidence to indicate that these methods alone have succeeded in causing a significant reduction in the surplus of unwanted pets (Arkow, 1991; Beaver, 1991; Murray, 1992a; Murray, 1992b).

Traditional solutions to pet overpopulation concentrated upon the supply (breeding) of pets and neglected the role of demand and pet retention in the overpopulation equation (Patronek and Glickman, 1994). For example Woodrow (1975) suggested that 'overproduction' was the core of the stray and unwanted problem in every country and if this supply could be reduced to the level of demand, then the problem would cease to exist. However, the supply of pets is driven by demand, similar to most other consumer commodities (Murray, 1992b). Therefore, if demand remains unchanged but supply is reduced from one source i.e. household breeding, the supply of pets from other sources will rise to meet demands (Patronek and Glickman, 1994). Neutering programs deal with the consequences of pet overpopulation rather than its cause (Faulkner, 1975).

The previous assumption that pet overpopulation is caused by overbreeding alone has now been deemed invalid (Arkow, 1991; Murray, 1992b). It has been suggested that excessive numbers of pets are more a result of over demand than over supply. This implies that the primary cause of pet overpopulation, abandonment and neglect is casual inappropriate pet acquisition and irresponsible pet ownership. These owners fail to comprehend what a lifetime pet ownership commitment entails and lack the time,

resources, knowledge or inclination to provide pets with adequate care and supervision (Carding, 1975; Fredrickson, 1975; Feldman, 1977; Council for Science and Society; Murray, 1984; Rollin, 1991; Murray, 1992a; Murray, 1992b). Support for this view came from Patronek *et al.* (1994) who reported that the number of owners contributing to pet population turnover through failure to retain their dog, was approximately three times the number of those that allowed their female dogs to breed. Future attempts to resolve this problem warrant greater emphasis on the human factors involved and may require help from colleagues in human psychology (Murray, 1992b; Schuerger, 1998).

CHAPTER II

THE PET POPULATION IN STRATHCLYDE REGION, SCOTLAND

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2.1 INTRODUCTION

2.1.1 Introduction

It has previously been identified that the prevalence of pet ownership and the structure and dynamics of the pet population differ markedly between geographical regions (Nassar and Mosier, 1986b; Rowan and Williams, 1987; Rowan, 1991; Patronek and Glickman, 1994; Patronek and Rowan, 1995). Significant temporal and regional variations in ownership patterns means that it may be inappropriate to extrapolate available pet population estimates from one geographical region or from one period to another (Lengerich *et al.*, 1992; Teclaw *et al.*, 1992; Patronek and Glickman, 1994). Consequently, it is important that the current dog and cat population and dynamics in any given area are determined by a comprehensive local survey.

2.1.2 Purpose

The purpose of this study was to complete a local survey in Strathclyde Region, Scotland to define pet ownership rates and obtain a reference dog and cat population in this area. Dog owning households that were randomly selected from the sampling frame were subsequently to become part of a second study comparing 'successful' and 'unsuccessful' dog ownership (Chapter 4).

2.2 MATERIALS AND METHODS

2.2.1 Research design

A cross-sectional telephone survey was conducted during February 1997 by the author and one other female interviewer.

2.2.2 Sampling frame

The sampling frame consisted of households in Strathclyde Region, Scotland which covers approximately 5,254 square miles. Demographic statistics for this area were obtained from the most recent British census which was recorded in 1991 (Census 1991 on CD-ROM). Strathclyde Region had a population of approximately 2,248,706 in 1991, residing in 907,953 households. The subdivision of this population into ethnic groups is outlined in Appendix I.

2.2.3 Sampling criteria

A systematic random sample of 2000 residential households, with a British Telecommunications (BT) listed telephone number, was selected to be surveyed. The pet owning status of the household was then determined.

2.2.4 Sampling procedure

A two stage sampling technique was used to randomly select households and accompanying telephone numbers from the latest BT phone books. Five regional BT phone books were used out of a total of 13 regional sets for Scotland. These five books listed the telephone numbers for households within the study region. Each book was subdivided into two sections; business telephone numbers and residential telephone numbers. The former section was excluded and only residential telephone numbers were considered. The first sampling stage involved determining the proportion of the research sample to be selected from each of the five regional BT phone books. First, the approximate number of residential telephone numbers listed in each phone book was determined. This was achieved by counting the number of listings in a page, for ten separate pages. The average of these counts was calculated and this figure was then multiplied by the total number of pages listing residential telephone numbers for each BT phone book. The proportion of the research sample to be generated from one phone

book was then determined by dividing the number of listings for each book by the total number of listing for all five books, then multiplying this proportion by the sample size (2000). Details of the BT phone books used in this survey and calculation of the proportion of the research sample to be selected from each of the five books is outlined in Appendix II.

The second sampling stage involved selection of households and accompanying telephone numbers from each regional BT phone book, corresponding to the proportion of the research sample required from each. This was accomplished by using three lists of randomly generated numbers, created by computer software (Microsoft Excel for Windows '95, Version 7), for each regional BT phone book. The ensuing three number combination was used to identify households in the following manner: the first number referred to the page number of the BT phone book, the second number referred to the column on that page (1 to 4), and the final number referred to the row within the chosen column from which the selection was to be made. With regard to the last of these, the numbers generated within the random list did not specify a precise row number. Instead these numbers referred to a measurement. This measurement indicated the distance down the chosen column from where the row selection was to be made. Each measurement was taken with a hand held ruler carefully placed exactly parallel to the side of the page and flush with the top of the page. The line at which the measurement intersected the chosen column was taken as the selected row. If the measurement intersected the column between two rows, alternative rows above or below this point were selected. Details of the formula entered into the computer software for generation of the three lists of random numbers and an example of the ensuing three number combination for one of five BT phone books is shown in Appendix III.

On completion of this process, the name, address and accompanying telephone number for each selection was carefully copied from the BT phone book and manually written by the researcher into pre-prepared tables. Each randomly selected entry was then contacted by the listed telephone number. If the number dialled was a non-viable telephone number, it was recorded as such but no replacement telephone number was selected.

2.2.5 Data collection

An initial call and up to two additional calls were made to each selected BT phone book entry, excluding non-viable telephone numbers, over a three week period. Telephone calls were made during day and evening hours on week days and at the weekend. If no response was obtained, the timing of the telephone call (day or evening) was recorded. Follow-up calls were then made at the alternative time of the day. As the results of this survey would be generalised to households and not to the entire population of adults, it was not necessary to go through a systematic process for selecting the member of the household to be interviewed. In general, interviews were conducted with the adult household member who answered the telephone, if they could provide information as to the household's current pet owning status. If a child member of the household answered the telephone, they were requested to select any adult household member who could complete the survey. Households that initially refused an interview, were not recalled.

Females were deliberately chosen to conduct the telephone interview throughout this survey. In addition, both the author and the second interviewer identified themselves as working at the University of Glasgow Veterinary School, in an attempt to reduce respondents' apprehension about the legitimacy of the call. A pre-prepared questionnaire was used by each of the interviewers (Appendix IV). The questionnaire was limited to a very short, simple interview due to the anticipated reluctance of British residents to disclose any personal information to a stranger via the telephone. All questions were open ended and allowed respondents to answer freely. Pre-testing of the questionnaire was not performed due to its assumed simplicity.

Households that were willing to participate in the survey were classified into pet owners or non-owners. Animals considered as pets included dogs, cats, caged birds, fish, horses, rabbits, guinea pigs and other small rodents. Several species of exotic animals were also regarded as pets. For pet owning households, the species of pet(s) currently owned was recorded. For dog and cat owners, the number of dogs and cats owned by these households was also noted. Interviewers recorded all data pertaining to the telephone calls manually on to pre-prepared tables (Appendix V).

2.2.5.1 Data storage

The information collected during implementation of the telephone survey was transferred to a computer database (Microsoft Access for Windows '95, Version 7). Microsoft Access is a database management system that permits the storage of data in tables. Each table is uniquely designed by the researcher by naming 'fields' (columns) and specifying the format of data to be stored in the field. Each field within the table relates to one stored category of information. Each individual row of the table is occupied by the data collected from one member of the research sample, with each characteristic being allocated to the appropriate column. To facilitate entry of data, 'forms' can also be constructed which are linked to their reference table. A form displays a single record on the screen at one time, with the complete selection of fields for data being recorded. Data entered into each form are automatically stored within an individual row of the corresponding reference table.

For the telephone survey, one table was constructed for data storage, consisting of nineteen fields and one form was designed for data input. To avoid operator error and reduce time consuming typing during input of data, 'sub-tables' (combo boxes) were designed which consisted of a list of options for fields storing a selection of categorical variables. These sub-tables were embedded in the data entry form with easy access to lists that could be scrolled through and the appropriate categorical variable selected. In addition, 'check boxes' were used which permitted a tick to be entered into a box to record that a characteristic was present or could be left blank when the characteristic being measured was absent.

2.2.6 Statistical analysis

Simple descriptive analysis was carried out in Microsoft Access using specifically designed 'queries'. Microsoft Access tables can be queried to limit and collate data by specifying one or more distinguishing criteria. Further descriptive statistics were compiled using Microsoft Excel for Windows '95, Version 7 after data had been imported from the Microsoft Access database. Comparison of the results obtained from the five BT phone books were evaluated using Pearsons chi-square test for independence (Dawson-Saunders and Trapp, 1994). Chi-square analyses were

undertaken using the Minitab Statistical Software Package. A significance level of 5% ($\alpha = 0.05$) was used throughout.

2.2.6.1 Population estimates

From the results obtained, the population of dogs was estimated using the following equation:

$$\text{P (Dogs)} = \frac{A}{B} \times C \times \frac{D}{A}$$

where P represents the estimated population of dogs, *A* represents the number of dog owning households that were interviewed, *B* represents the total number of households that were successfully interviewed, *C* represents the number of households in Strathclyde Region and *D* represents the total number of dogs from all dog owning households. As can be seen, *A/B* multiplied by 100 represents an estimation of the percentage of households in Strathclyde Region that own a dog and *D/A* represents the average number of dogs per dog owning household.

Ninety five per cent confidence intervals for estimates of population size were calculated by the following method:

$$\text{95\% CI for P, } \pm\ 1.96\left(\frac{N}{\sqrt{n}}\right) \times \sigma_x$$

where P represents the estimated population size, *N* represents the total number of households in Strathclyde Region, *n* represents the number of households in the research sample that were successfully interviewed and σ_x represents the standard deviation of *x*, where *x* represents the average number of dogs per household, with respect to all households in the research sample.

The population of cats in Strathclyde Region and 95% confidence intervals for this estimate were calculated by the same method, as described above for dogs.

2.3 RESULTS

2.3.1 Telephone Response

Results regarding response from the telephone survey are presented in Table 2-1. The results obtained from each individual BT phone book were compared using chi-square analysis (Table 2-2). Apart from the proportion of phone book entries dialled that were non-viable telephone numbers and the proportion of first callings that were answered as opposed to those that obtained no response, all other comparisons indicated that no significant difference existed between the responses achieved from each BT phone book. The response obtained from all books considered together is therefore reported below and presented in Figure 2-1.

Two thousand listed names and accompanying telephone numbers were randomly selected from the five regional BT phone books to be surveyed. This represented 0.2% of households within the study region. Of the 2000 phone book entries selected, 85 (4.2%) were non-viable telephone numbers. Of the 1915 phone book entries with a viable telephone number, a total of 1798 (93.9%) households were successfully contacted. Reasons for unsuccessful contact after a maximum of three calls included no answer (74, 3.9%), answer machine (42, 2.2%) and permanent engaged tone (1, 0.1%).

Table 2-3 presents the relative response rates obtained from the first, second and third calls during implementation of the telephone survey. As can be seen, the proportion of telephone calls successfully answered on the first call was higher than the second call which was higher than the third call (Figure 2-2). With respect to non-responses, the relative proportion of calls that were received by an answer machine increased from the first telephone call, to the second and to the third attempts at contacting non-responding households (Figure 2-3).

Of the 1798 households contacted, 27 (1.5%) refused to be interviewed. The overall survey response rate for households that successfully completed an interview (n=1771) was 88.6% of all the telephone book entries selected, 92.5% of all entries dialled that were a viable telephone number and 98.5% of telephone calls that were answered.

TABLE 2-1: Response obtained from a telephone survey to determine the pet owning status of 2000 randomly selected households in Strathclyde Region, Scotland.

CATEGORY	BT PHONE BOOK					TOTAL
	276	277	278	518	519	
Number of telephone numbers dialled	329	565	337	348	421	2000
Calls which were not a viable number	15	28	22	8	12	85
Total dialled with viable number	**314**	**537**	**315**	**340**	**409**	**1915**
Answer machine 1st call	27	34	21	21	34	137
No answer 1st call	69	107	127	73	118	494
Total not answered 1st call	96	141	148	94	152	631
Answer machine 2nd call	8	20	12	13	12	65
No answer 2nd call	18	37	51	21	39	166
Total not answered 2nd call	26	57	63	34	51	231
Answer machine 3rd call	6	12	5	11	8	42
No answer 3rd call	10	15	21	10	18	74
Total calls not answered	16	27	26	21	26	116
Permanent engaged tone	0	0	1	0	0	1
Answered on 1st call	218	396	166	246	257	1283
Answered on 2nd call	70	84	85	60	101	400
Answered on 3rd call	10	30	37	13	25	115
Total answered	**298**	**510**	**288**	**319**	**383**	**1798**
Number unwilling to be interviewed	4	6	6	6	5	27
Households interviewed	**294**	**504**	**282**	**313**	**378**	**1771**

TABLE 2-2: Response obtained from a telephone survey to determine the pet owning status of households in Strathclyde Region, Scotland and comparison between each regional British Telecommunications phone book from which telephone numbers were randomly selected.

CATEGORY	BT PHONE BOOK					χ^2	*P*-VALUE
	276	277	278	518	519		
Viable telephone numbers	314 (95.44%)	537 (95.04%)	315 (93.47%)	340 (97.70%)	409 (97.15%)	10.35	0.03
Non-viable telephone numbers	15 (4.56%)	28 (4.96%)	22 (6.53%)	8 (2.30%)	12 (2.85%)		
1st call - answered	218 (69.43%)	396 (73.74%)	166 (52.70%)	246 (72.35%)	257 (62.84%)	48.63	<0.001
1st call - no response	96 (30.57%)	141 (26.26%)	149 (47.30%)	94 (27.65%)	152 (37.16%)		
2nd call - answered	70 (72.92%)	84 (59.37%)	85 (57.05%)	60 (63.83%)	101 (66.45%)	7.583	0.10
2nd call - no response	26 (27.08%)	57 (40.43%)	64 (42.95%)	34 (36.17%)	51 (33.55%)		
3rd call - answered	10 (38.46%)	30 (52.63%)	37 (57.81%)	13 (38.23%)	25 (49.02%)	4.99	0.29
3rd call - no response	16 (61.54%)	27 (47.37%)	27 (42.19%)	21 (61.77%)	26 (50.98%)		
Total calls - answered	298 (94.90%)	510 (94.97%)	288 (91.43%)	319 (93.82%)	383 (93.64%)	5.03	0.28
Total calls - no response	16 (5.10%)	27 (5.00%)	27 (8.57%)	21 (6.18%)	26 (6.36%)		
Did not complete interview	4 (1.34%)	6 (1.18%)	6 (2.08%)	6 (1.88%)	5 (1.31%)	1.48	0.83
Completed interview	294 (98.66%)	504 (98.82%)	282 (97.92%)	313 (98.12%)	378 (98.69%)		

FIGURE 2-1: Response obtained from a telephone survey to determine the pet owning status of 2000 randomly selected households in Strathclyde Region, Scotland.

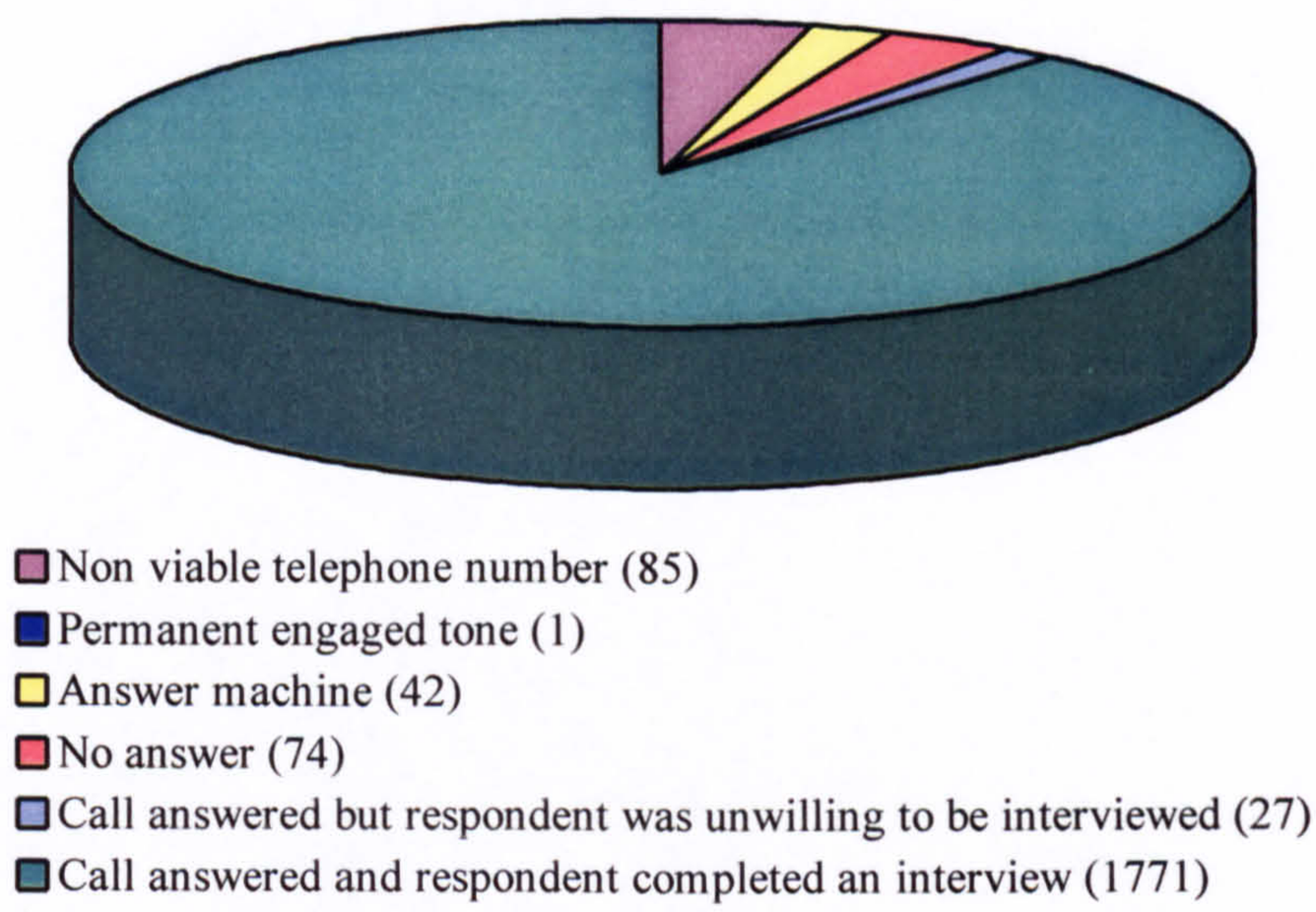


FIGURE 2-2: Relative response rates obtained from the first telephone call to 1915 households, from the second call to 632 non-responding households and from the third call to 232 non-responding households, during implementation of a telephone survey to determine the pet owning status of households in Strathclyde Region, Scotland.

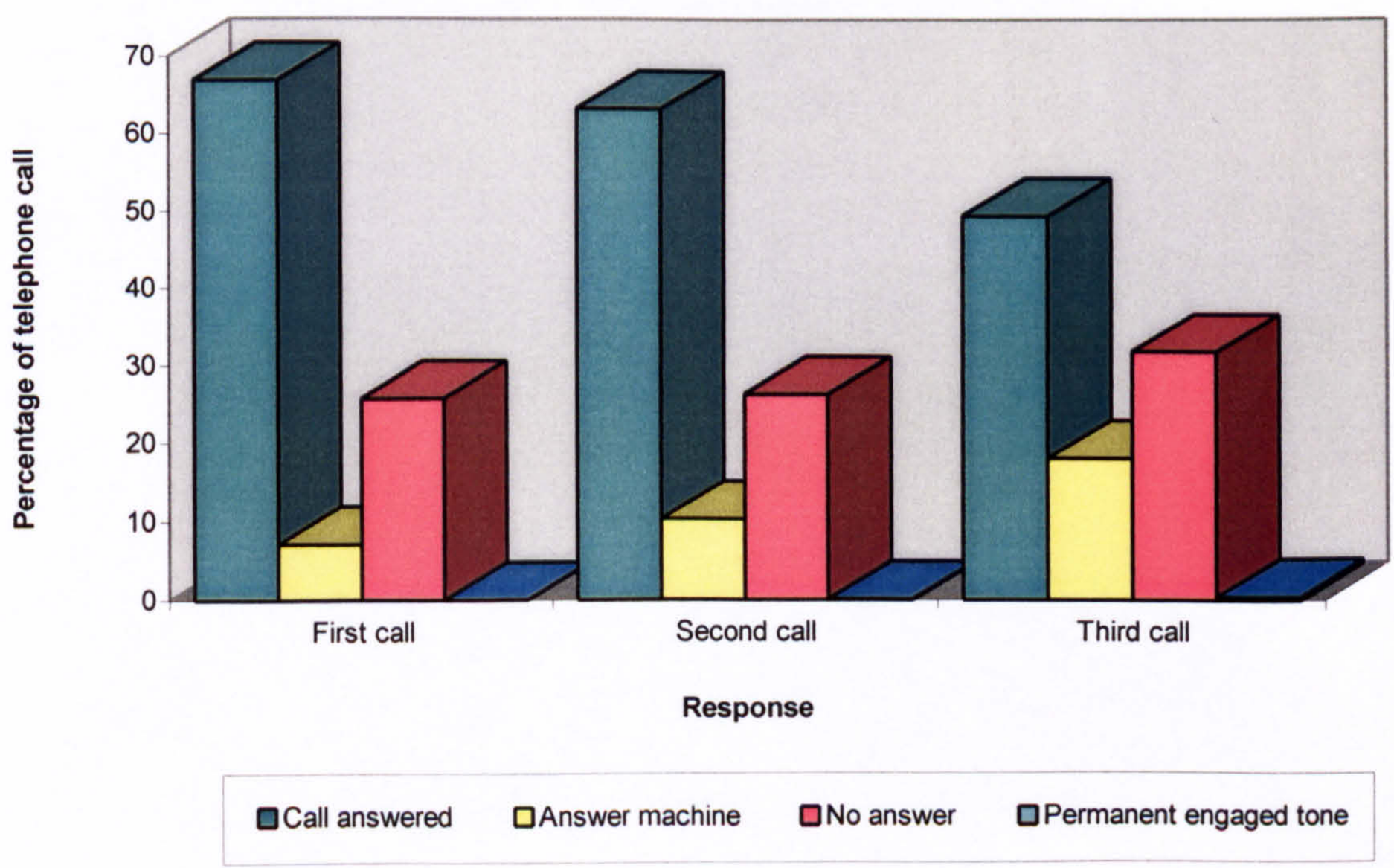
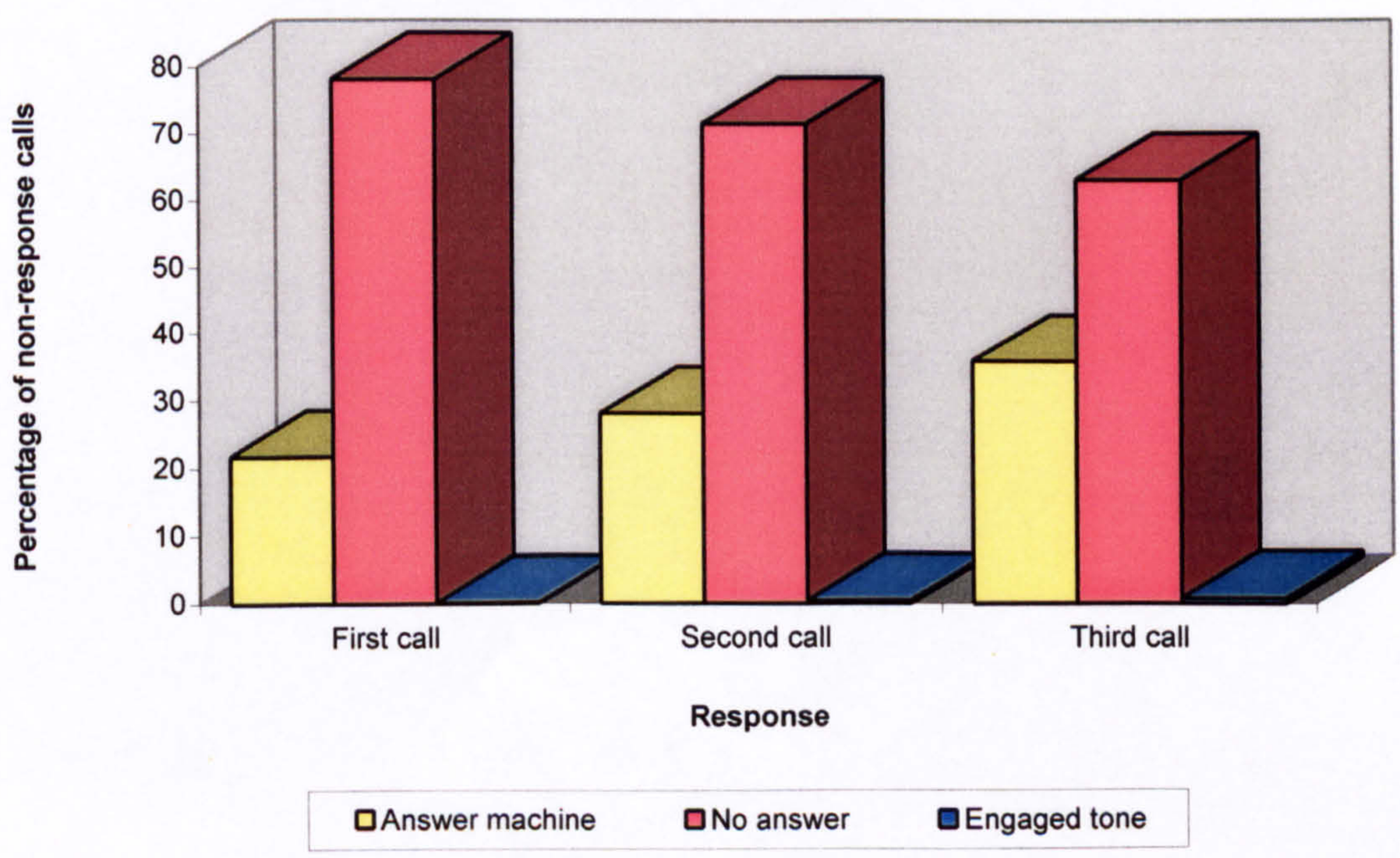


TABLE 2-3: Relative response obtained from the first telephone call to 1915 households, from the second call to 632 non-responding households and from the third call to 232 non-responding households, during implementation of a telephone survey to determine the pet owning status of households in Strathclyde Region, Scotland.

CATEGORY	1st CALL	2nd CALL	3rd CALL
Number of answered calls (% of calls)	1283 (67.00)	400 (63.29)	115 (49.57)
Number of non-responses (% of calls)	632 (33.00)	232 (36.71)	117 (50.43)
Answer machine (% of non-responses)	137 (21.68)	65 (28.02)	42 (35.90)
No answer (% of non-responses)	494 (78.16)	166 (71.55)	74 (63.25)
Engaged tone (% of non-responses)	1 (0.16)	1 (0.43)	1 (0.85)

FIGURE 2-3: Relative non-response rates of 632 non-responding households obtained from the first telephone call, 232 obtained from the second call and 117 obtained from the third call, during implementation of a telephone survey to determine the pet owning status of households in Strathclyde Region, Scotland.



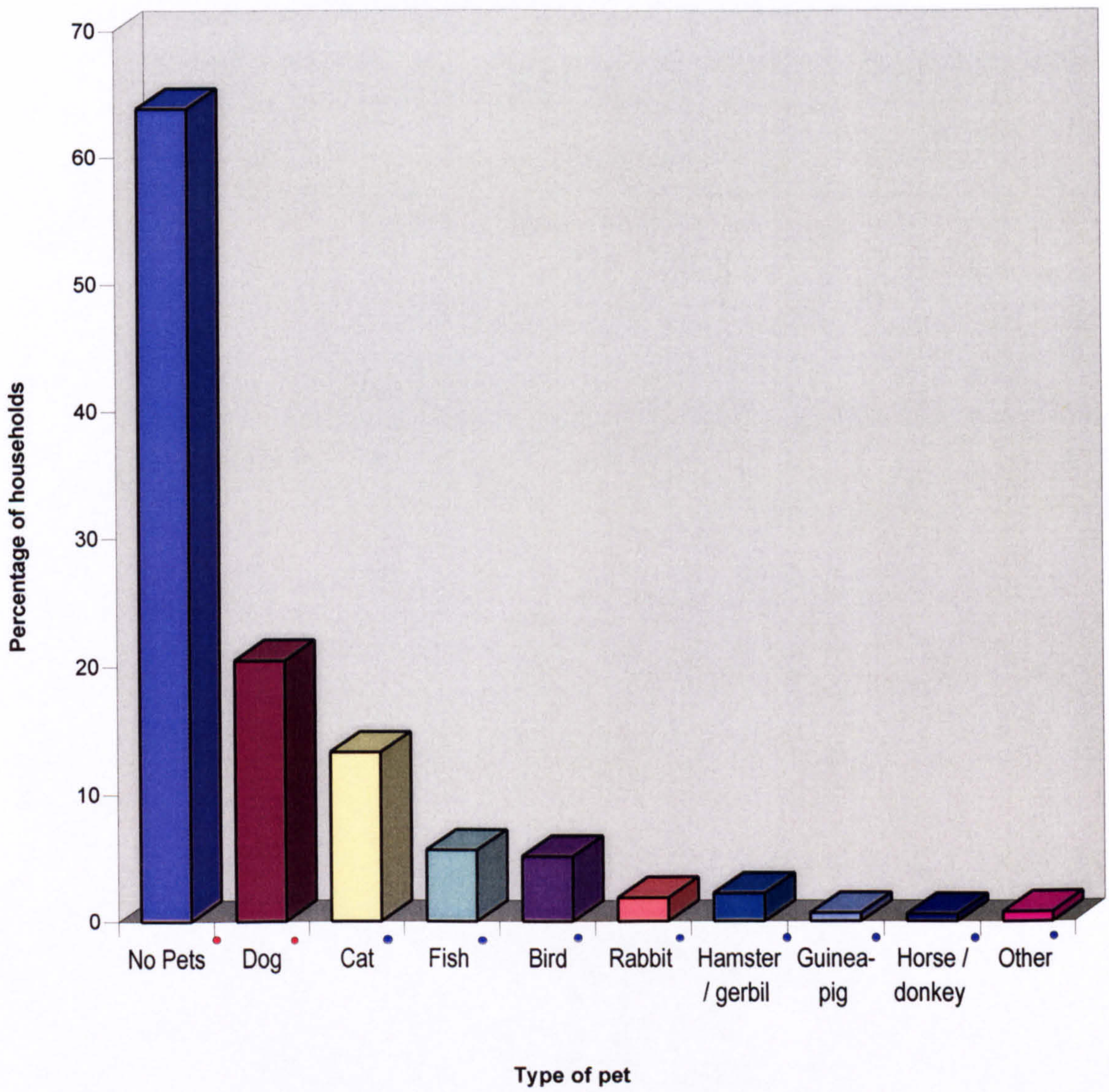
2.3.2 Descriptive statistics

Considering the sample of 1771 households that were interviewed, 639 (36.1%) were pet owners and 1132 (63.9%) did not own any pets. Dogs were owned in 362 (20.4%) of this sample. Unfortunately, due to interviewer error, 41 (11.3%) households that owned dogs were not questioned with regard to other pets owned. This represented 2.3% of the interviewed sample. Using the data from the 1730 successfully surveyed households, cats were owned in 231 (13.4%), rabbits were owned in 32 (1.8%), a hamster or a gerbil was owned in 38 (2.2%), guinea pigs were owned in 11 (0.6%), caged birds were owned in 89 (5.1%), fish were owned in 97 (5.6%), a horse or a donkey was owned in 10 (0.6%) and 13 (0.8%) households owned other types of pets including chinchillas, pet sheep, lizards, iguanas, snakes, tortoises, terrapins, stick insects and scorpions (Figure 2-4).

The type of pets owned by households selected from each regional BT phone book is presented in Figure 2-5. Chi-square analysis of these data showed no significant variation in the pet owning status of households selected from these five regional BT phone books (Table 2-4).

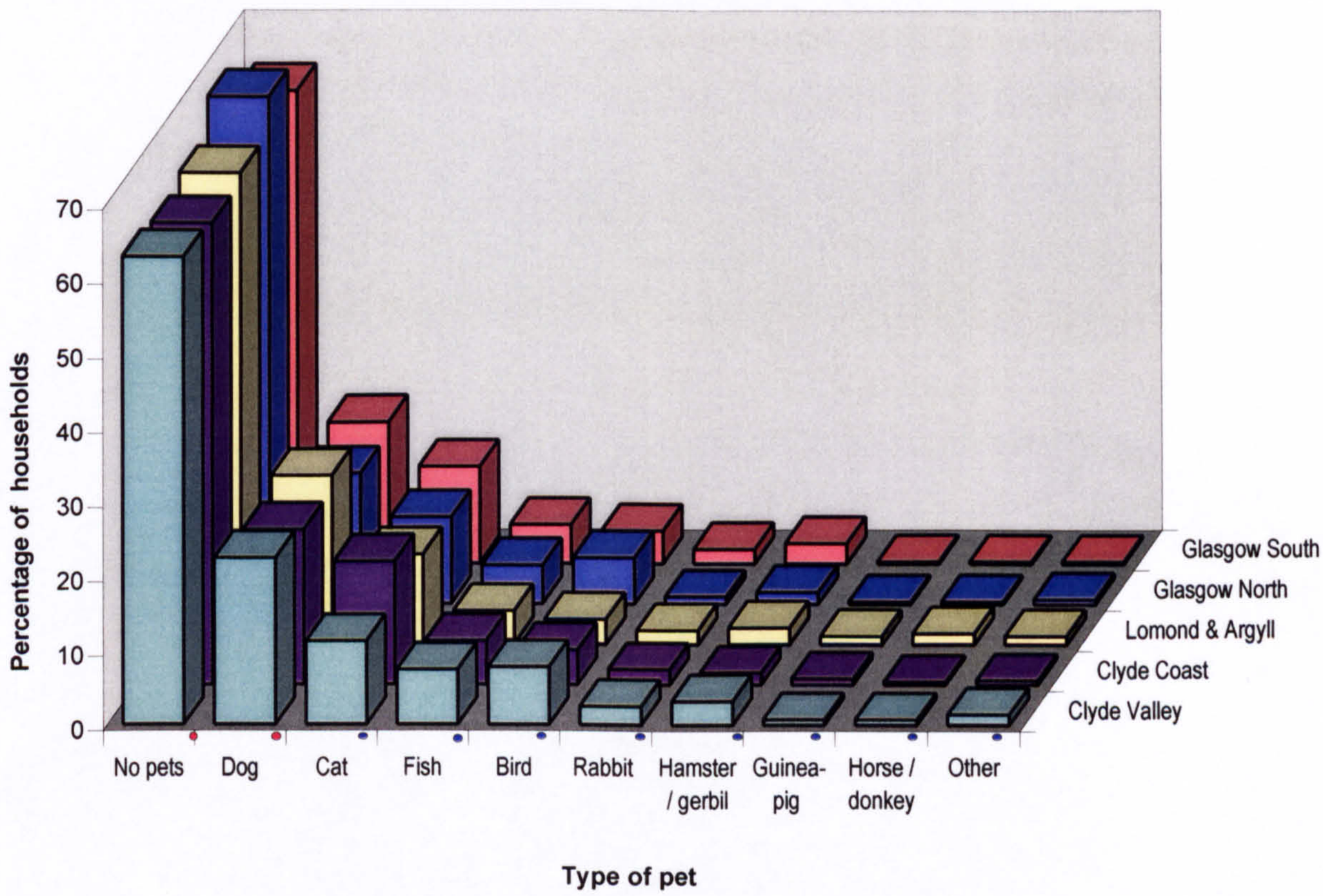
Table 2-5 presents details of pets owned when only pet owning households were considered. Of the 598 successfully surveyed pet owning households, 431 (72.1%) owned a single species of pet whereas 167 (27.9%) owned two or more species of pet. Dogs were the sole pet in 59.5% of dog owning households and 31.9% of all pet owning households. Cats were the sole pet in 63.6% of cat owning households and 24.6% of all pet owning households. Both dogs and cats were owned in 10.9% (65) of pet owning households. Tables 2-6 and 2-7 present details of other pets owned in dog and cat owning households, respectively. Most dog owning households kept a single dog (77.4%) and similarly, most cat owning households (73.7%) kept one cat. In those households with dogs, the mean (median) ± sd number of dogs kept was 1.3 (1) ± 0.8, in households with cats the mean (median) ± sd number of cats was 1.4 (1) ± 0.8. Alternatively, the average (median) ± sd number of dogs per household, with respect to all households in the research sample, was calculated as 0.3 (0) ± 0.6, and the average number of cats per household was calculated as 0.2 (0) ± 0.6.

FIGURE 2-4: Pet ownership rates among households that successfully completed a telephone interview in Strathclyde Region, Scotland.



Key ● - n =1771
● - n =1730

FIGURE 2-5: Pet ownership rates among households that successfully completed a telephone interview, for each British Telecommunications phone book listing telephone numbers for Strathclyde Region, Scotland.



Key

	BT phone book number	● Sample size (n)	● Sample size (n)
Clyde Valley	276	294	285
Clyde Coast	277	504	494
Lomond & Argyll	278	282	274
Glasgow North	518	313	309
Glasgow South	519	378	368

TABLE 2-4: Number of households, from each regional British Telecommunications phone book area, that reported ownership of pets during a telephone survey undertaken in Strathclyde Region, Scotland and chi-square comparison between these five books.

SPECIES OF PET	BT PHONE BOOK					TOTAL	χ^2	*P*-VALUE
	276	277	278	518	519			
Pet (s) owned	109	191	103	99	137	639	3.56	0.47
No pet owned	185	313	179	214	241	1132		
Dogs	66	105	64	55	72	362	3.69	0.45
No dogs	228	399	218	258	306	1409		
Cats	32	82	33	36	48	231	6.82	0.15
No cats	253	412	241	273	320	1499		
Fish	21	29	12	16	19	97	2.76	0.60
No fish	264	465	262	293	349	1633		
Birds	22	23	9	19	16	89	7.17	0.13
No birds	263	471	265	290	352	1641		
'Other' pets	19	21	17	10	15	82	5.81	0.21
No 'other' pets	266	473	257	299	353	1648		
Rabbits	7	10	5	3	7	32	-	-
Hamsters/gerbils	9	8	6	5	10	38	-	-
Guinea-pigs	2	4	3	1	1	11	-	-
Horses/donkey	2	2	4	1	1	10	-	-
Miscellaneous	4	3	3	2	1	13	-	-

TABLE 2-5: Type of pet(s) found in 598 households that reported ownership of pets, during a telephone survey undertaken in Strathclyde Region, Scotland.

TYPE OF PET	NUMBER OF HOUSEHOLDS	% OF PET OWNING HOUSEHOLDS
Single species of pet	431	72.07
Multiple species of pet	167	27.93
Dog	321	53.68
Cat	231	38.63
Fish	97	16.22
Bird	89	14.88
Rabbit	32	5.35
Hamster/gerbil	38	6.35
Guinea-pig	11	1.84
Horse/donkey	10	1.67
Other species of pet	13	2.17

TABLE 2-6: Other types of pet(s) owned in 321 households that reported dog ownership during a telephone survey undertaken in Strathclyde Region, Scotland.

CATEGORY	NUMBER OF HOUSEHOLDS	% OF DOG OWNING HOUSEHOLDS
No other pets owned	191	59.50
Own other pets	130	40.50
1 other type of pet	88	27.40
>1 other type of pet	42	13.08
Cat	65	20.25
Rabbit	14	4.36
Hamster/gerbil	14	4.36
Guinea-pig	7	2.18
Bird	41	12.77
Fish	46	14.33
Horse/donkey	8	2.49
Miscellaneous	6	1.87

TABLE 2-7: Other types of pet(s) owned in 231 households that reported cat ownership during a telephone survey undertaken in Strathclyde Region, Scotland.

CATEGORY	NUMBER OF HOUSEHOLDS	% OF CAT OWNING HOUSEHOLDS
No other pets owned	147	63.64
Own other pets	84	36.36
1 other type of pet	57	24.67
>1 other type of pet	27	11.69
Dog	65	28.14
Rabbit	8	3.46
Hamster/gerbil	7	3.03
Guinea-pig	4	1.73
Bird	13	5.63
Fish	22	9.52
Horse/donkey	6	2.60
Miscellaneous	8	3.46

2.3.3 Dog and cat population

By extrapolating the proportions of households that owned dogs or cats to the total number of households within the study region, it was estimated that approximately 185,589 households owned a dog and 121, 235 households owned a cat. On the basis of 1.3 dogs per dog owning household and 1.4 cats per cat owning household, the dog population (± 95% CI) was estimated to be 248,649 (± 25,372) and the cat population (± 95% CI) was estimated to be 170,044 (± 23,960) in the year 1997. Considering all households in the study region, from these estimates a 1:3.6 dog to household ratio and 1:5.3 cat to household ratio were calculated. Based on a human population of 2,248,706, the ratio of dogs to humans was 1:9.0 and cats to humans was 1:13.2.

2.4 DISCUSSION

2.4.1 Telephone survey

This survey used questionnaires to collect data from households regarding pet ownership, with a telephone survey selected as the questionnaire strategy. High cost, personnel requirements and the reasonably widespread distribution of the target population prohibited the use of a personal interview. While the administrative requirements for a mail survey are the least difficult to meet (Mork, 1970; Dillman, 1978), the appeal of a telephone survey as opposed to a mail survey included the speed by which a telephone survey can be conducted and the higher response rates achieved. Although it has been reported that a telephone survey may produce a lower quality of response than a mail survey (Siemiatycki, 1979, Siemiatycki *et al.*, 1984), the questionnaire was limited to a very short, simple format which would occupy less than five minutes of respondents' time. With such a telephone survey, the quality of data gathered should not be compromised (Dillman, 1978). Simplicity in the formulation of questions is crucial in the design of telephone interviews, where mental imagery must accomplish what visual aids can achieve in personal interviews and mail surveys (Dillman, 1978; Hartge and Cahill, 1998).

The total cost of conducting this survey was not calculated. Both mail and telephone surveys are generally reported to be far less costly than personal interviews, with a mail survey incurring the least expense (Hotchstim, 1967; Dillman, 1978; Siemiatycki, 1979;

Hartge and Cahill, 1998). A significant factor influencing cost of telephone surveys is length of the interview. Telephone interviews as long as one hour are reported to be equivalent in cost to personal interviews (O'Toole *et al.*, 1986) whereas for interviews under 10 minutes, cost is comparable to conducting a mail survey (Barrett *et al.*, 1992). As discussed above, the questionnaire used in this survey took approximately one to five minutes to complete. Consequently, the cost incurred here would probably be comparable to, if not lower than, conducting a mail survey with follow-up procedures.

The method used to select the research sample involved random sampling from the most recently published BT phone books (Appendix II). Although the five BT phone books used were the latest publications for the study region, between six and 17 months had elapsed between publishing the books and conducting the survey. Two of the main disadvantages of sampling from phone books stem from such a time interval: these are exclusion of telephone numbers for households that have acquired a new telephone and exclusion of those who have moved since the phone book was published. A third disadvantage of sampling from phone books involves households who deliberately have unlisted telephone numbers. Exclusion of any of the above three subpopulations, who could potentially possess different demographic characteristics from the general population and therefore have different pet ownership status, could result in sampling bias. The possibility that certain households may be listed in more than one BT phone book could be an additional source of sampling bias.

With respect to exclusion of new telephone numbers during the time lapse, anecdotal evidence suggested that a significant proportion of households in Strathclyde Region acquired a new telephone number. This was due to the emergence of several new companies providing a telephone service in this area, causing direct competition to the traditional BT service. Dillman (1978) reported from a survey undertaken in Washington that sampling from phone books, some of which were up to one year old, resulted in nine to fourteen per cent of the sampled numbers being disconnected. In the present survey, the percentage of disconnected numbers (non-viable telephone numbers) was only 4.5% (85), which suggests that disconnected numbers were not a large problem. Of interest is the finding that one of the significant differences between the five phone books used in this survey was the proportion of non-viable telephone

numbers. Analysis of these proportions, in relation to the age of each phone book, revealed a direct relationship (data not shown).

The alternative to sampling from phone books involves dialling lists of randomly generated telephone numbers, also known as random digit dialling (RDD). This method was developed to overcoming the problems of new listings, recent changes in numbers and unlisted numbers, by allowing access to all working telephone numbers (Dillman, 1978). However, RDD has its own disadvantages, the most important of which in favouring rejection of this method in the present survey, is the fact that the respondent's identity cannot be established before conducting the telephone survey. One of the aims of this telephone survey was to generate a sample of dog owning households that would become part of a mail survey. Prior knowledge of the respondent's name and address was therefore imperative, as it was anticipated that respondents would be reluctant to impart this information to a stranger via the telephone.

2.4.1.1 Response rate

A total of 1771 households successfully completed a telephone interview from a sample of 2000 randomly selected BT phone book listings. This represented a response rate of 88.6%. Alternatively, a response rate of 92.5% was achieved, if exclusion of the 4.2% (85) of the research sample that were non-viable telephone numbers was made prior to calculation of the response rate. Some authors calculate response rates to telephone surveys based on the number of successfully completed questionnaires, as a proportion of the number in the research sample minus non-eligible and non-contactable households. Olson *et al.* (1992) reported an 87.0% response rate to their telephone survey, which included only households that were contacted, whereas if all eligible households were considered, a 77.0% response rate was obtained. Calculation of the response rate based on contactable households only, would result in a 98.5% response rate for this survey.

Response rates in questionnaire surveys vary widely, depending on how the target population is selected, the method used to administer the questionnaire and the topic of interest (Dillman, 1978). The response rate of this survey was considered excellent. Comparable studies which used the telephone to elicit data about pet populations have reported response rates between 62 to 88% (Schneider and Vaida, 1975; Griffiths and

Brenner, 1977; Miller, Spangler and Dorn, 1987; Robertson *et al.*, 1990; Lengerich *et al.*, 1992; Manning and Rowan, 1992; Anonymous, 1995b; Dunmont, 1996; Patronek *et al.*, 1996a; Patronek *et al.*, 1996b; Patronek, Beck and Glickman, 1997). Dillman (1978) reported that response rates of between 80 to 90% can consistently be attained from telephone surveys of the general public. Although no advance letter was sent to the research sample, a procedure found to improve response rates, the response rate in this survey was better than the above reports.

With respect to the 1915 viable phone numbers called, 6.1% elicited no response, which represented 3.9% 'no answer', 2.2% 'answer machine and 0.1% 'permanent engaged tone'. For this survey, a total of three follow-up calls were made to non-responding household, which is similar to other surveys (Robertson *et al.*, 1990; Manning and Rowan, 1992; Patronek *et al.*, 1996a). However, some researchers have reported as much as seven to nine follow-up calls (Siemiatycki, 1979; Olson *et al.*, 1992). Dillman reported four to seven per cent no answer rates, despite intensive follow-up efforts, which is comparable to the proportion obtained in this survey. It seems unlikely, therefore, that the response rate achieved would have significantly improved with additional follow-up calls to non-responding households.

Of interest, is that over one third of the final non-responses were answered by an answering machine. However, if this is analysed in relation to the call number (first, second or third), the proportion of non-responses answered by an answering machine was only 21.7% on the first call, increased to 28.0% on the second call and reached 35.9% on the final call. The likely reason for this is that there exists a subpopulation of households that use answer machines to 'screen calls'. For such households, irrespective of the number of telephone calls made, the call would never be answered. If this practice of call 'screening' increased, the efficiency of telephone surveys could be compromised. For this survey, the characteristics of non-respondents were not determined. However if such households represented a subpopulation with different pet ownership status than the general population, results could be biased.

2.4.2 Pet ownership

The dog and cat populations of Strathclyde Region were estimated to be 248,649 and 170,044, respectively. Reports from North America and the UK have discussed the increased popularity of the domestic cat and recently documented that the total owned cat population has surpassed the dog population in many areas (Troutman, 1988a; Arkow, 1991; Anonymous, 1995; Patronek and Rowan, 1995; Gehrke, 1997, PFMA, 1999). This higher feline population is attributable to individual households keeping more cats, with slightly higher rates of dog ownership still identified. The relative feline population tends to outnumber the canine population in urban communities, where modern working lifestyles favour the more independent cat which requires less maintenance and allows owners greater personal freedom compared to dogs (Arkow, 1991, PFMA, 1999). In contrast to the above reports, the present study estimated that the dog population remains substantially higher than the cat population in Strathclyde Region.

Data from this study provide baseline dog and cat population statistics for Strathclyde Region based on the owned pet population, but take no account of feral and stray animals or the animal welfare centre population of dogs and cats. Reports have indicated that the stray and feral cat population in North America is large and possibly of similar size to the owned population (Anonymous, 1995; Patronek and Rowan, 1995; Mahlow and Slater, 1996; Patronek, 1998). Researchers have examined feral cat colonies in the UK, with estimates that the feral or 'unwanted' cat population was approximately 1.2 million in 1982, representing just under 20% of the total feline population (Dard, 1978; UFAW, 1982; Neville, 1983; Neville and Remfry, 1984; Neville, 1989; Passanisi and MacDonald, 1990; Page *et al.*, 1993; Remfry, 1996). It is important to clarify therefore, that the population of cats reported above, applies to owned cats only and does not refer to the entire feline population.

A pet ownership rate of 36.1% was estimated in this study. Dogs and cats were the most prevalent species, owned by 20.4% and 13.4% of households, respectively. To the author's knowledge, no other survey has been conducted in Strathclyde Region to compare with these results. A limited number of published pet ownership patterns in the UK, together with demographic characteristics of the pet population, are available (Carding, 1969; Jordan, 1973; Carding, 1975; Fennell, 1975; Godwin, 1975; Edney and

Smith, 1986; Council for Science and Society, 1988; Thrusfield, 1989; Passanisi and MacDonald, 1990; Mellor *et al.*, 1999). In addition, the Pet Food Manufacturers Association have, for many years, sponsored annual surveys to estimate the size and nature of the UK pet population. Although their results are usually unpublished, data are available on request (PFMA, 1999). According to the above reports, approximately 4.75 to 6.9 million pet dogs and 3 to 8.0 million pet cats, together with a vast number of other pet animals including horses, cage birds, small mammals, fish and wild and exotic pets, reside in households in the UK. Roughly half of all households have been reported as owning at least one companion animal, with an estimated 24 to 27% of households owning dogs, 13.8 to 20% owning cats and 12% owning birds. These figures are noticeably higher than those estimated in present investigation. Despite these higher rates of pet ownership, Carding (1975) reported a 1:9.4 dog to human ratio and a 1:12.4 cat to human ratio, which are comparable to the estimates of the present study. Thrusfield (1989) reported a 1:3.1 dog to household ratio and 1:3.2 cat to household ratio. A 1:3.65 dog to household ratio was estimated in the present study, similar to Thrusfield's findings. However, the estimated cat to household ratio (1:5.34) was significantly lower than Thrusfield's report. This may reflect the lower proportion of the national cat population that resides in Scotland, as reported by Anderson (1983). This report highlighted varying rates of pet ownership in different regional areas of Britain, with Scotland representing 10% of households but only 9% and 6% of the dog and cat population, respectively. According to this author, the ratio of dogs to cats in Scotland was 1.5:1.0. This compares favourably with the present study which estimated a 1.46:1.0 dog to cat ratio.

Several pet population studies have appeared in the literature from countries outwith the UK, especially from North America (Schnurrenberger *et al.*, 1961; Marx and Furcolow, 1969; Dorn, 1970; Anvik, Hague and Rahaman, 1974; Franti and Kraus, 1974; Franti *et al.*, 1974; Schneider and Vaida, 1975; Griffiths and Brenner, 1977; Heussner *et al.*, 1978; Heussner and Grant, 1978; Rhoades and Selby, 1979; Franti *et al.*, 1980; Nassar and Mosier, 1980; Selby *et al.*, 1980; Nassar and Mosier, 1982; Charles, Charles Research groups, 1983; Nassar, Mosier and Williams, 1984; Wise, 1984a; Wise, 1984b; Wise and Kushman, 1984a; Miller, Spangler and Dorn, 1987; Wise, 1987; Marx *et al.*, 1988; Troutman, 1988a; Troutman, 1988b; Troutman, 1988c; Troutman, 1988d;

Troutman, 1988e; Robertson *et al.*, 1990; Lengerich *et al.*, 1992; Manning and Rowan, 1992; Teclaw *et al.*, 1992; Wise and Yang, 1992; Leslie *et al.*, 1994; Patronek and Glickman, 1994; Wise and Yang, 1994; Anonymous, 1995b; Margawani and Robertson, 1995; Patronek and Rowan, 1995; Luke, 1996; Gehrke, 1997; Patronek, Beck and Glickman, 1997). Surveys of the pet population, absolute dog numbers and veterinary needs have also been conducted in some developing countries (Rangel, Lara and de Aluja, 1981; Brooks, 1990; McCrindle, Cornelius and Schoeman, 1997). Differences in study methodology, geographical location and time period preclude accurate comparison of results with the present study. In general, a wide variety of pet ownership rates have been reported, the majority of which were considerably higher than the present survey.

As discussed in Chapter 1, wide variations in pet ownership rates have consistently been reported. Many cultural, socio-economic and religious factors may contribute to major differences in attitudes towards and ownership of companion animals between different countries (Brown, 1985). However, it is more difficult to account for the substantial disagreement in national pet ownership rates reported by various researchers and the varying levels of pet ownership for each locality within a country. There are many factors that could account for these inconsistencies and consideration of these, may help explain the low pet ownership rates estimated in this present survey for Strathclyde Region.

First is the issue of survey design and the method by which researchers elicit data from the research sample. Patronek and Rowan (1995) reported a consistent difference between surveys undertaken in North America in the method of sampling, with surveys that estimated high pet ownership rates typically being conducted using mail questionnaires to non-randomly generated household panels, whilst surveys that produced lower estimates were conducted using telephone questionnaires to randomly generated samples. Although household panels are representative of the general population on certain demographic variables, they could differ from a randomly generated sample in ways that may be important determinants of pet ownership. Furthermore, mail surveys typically produce lower response rates than those achieved from telephone surveys. A response bias may then occur when responding and non-responding households differ in the characteristics that the survey is measuring. For example, with mail surveys about pet ownership, pet owners tend to be more likely to

respond than non-owners. Such a response bias will overestimate pet ownership obtained from a mail survey, unless corrected for non-responders (Rowan, 1991; Teclaw *et al.*, 1992; Rowan and Patronek, 1995). While the characteristics of non-responding households were not assessed during this survey, it is unlikely that a response bias occurred due to the high participation rate.

Conversely, validity of response has been reported to be higher in mail surveys compared to telephone surveys (Siemiatycki, 1979; Siemiatycki *et al.*, 1984). In addition, telephone surveys are reported to experience more under-reporting than mail surveys, particularly when dealing with sensitive issues and socially embarrassing questions (Siemiatycki, 1979; Siemiatycki *et al.*, 1984). Patronek, Beck and Glickman, (1997) revealed that a substantial number of households failed to report having lost or relinquished a pet to animal welfare centres during a telephone survey, demonstrating under-reporting of a sensitive question. Hartge and Cahill (1998) suggested that sensitive topics may be difficult to query as respondents may be suspicious of the legitimacy of the call. The pet ownership status of a household would, at first inspection, appear to be a non-sensitive questions that should not unduly suffer from under-reporting during a telephone survey. However, in certain housing categories pet ownership is prohibited, such that questions pertaining to the presence of pets would pose as a sensitive question to violators of housing laws. This latter point is particularly relevant for Strathclyde Region, due to the high number of households residing in 'high rise flats' which currently prohibit pets.

Discrepancies in pet population figures may also result from the phrasing of questions included in the survey questionnaires because unless clearly defined, 'pet' may be interpreted in different ways. For example, some respondents may include stray animals or another household's pet that they feed from time to time (Rowan, 1991). Furthermore, several different species may be reported as pets whereas others may consider their non-traditional or exotic pets as irrelevant to surveys (Leslie et al., 1994). More importantly, as discussed in Chapter 1, research has shown that certain household demographic factors are important determinants of pet ownership. Human attitudes and individual preferences also affect pet ownership rates and together with observable demographic factors, are assumed to induce considerable variations in pet ownership rates between different geographical locations. Considering the low pet ownership rate

of Strathclyde Region, community setting, home ownership status and housing type may be important factors.

Strathclyde Region encompasses Glasgow, the largest city and highest area population density in Scotland. This city has an estimated 292,260 households which represents almost one third of all households within the study region. Pet populations in large cities are reported to be considerably lower than the figures for rural communities and national surveys (Marx and Furcolow, 1969; Franti and Kraus, 1974; Franti *et al.*, 1974; Griffiths and Brenner, 1977; Marx *et al.*, 1988; Brooks, 1990; Leslie *et al.*, 1994; Melson *et al.*, 1997). With regard to home ownership status, this factor has considerable effect on the probability of owning a dog or cat, with reports that ownership is dramatically higher amongst home owners (Griffiths and Brenner, 1977; Wise and Kushman, 1984a; Troutman, 1988b; Troutman, 1988c; Nassar and Mosier, 1991; Wise and Yang, 1992; PFMA, 1999). Lower rates of pet ownership in rented accommodation may reflect prohibition of pets by property owners (Hart and Kidd, 1994). Considering housing type, researchers have reported that pet ownership is lower in buildings encompassing multiple as opposed to single family dwellings (Franti *et al.*, 1974; Teclaw *et al.*, 1992; Hart and Kidd, 1994). Single family homes perhaps allow more space for pets. A large number of households in Glasgow reside in multiple family tenement apartments which often attract home renters, and 'high rise flats' which prohibit pet ownership. Finally, Glasgow, with its two main universities and several smaller academic institutes, has a large student population which is less likely to own pets (Marx and Furcolow, 1969; Dorn, 1970). Home ownership is uncommon among students and the instability of this population is not conducive to pet ownership.

The points mentioned above, in combination with other undetermined factors that may influence ownership of pets, could account for the low pet ownership rates found in this present study. Alternatively, the rate of pet ownership reported in this investigation could be artificially lowered due to survey bias and under-reporting. However, it will be impossible to clarify the situation until additional surveys are conducted in this region to compare with the results here.

In agreement with the present investigation, studies conducted in other countries, as mentioned above, have found that a higher proportion of households keep dogs than any

other pet, with the next most popular pet being cats. In contrast, birds were reported as the most popular pet in Bali, Indonesia, with the proportion of households owning birds being much higher than that reported by other surveys (Margawani and Robertson, 1995). Whilst most existing cultures keep pets, the favourite species may vary. Consequently, the importance of birds in the traditional Indonesian culture is reflected in the high rate of ownership in this country (Margawani and Robertson, 1995). Ownership of birds, fish, small mammals, 'exotic' and 'speciality' pets has increased dramatically in recent years, expanding the large number and diversity of companion animals owned (Beck and Meyers, 1996; Kremzier Smith *et al.*, 1998; Hoff *et al.*, 1999). Consequently, several species were reported as pets in the present study, similar to the findings of others (Franti and Kraus, 1974; Rhoades and Selby, 1979; Franti *et al.*, 1980; Charles, Charles Research groups, 1983; Wise and Kushman, 1984a; Council for Science and society, 1988; Troutman, 1988a; Troutman, 1988d; Troutman, 1988e; Robertson *et al.*, 1990; Manning and Rowan, 1992; Teclaw *et al.*, 1992; Wise and Yang, 1992; Wise and Yang, 1994; Gehrke, 1997).

2.4.3 Control sample selection

In addition to determining the pet ownership status of households in Strathclyde Region, this survey had a second purpose. Current dog owning households that were randomly located from the population of dogs within the study region, subsequently became the control sample for a case-control study. Therefore, it was imperative that this control sample was representative of the population from which the cases were selected. The potential for bias in a control group selected by this method exists, if low response rates are achieved and non-responders differ demographically from responders. Fortunately, the participation in this telephone survey was extremely high and almost eliminated such a problem. In addition, Olson *et al.* (1992) evaluated the use of Random Digit Dialling as a method of control selection and reported that for most measures, no difference was found between the control sample and the general population.

2.4.4 Summary

A telephone survey was conducted to establish the pet owning status of a randomly selected sample of households in Strathclyde Region, Scotland and to estimate the dog and cat populations by extrapolation of results to local census data. Results revealed that

36.1% of households were pet owners, with dogs and cats being the most prevalent species owned. Dogs were owned in 20.4% of households while cats were owned in 13.4% of households. Several other species also were owned as pets. The canine population of Strathclyde Region was estimated to be 248,649 and the feline population estimated to be 170,044. These dogs and cats were owned by an estimated 185,589 and 121,235 households, respectively.

The results obtained from this telephone survey provide a useful index of pet ownership rates and dog and cat numbers for Strathclyde Region, Scotland. Other regional areas of the UK could follow this example and determine their own pet ownership patterns, as it would be inappropriate to extrapolate the estimates calculated from this survey to other areas. Alternatively, Nassar and Mosier (1986) described the use of a statistical model to compute pet population statistics in a local community. This model was based on four demographic factors found to be important in estimating the probability of households owning a pet and the probable number of pets within the household. The model utilises local census data, avoids extrapolating estimates from other surveys and does not entail conducting a local survey.

Due to limited time and resources, a somewhat limited survey was undertaken in the present study. A more comprehensive investigation, with a different questionnaire, could elicit data on each variable that may be significant in affecting the structure and dynamics of the pet population. Population based studies could include questions on pet ownership, acquisition patterns (source of pets, age at acquisition, cost), reproduction status, birth rates and death rates. In addition, human demographic factors associated with pet ownership, human attitudes, animal health and use of veterinary services would also be valuable information to collect.

The results reported here indicate that a telephone survey is an efficient means of collecting data pertaining to pet ownership status of households in Scotland. However, unlike other countries, telephone surveys are not commonly undertaken in the UK, and the response of British residents to lengthy telephone interviews is unknown. Therefore, while limited amounts of information concerning pet populations can be generated from a telephone survey, this finding can not be generalised to more extensive data collection as described above, where a mail survey would perhaps be more appropriate.

CHAPTER III

AREA BASED SOCIO-ECONOMIC ANALYSIS OF PET OWNERSHIP

CHAPTER III

AREA BASED SOCIO-ECONOMIC ANALYSIS OF PET OWNERSHIP

3.1 INTRODUCTION

3.1.1 Introduction

The telephone survey outlined in Chapter 2 collected data regarding the pet ownership status of households in Strathclyde Region, Scotland. While the presence of companion animals within successfully interviewed households was established, factors that may be associated with pet ownership were not queried. In particular, household demographic and socio-economic characteristics that may influence the propensity of a household to own a pet were undetermined. It has been suggested that sensitive topics, including demographic variables, may be difficult to query by telephone, as many respondents are suspicious about the legitimacy of the call (Hartge and Cahill, 1998). The anticipated reluctance of respondents to disclose personal information to a stranger via the telephone, featured heavily in the non-collection of demographic data in the telephone survey of Chapter 2.

As discussed in Chapter 1, Section 2, previous studies of human and pet populations have shown a relationship between dog and cat ownership and household demographic factors. Accordingly, it has been hypothesised that each household decides whether to own a pet, and what combination of pets to own, based on observable socio-economic and demographic factors, together with unobservable human attitudes and individual preferences (Wise and Kushman, 1984a). Besides the fundamental desire to own a pet, successful ownership should incorporate adequate financial resources to support such an undertaking. In this respect, pet ownership may be considered to be dictated by financial equity, similar to many other goods that consumers own. However, the influence of socio-economics in predicting pet ownership has been variably reported. Some researchers have found that the ownership of pets is more likely in households with

higher incomes (Dorn, 1970; Franti and Kraus, 1974; Beck, 1975; Beck, 1980; Franti *et al.*, 1980; Wise, 1984a; Wise, 1984b; Troutman, 1988b; Troutman, 1988c; Teclaw *et al.*, 1992; Wise and Yang, 1992), whereas many researchers have found this variable to be less influential than other demographic factors, with similar ownership rates in all social classes (Godwin, 1975; Anderson, 1983; Wise and Kushman, 1984a; Robertson *et al.*, 1990; Leslie *et al.*, 1994).

The aforementioned studies used the measure of social class or household income as the indicator of differences in socio-economic status between households, with occupation providing the basis for classification to a social class. Being in a lower social class, i.e. in semi-skilled or unskilled occupations, is interpreted as indicating household earnings at the lower end of the income scale. However, social class is not the only measure of social disadvantage and doubts have recently been expressed about the value of social class in this respect (Carstairs and Morris, 1991). Data reported in relation to social class suffer from the inflexible nature of this classification and the failure of occupational class to produce a population ordering in terms of basic socio-economic circumstances. Numerous occupational categories are also eligible for each social class. Hence, each class does not consist of homogeneous categories and allocation to social class is often inconsistent. Consideration of these problems may explain the discrepancies encountered when assessing the association between socio-economics and pet ownership.

In recent years, researchers have diverged from the narrow focus on absolute dimensions of poverty and lack of resources, towards a broader perspective on the multifactorial nature of social disadvantage and social exclusion. Deprivation, defined as observable and demonstrable social disadvantage relative to an acceptable standard, encompasses various conditions, independent of income, experienced by people who are materially poor and incorporates the social nature of humans to participate and integrate in society (Gibb *et al.*, 1998). Unlike the conventional concept of poverty, deprivation cannot be adequately studied through a single focus on income. Instead, a broad range of indicators are used to identify and measure its various dimensions including provisions, attainment and opportunity in employment, housing, education and health (Gibb *et al.*, 1998). Within this framework, populations have been shown to be much more diverse in respect to deprivation than in terms of social class, and this greater discrimination enhances its value as an explanatory factor in epidemiological studies (Carstairs and Morris, 1991).

Access to data concerning variables that measure those circumstances of the population that may be interpreted as conferring or denying access to material benefit, assists investigators wishing to undertake appropriate socio-economic analysis. In this respect, the national population census, a ten yearly event, provides the only source of objective and uniform data for the entire UK population. The census is an ancient device for providing a complete count of a population at one point in time and recording their characteristics (Rees, 1995). The General Register Office for Scotland is responsible for the registration of births, marriages, deaths, divorces and adoptions in Scotland. The office also carries out the decennial census of the Scottish population. Census data have been published as large computer readable files for some time and details pertaining to the 1991 census are available on CD-ROM (Census 1991 on CD-ROM). The UK census employs a fairly simple questionnaire. For example, the 1991 census asked 19 individual and five households questions (Rees, 1995). Nevertheless, an enormous number and variety of information can be produced from these basic data, with increasingly sophisticated analysis being made by researchers.

Under the Census Act of 1920, amended by the Census Act of 1991, respondent confidentiality is ensured by prohibiting the disclosure of variables measuring individual household attributes (Rees, 1995). Instead, census data are released to researchers in the form of output tables that collate individual household data to form counts for different area levels. Under the limits of confidentiality, the smallest output area released from the 1991 census must include data from 16 households or 50 people. Three types of area data were produced from the 1991 census: national statistics, local based statistics and small area statistics, each providing information for defined geographical scales (Rees, 1995). Researchers which rely on the census to provide objective attributes for the population under investigation, are constrained by these output tables into area based analysis that describes the area of residence as opposed to individual households.

Area based analysis has been used as a method of discriminating between populations which are, to some degree, exposed to and share the same environment and consequently, the attributes of that environment (Carstairs and Morris, 1991). Such an approach often exploits the postcode system, with the postcode providing a convenient means of allocating an area reference based on the individual's address. Area based analysis has been used in a number of epidemiological studies examining, for example,

the link between human health and physical features of the environment, air pollution and the hardness of water (Carstairs and Morris, 1991). Use of area based methods to examine variations by social and economic factors has been a more recent field of study. Using socio-economic data available from the census, researchers have attempted to locate areas, and the population within them, on a dimension that reflects the level of deprivation. Deprivation is conceptualised in a broad and inclusive way by selecting a comprehensive set of indicators that reflect the multiple nature of deprivation as it relates to housing, health, education, crime, labour market and material poverty (Gibb *et al.*, 1998). By this method, a range of individual variables from the small area statistics output of the census, are combined to form a single deprivation score for each small area. The resultant values create a distribution of scores on a dimension ranging from affluent to deprived. In recent years, a number of deprivation indexes have been constructed for national and local studies (Carstairs and Morris, 1991; Duguid, 1995; Gibb *et al.*, 1998). These studies represent a range of objectives, statistical techniques and methods of validation. Given that no universally accepted definition of deprivation exists, variables selected for inclusion in these studies have been diverse.

3.1.2 Purpose

The purpose of this study was to apply the most recent deprivation index for areas within Strathclyde Region, to the pet ownership data obtained from the survey outlined in Chapter 2. The aim was to use an area based approach to investigate the association between deprivation and pet ownership. Given that the urban and rural characteristics of an area are appropriate to study using an area based approach, the relationship between community setting and pet ownership was also explored using available census data. Geographical Information Systems were applied to the data to display the spatial distribution of pet ownership in relation to area deprivation and community setting.

3.2 MATERIALS AND METHODS

3.2.1 Research design

A telephone survey was undertaken in Strathclyde Region, Scotland to establish the pet ownership status of 2000 randomly selected households. Based on the results obtained, and using an area based approach at the postcode sector level, the association between deprivation and pet ownership and community setting and pet ownership were assessed.

3.2.2 Study region and research sample

The characteristics of the study region, the population from which the research samples were selected and the sampling criteria and procedure have been described previously (Chapter 2, Section 2).

3.2.3 Data collection

3.2.3.1 Pet ownership

From the total research sample of 2000, data were successfully collected from 1771 households with regard to their pet ownership status. Of these households, 639 were pet owners and 1132 were non-owners. Dog ownership status was requested from all 1771 households whereas cat ownership and ownership of pets other than dogs or cats was requested from only 1730 of the households. Considering these samples, 362 households were dog owners whereas 1409 were not dog owners, 231 were cat owners while 1499 were not cat owners and 218 households owned a pet other than a dog or cat, with 1512 households not owning a pet other than a dog or cat (Chapter 2, Section 3).

Details pertaining to the successfully interviewed households were manually written by the researcher into pre-prepared tables (Appendix V). Information recorded included the name, address and accompanying telephone number for each household listed within the BT phone book, the pet ownership status, the species of pet owned and for dog and cat owners, the number of each of these species owned. The address listed within the BT phone book was abbreviated somewhat and subject to validation using the Royal Mail Postal Address Book (1997). Each individual address was located in this book to confirm a correct place name and corresponding postal town. The postcode for each address was also collected and carefully entered into the pre-prepared tables.

3.2.3.3 Postcode sector

Royal mail postcodes contain six or seven characters. Given a full unit postcode, an address may be allocated to a range of area levels, including postcode sector (Table 3-1). About 900 Royal Mail postcode sectors are located in Scotland. Re-organisation of the Scottish local authority districts in 1996/97 resulted in changes to administrative boundaries and the formation of new authorities. Consequently, problems are now encountered at the postcode sector level, with many postcodes crossing local authority

boundaries. Census 1991 output data addresses this problem by allocating some unit postcodes to 'part' postcode sectors. This manipulation results in 1,155 Scottish postcode sectors. A total of 409 of these postcode sectors are located within Strathclyde Region. These sectors vary considerably in size. Between 16 to 6782 households are located in each sector, with an average of 2209 households over all postcode sectors. Likewise, a wide range in population size from 45 to 18330 exist in each sector, with an average population size of 5278 over all postcode sectors. To permit area based analysis of data pertaining to pet ownership, postcode data for successfully interviewed households were transformed into postcode sector coding by deleting the last two characters from each unit postcode.

3.2.3.2 Deprivation

Data regarding the distribution of deprivation within Strathclyde Region were obtained from the most recent deprivation index for Scotland (Gibb *et al.*, 1998). The existing Scottish deprivation index (Duguid, 1995) was derived wholly from the 1991 census and was constructed at the small area level of the enumeration district. The index was revised because of evidence of significant social, economic and physical change in many of these small areas since 1991. In contrast, the new deprivation index was formulated at the level of postcode sector and combines 1991 census indicators with more recent, non-census indicators of deprivation. Twelve indicators were used to construct the updated index: overcrowding, lack of amenities, vacant dwellings, participation at school, children in dependent only households, no car households, standardised mortality ratios, low birth weights, unemployment rate, insurance weightings index, students in higher education and income support claimants. Area based analysis at postcode sector level was selected because postcode sectors are the smallest consistent geography that can match census and non-census data. A distribution of scores of deprivation for each postcode sector in Scotland were formulated, with positive signed indicator scores representing below average or deprived areas. Given that the index attempts to measure deprivation and not well being, all negative score were set at zero thus focusing on deprivation. Deprivation scores for each postcode sector located within the study region were generously supplied by D. MacKay, Department of Urban Studies, University of Glasgow and ranged between 2.43 to 16.97. To permit analysis, these deprivation data were coded into categorical variables. Minimum deprivation was defined as scores less

than six, low deprivation as scores between six to less than 10, moderate deprivation as scores between 10 to less than 14 and high deprivation as scores of 14 or greater.

3.2.3.3 Community setting

Details pertaining to the urban or rural characteristics of postcode sectors in Strathclyde Region were obtained from the census 1991 (Census 1991 on CD ROM). The urban or rural indicator assigned by the census office is outlined in Table 3-2. This classification system is applicable to enumeration districts which are smaller than postcode sectors. Nevertheless, an alternative measure of the urban or rural characteristics of an area is that of population density. Correlation between these two variables has been reported to be high, with population density decreasing as the rurality of an area increases (Carstairs and Morris, 1991). Data required to calculate the population density of each postcode sector in Strathclyde Region were obtained from the small area output statistics of the 1991 census. The total population within each sector was retrieved and served as the numerator. The size of each sector, in kilometres squared, served as the denominator. The resultant figure represented the total number of persons per kilometre squared and as such, gave an indication of population density for each postcode sector. For postcode sectors within the study region, population density ranged between 1 to 10,890. To permit analysis, these population density data were coded into categorical variables. Low was defined as a population density less than 3600, medium as a population density between 3600 to less than 7200 and high as a population density of 7200 or greater.

3.2.4 Data storage and manipulation

Data concerning the pet ownership status of successfully interviewed households, postcode sector deprivation score and the urban or rural characteristics of each postcode sector were transferred to a computer database (Microsoft Access for Windows '95, Version 7). Three separate Microsoft Access tables were constructed, each containing information for one of the above three variables. To permit analysis, all three tables were merged into one table using a specifically designed 'query', with the postcode sector serving as the cross reference to merge fields. This procedure effectively allocated each successfully interviewed household a deprivation score relative to the postcode sector location of the household and similarly, the urban or rural characteristics of the corresponding postcode sector.

TABLE 3-1: Allocation of an address to different area levels using the unit postcode.

CATEGORY	POSTCODE			
Full unit postcode	G31 2QQ			
Subdivision of unit postcode	G	31	2	QQ
Area level	Area	District	Sector	Unit

Note

Area	- 121 postcode areas in the UK
District	- approximately 20 postcode districts in an area
Sector	- approximately 300 addresses in a sector - limited to a single digit i.e. maximum number of sectors per district is 10
Unit	- approximately 15 addresses per unit

Table adapted from the Royal Mail Postal Address Book, 1997.

TABLE 3-2: Urban or rural indicator assigned by the census office for each enumeration district.

INDICATOR	POPULATION
1	an urban block with population of 1 million or more
2	an urban block with population of 100,000 to < 1 million
3	an urban block with population of 10,000 to < 100,000
4	an urban block with population of 1,000 to < 10,000
5	a rural area or continuous urban block of less than 1,000

Note

A gap of one kilometre or more represent a break in the continuity of a built up area.

3.2.5 Statistical analysis

Simple descriptive analyses were performed using Minitab for Windows, 9.2. (Minitab Inc.) after data were imported from the Microsoft Access database. With non-owners serving as the comparison group, the association between pet ownership and area deprivation was assessed using the Pearson chi-square test for independence. Pet ownership, dog ownership, cat ownership and ownership of a pet other than a dog or cat were assessed separately. In a similar manner, the association between pet ownership and the urban or rural characteristics of the postcode sector where the household was located was also analysed. A significance level of 5% ($\alpha = 0.05$) was used throughout.

3.2.6 Spatial display

A Geographical Information System (GIS) was applied to the data to create maps that displayed the spatial distribution of pet ownership, in relation to the geographically variable parameters of deprivation and community setting. MapInfo Professional 5.5 for Windows '95 (Desktop Mapping Software, MapInfo Corporation) was the GIS used in the present study. A GIS is a computer system that stores, manages and displays spatially referenced data (Paterson, 1995). Two or three dimensional images of an area are generated on the computer screen, showing natural and artificial features. To accomplish this, GIS stores all geographical data as digital codes that accurately represent the spatial relationship between objects. Field data can be stored and displayed by GIS if they are spatially referenced and differences between their distribution, difficult to interpret in a table or graph, can be seen.

Spatially referenced data are points that can be located precisely in space such as grid references. Postcodes correspond to grid references and can be used to locate data points precisely on a map. Postcode data for all respondents to the telephone survey were saved onto 3.5'' 1.44 Mb floppy diskette and then mailed to Graphical Data Capture Ltd. for geocoding. Geocoding refers to converting postcode information to grid reference. Geocoded data received from Graphical Data Capture Ltd were imported into MapInfo, together with data from tables and queries stored in Microsoft Access. The geographical distribution of variables recorded in the survey could then be displayed by querying, in order to link data with geocode points. Thematic maps that aggregate data over a pre-defined area were created by overlying points on background digitised boundary files for

Strathclyde Region, incorporating the deprivation and urban and rural characteristics of postcode sectors. Digitised boundary data for Scotland were obtained from Graphical Data Capture Ltd.

3.3 RESULTS

3.3.1 Sample recruitment

Considering the 1771 interviewed households, postcode retrieval and postcode sector allocation was successfully achieved for 1727, which represented 618 pet owners and 1109 non-owners. Of these households, 345 were dog owners and 1382 did not own a dog, 224 were cat owners, 1463 did not own a cat and 40 households were inadvertently not questioned about cat ownership. Likewise, 211 households owned a pet other than a dog or cat, 1476 did not own a pet other than a dog or cat and 40 households were not questioned about ownership of a pet other than a dog or cat. Reasons for unsuccessful postcode sector allocation included 26 households that were located outwith the boundaries of Strathclyde region, such that their unit postcode could not be matched with one of the 409 Strathclyde Region postcode sectors. Eight households had an incorrect postcode logged in the database, with characters missing from the unit postcode. For ten households, the address listed in the BT phone book failed to be linked with a corresponding address and unit postcode within the Royal Mail postcode directory. With the above knowledge, Table 3-3 outlines the total sample size available for each analysis.

3.3.2 Pet ownership

Considering the 1727 interviewed households that were successfully allocated to one of the 409 postcode sectors in Strathclyde Region, Table 3-4 outlines the proportion of pet owning and non-pet owning households in each postcode sector deprivation category. Chi-square analysis of these data revealed that the higher proportion of pet owning households with a minimum deprivation score, compared to households that did not own a pet, was significant (Pearson χ^2=13.80, P<0.01). Figure 3-1 demonstrates the spatial distribution of pet ownership in relation to postcode sector deprivation. With respect to the urban or rural characteristics of postcode sectors, Table 3-5 outlines the proportion of pet owning and non-pet owning households in each postcode sector population density category. Again, the higher proportion of pet owning households located in postcode sectors with a low population density, compared to households that

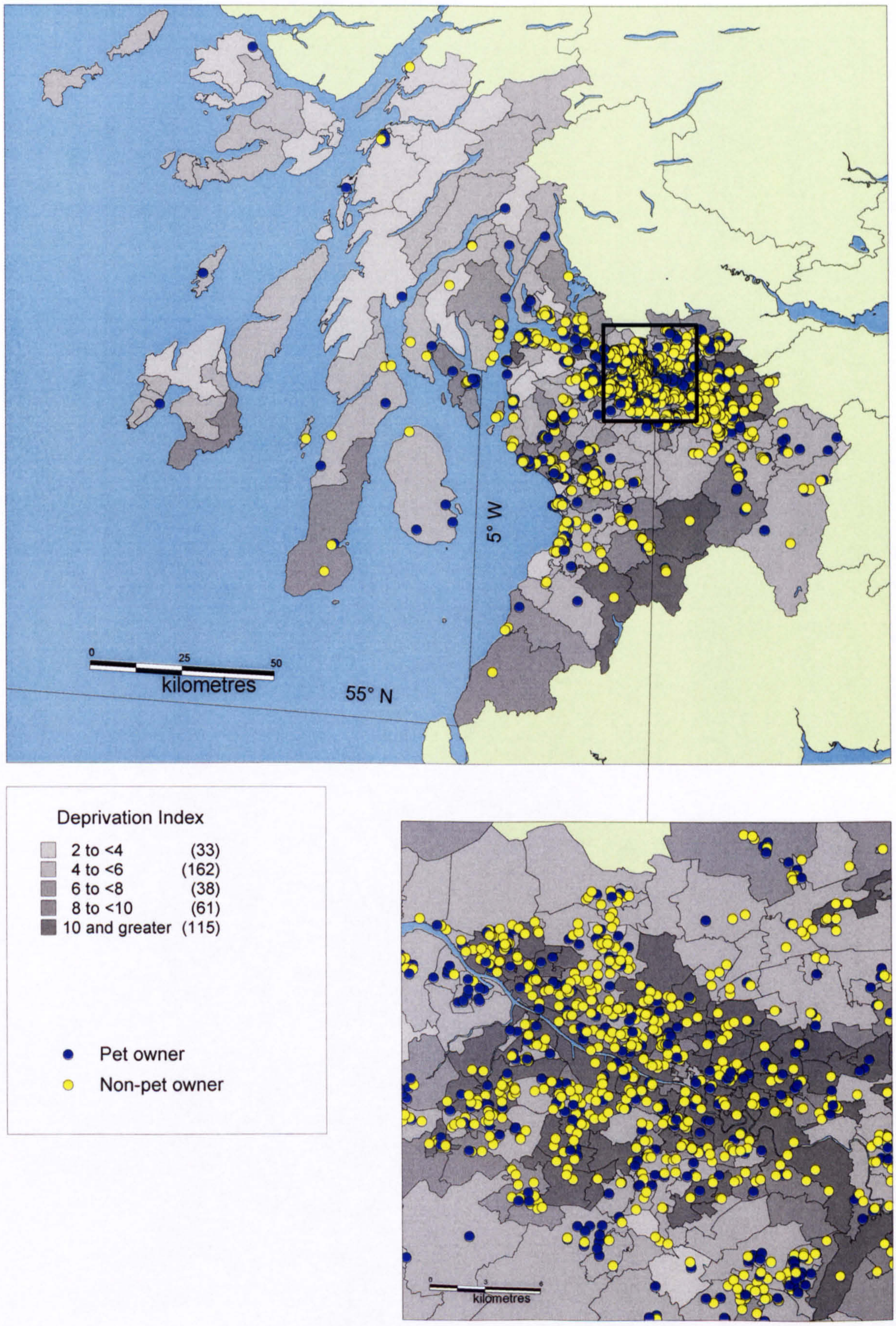
TABLE 3-3: Total sample size available for assessment of demographic factors associated with pet ownership in Strathclyde Region, Scotland, from a telephone survey to determine the pet ownership status of 2000 randomly selected households.

CATEGORY	ANY PET	DOG	CAT	OTHER PET*
Telephone numbers dialled	2000	2000	2000	2000
Non-viable telephone numbers	85	85	85	85
Total dialled with viable number	1915	1915	1915	1915
No response to telephone call	117	117	117	117
Total calls answered	1798	1798	1798	1798
Number unwilling to be interviewed	27	27	27	27
Interviewer error**	0	0	41	41
Households interviewed	1771	1771	1730	1730
Postcode outwith Strathclyde Region	26	26	26	26
Incorrect postcode logged in database	8	8	8	8
Failure to link address with postcode	10	10	9	9
Successful postcode sector allocation	1727	1727	1687	1687
Households which own a pet	618	345	224	211
Households which do not own a pet	1109	1382	1463	1476

* Pet other than a dog or cat (rabbit, hamster, gerbil guinea-pig, cage bird, fish, horse, donkey or 'exotic' pet).

** Dog owning households that were not questioned with regard to other pets owned.

FIGURE 3-1: The spatial distribution of pet ownership in relation to postcode sector deprivation in Strathclyde Region, Scotland.



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did not own any pets, was significant (Pearson χ^2=8.78, P=0.01). Figure 3-2 represents the spatial pattern of pet ownership in relation to the urban or rural characteristics of postcode sectors.

3.3.3 Dog ownership

With regard to the 1727 households questioned about dog ownership and that postcode sector allocation was possible, Table 3-4 outlines the proportion of dog owning and non-dog owning households in each postcode sector deprivation category. Chi-square analysis of these data revealed that the higher proportion of dog owning households with a minimum deprivation score, compared to households that did not own a dog, was significant (Pearson χ^2=14.84, P<0.01). Figure 3-3 demonstrates the spatial distribution of dog ownership in relation to postcode sector deprivation. With respect to community setting of postcode sectors, Table 3-5 outlines the proportion of dog owning and non-dog owning households in each postcode sector population density category. The higher proportion of dog owning households located in postcode sectors with a low population density and the lower proportion located in postcode sectors with a high population density, compared to households that did not own a dog, was highly significant (Pearson χ^2=15.82, P<0.001). Figure 3-4 represents the spatial pattern of dog ownership in relation to population density of postcode sectors.

3.3.4 Cat ownership

Considering the 1687 households questioned about cat ownership, Table 3-4 outlines the proportion of cat owning and non-cat owning households in each postcode sector deprivation category. The higher proportion of cat owning households with a minimum deprivation score and the lower proportion with a high deprivation score, compared to households that did not own a cat, showed a trend towards statistical significance (Pearson χ^2=6.68, P<0.08). Figure 3-5 represents the spatial pattern of cat ownership in relation to postcode sector deprivation score. With respect to community setting of postcode sectors, Table 3-5 outlines the proportion of cat owning and non-cat owning households in each postcode sector population density category. Chi-square analysis of these data revealed no significant difference between cat owning and non-cat owning households (Pearson χ^2=0.41, P=0.82). Figure 3-6 demonstrates the spatial distribution of cat ownership in relation to community setting of postcode sectors.

FIGURE 3-2: The spatial distribution of pet ownership in relation to the population density of postcode sectors in Strathclyde Region, Scotland.

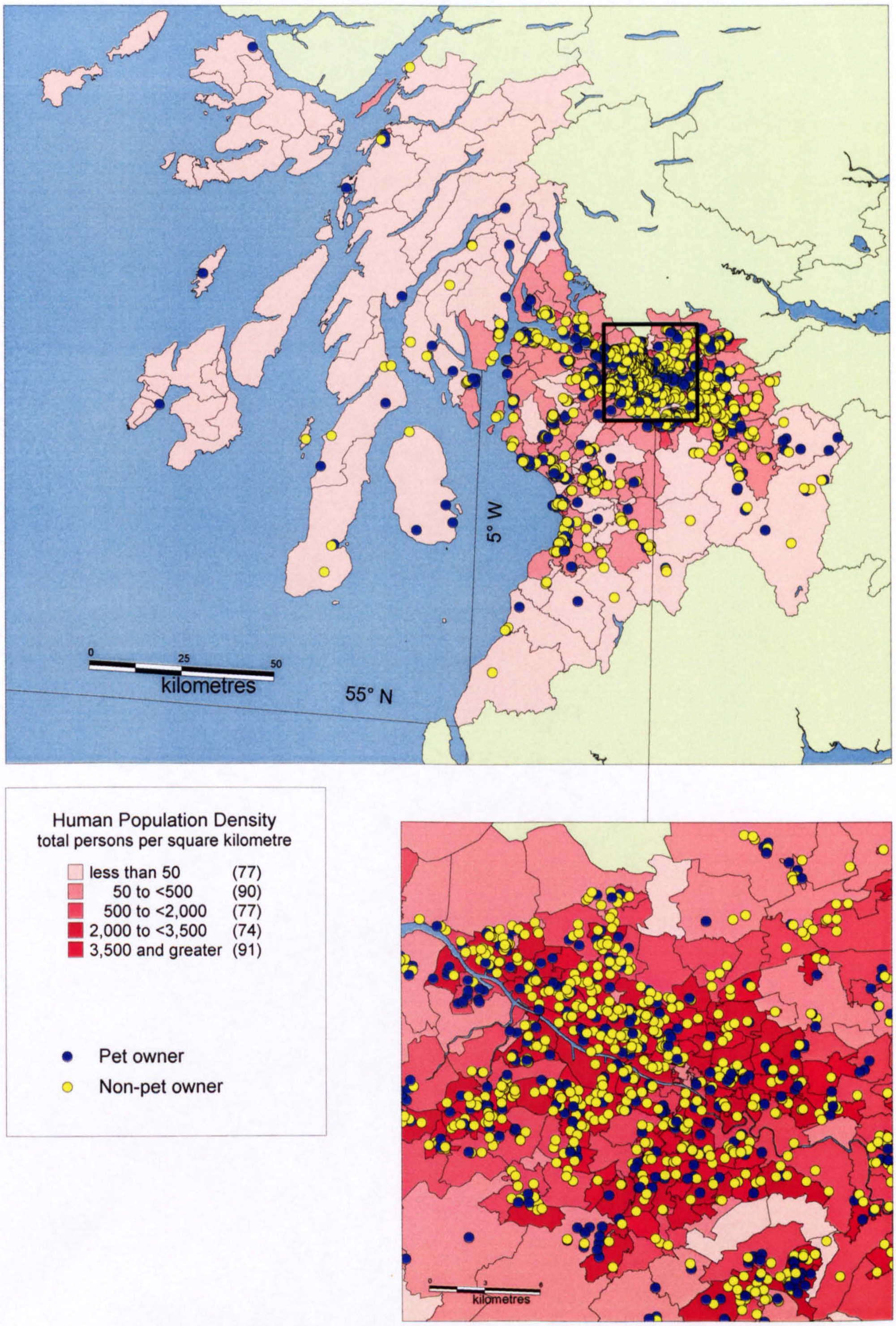

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FIGURE 3-3: The spatial distribution of dog ownership in relation to postcode sector deprivation in Strathclyde Region, Scotland.

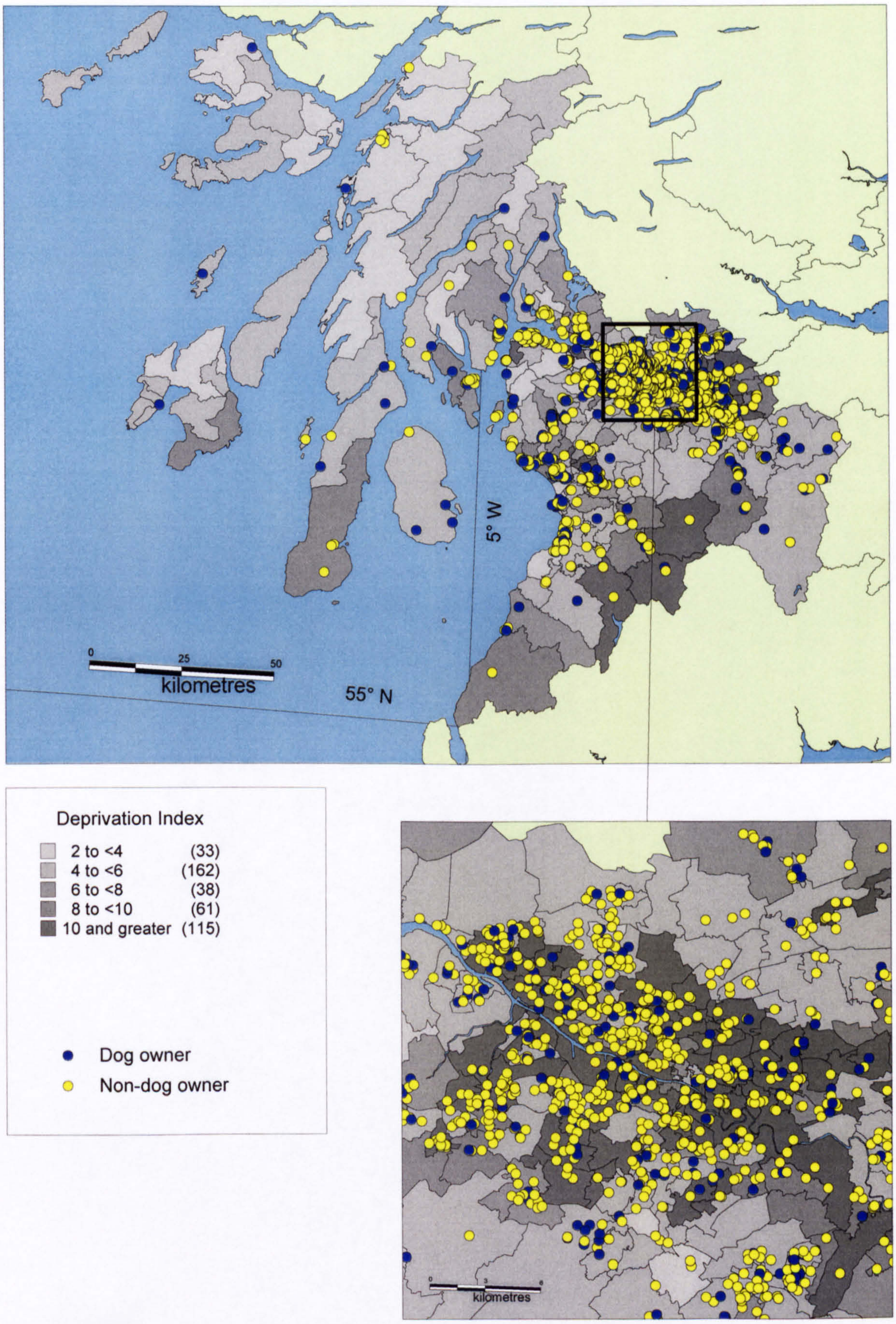

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FIGURE 3-4: The spatial distribution of dog ownership in relation to the population density of postcode sectors in Strathclyde Region, Scotland.

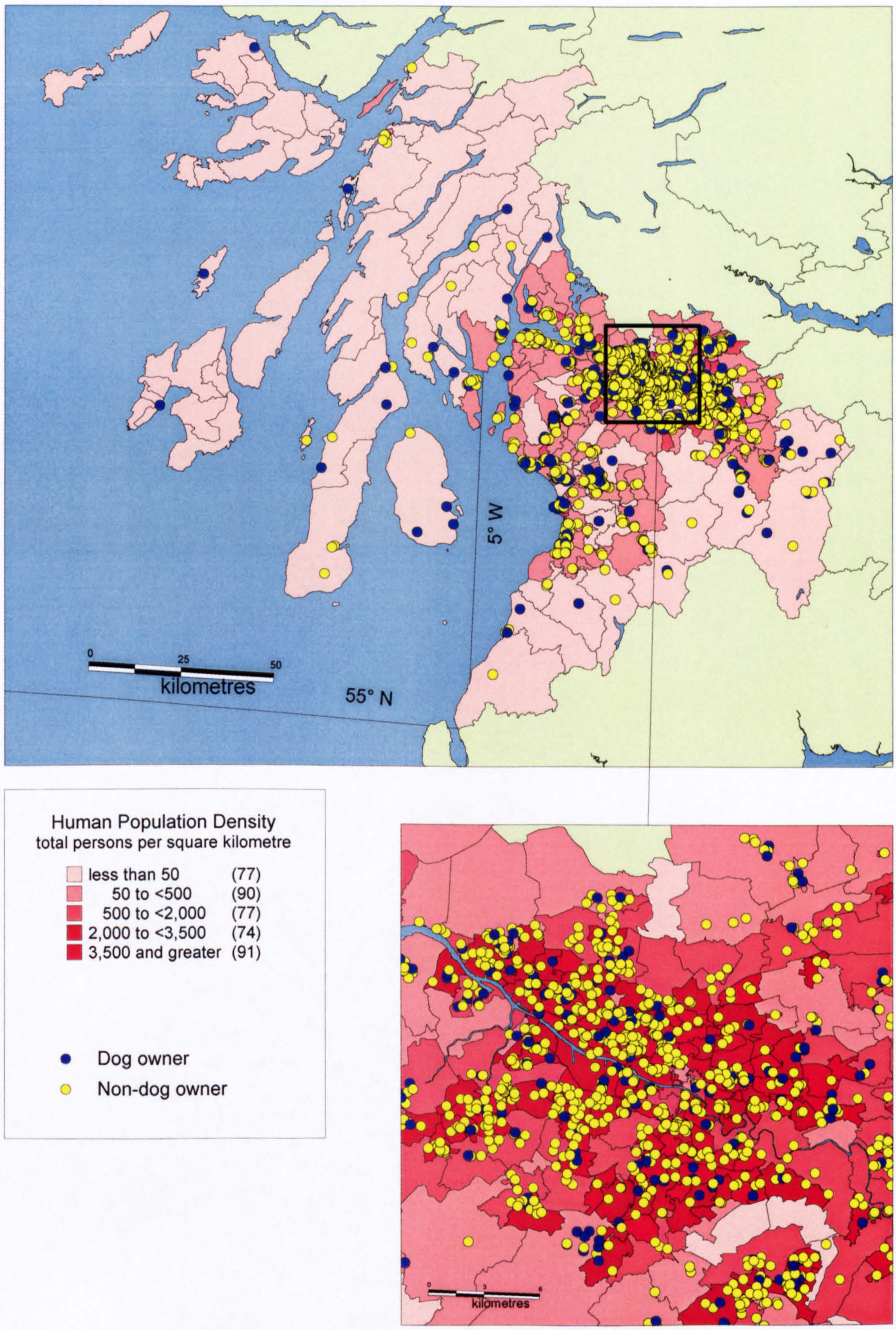

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FIGURE 3-5: The spatial distribution of cat ownership in relation to postcode sector deprivation in Strathclyde Region, Scotland.

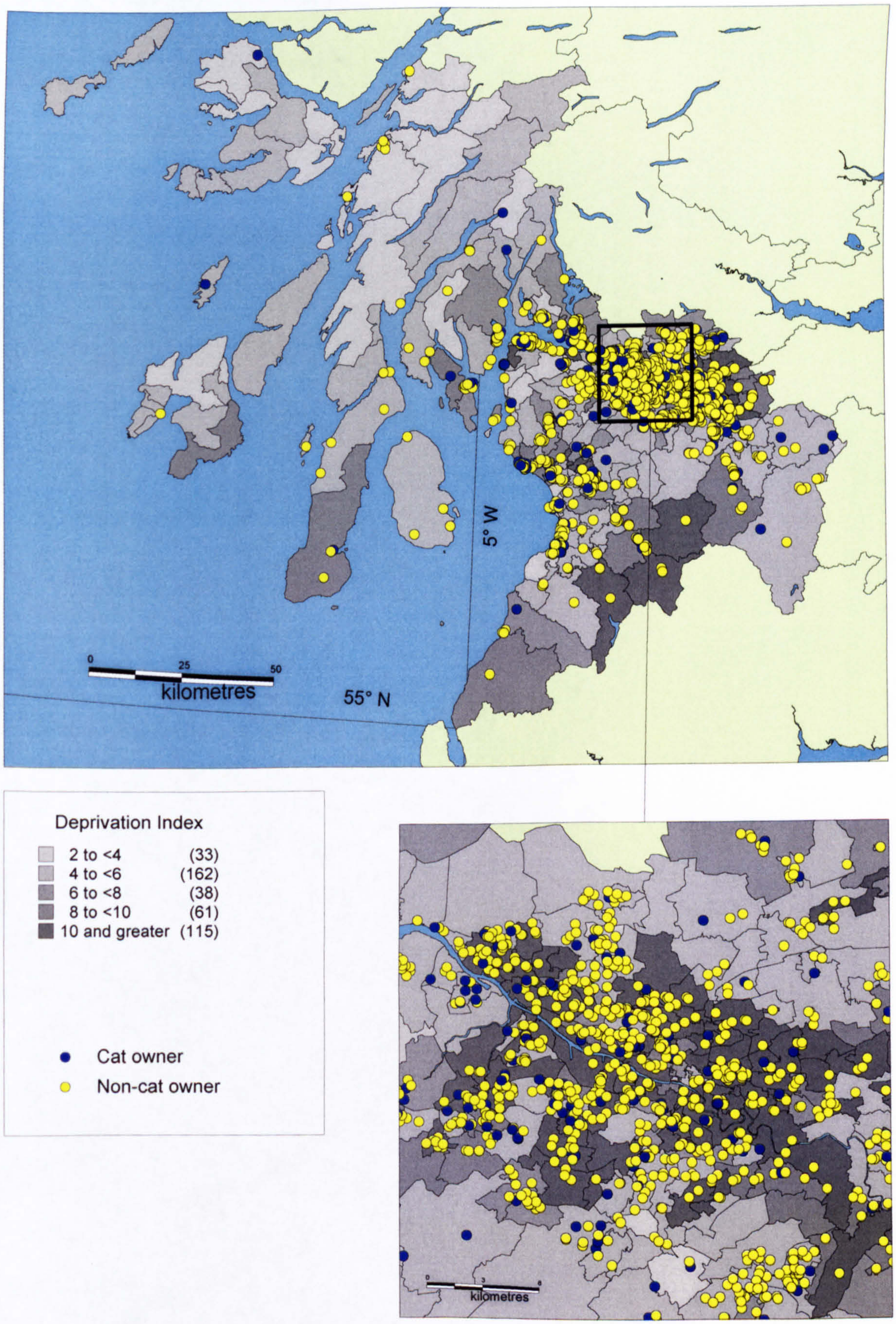

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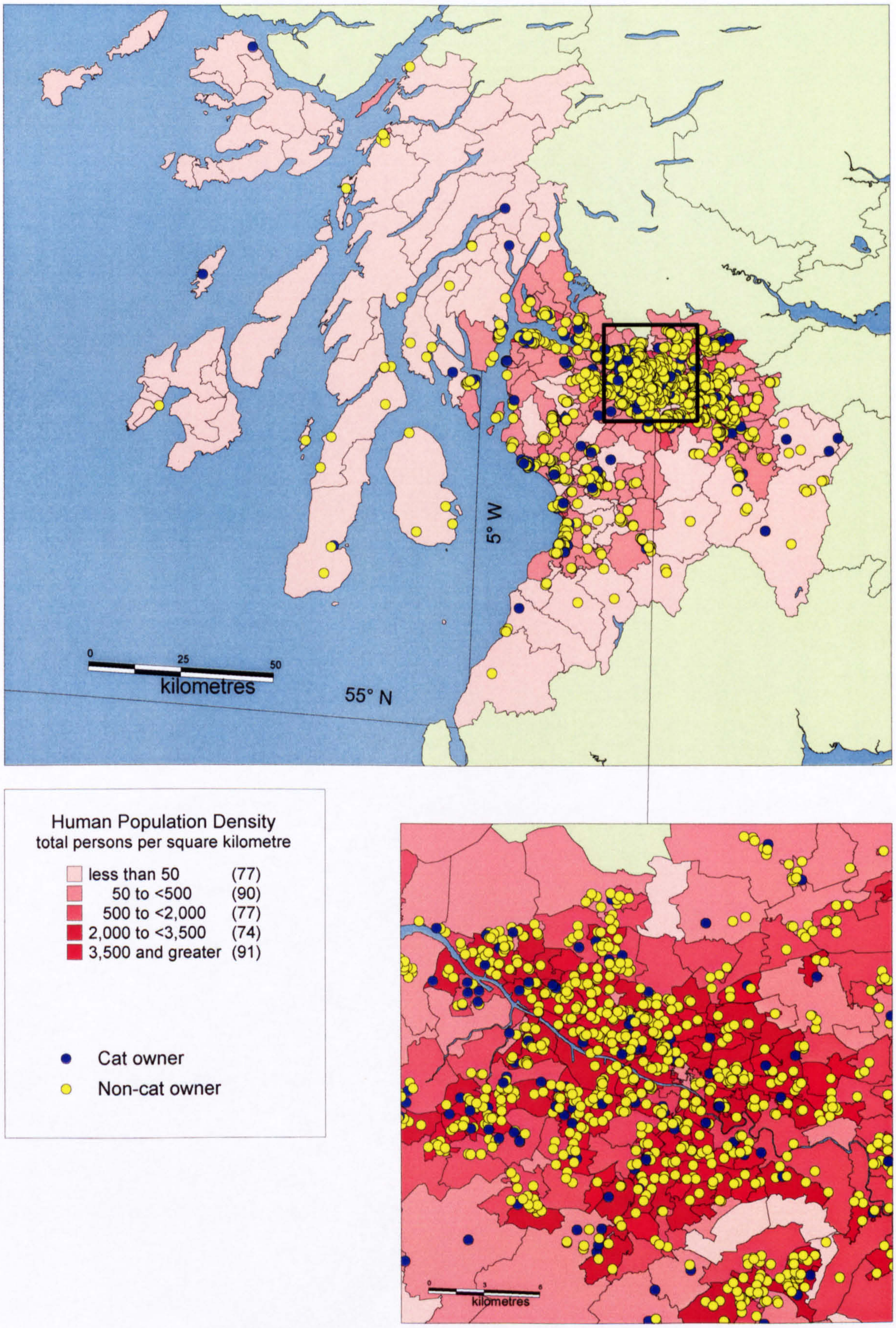
FIGURE 3-6: The spatial distribution of cat ownership in relation to the population density of postcode sectors in Strathclyde Region, Scotland.



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3.3.5 Ownership of a pet other than a dog or cat

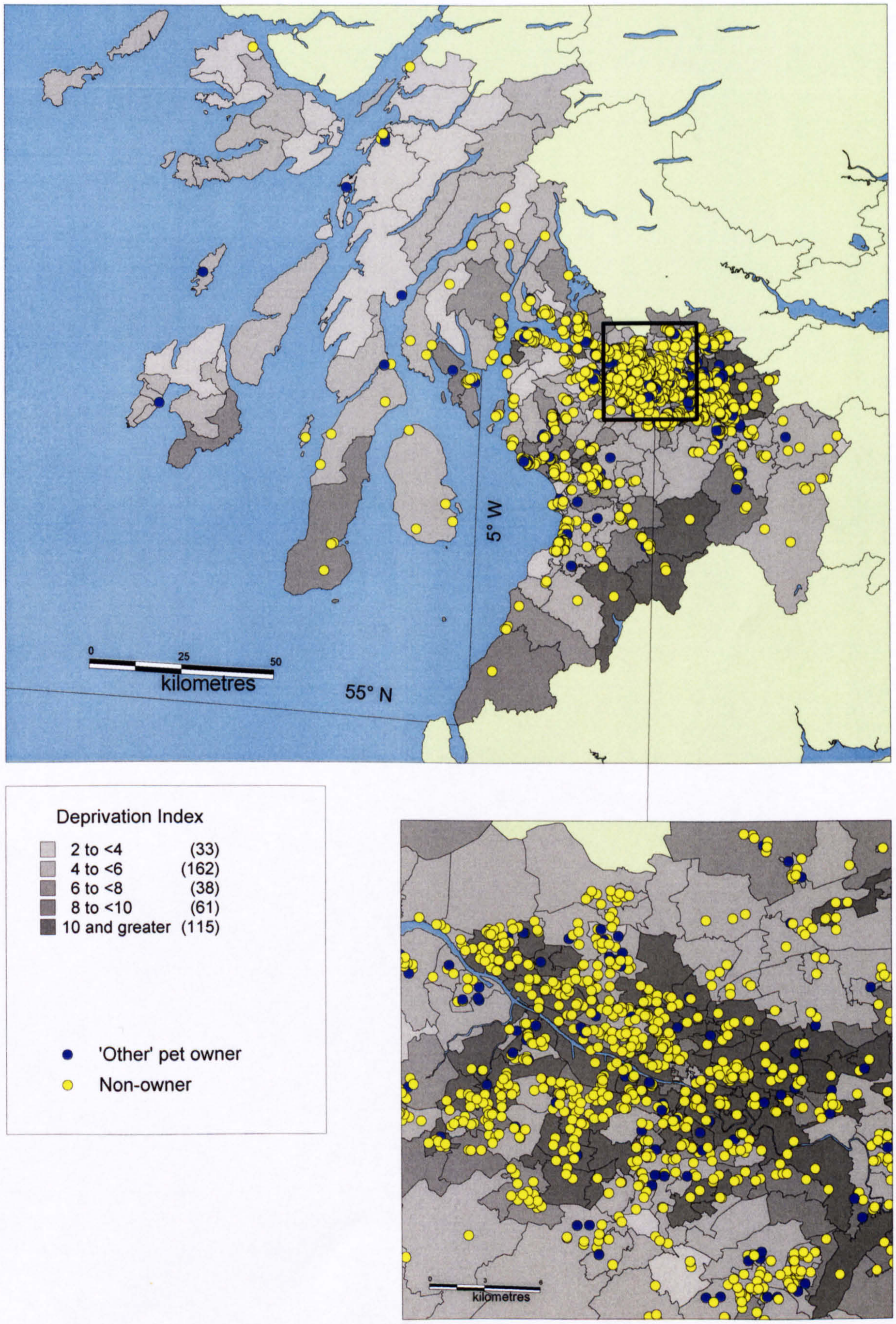
With regard to the 1687 households successfully questioned about ownership of a pet other than a dog or cat, Table 3-4 outlines the proportion of owning and non-owning households in each postcode sector deprivation category. Chi-square analysis of these data revealed no significant difference between these two groups (Pearson χ^2=4.72, P=0.19). Figure 3-7 demonstrates the spatial distribution of households that owned a pet other than a dog or cat in relation to postcode sector deprivation. Considering the urban or rural characteristics of postcode sectors, Table 3-5 outlines the proportion of households that did or did not own a pet other than a dog or cat in each postcode sector population density category. The higher proportion of pet owning households that were located in postcode sectors with a low population density, and the lower proportion located in postcode sectors with a high population density, compared to households that did not own a pet other than a dog or cat, was significant (Pearson χ^2=8.30, P=0.02). Figure 3-8 represents the spatial pattern of ownership of a pet other than a dog or cat in relation to the urban or rural characteristics of postcode sectors.

3.4 DISCUSSION

3.4.1 Area based analysis

This study used data collected during a telephone survey to establish the pet ownership status of households in Strathclyde Region. These initial data represented the basis of a demographic and socio-economic analysis. To supplement the study, data concerning the population under investigation were retrieved for the most recent British census (Census 1991 on CD-ROM). Data pertaining to the distribution of deprivation within Strathclyde Region were also obtained from the new deprivation index for Scotland (Gibb *et al.*, 1998). This index combines variables from the 1991 census with more recent non-census indicators of deprivation. However, reliance on the census as the source of data has apparent deficits. Population characteristics are comprehensively available for small areas only, at ten yearly intervals. Thus, the investigation was constrained by the census output tables into area based analysis, and the examination of events between census years may have been biased, if significant population change occurred during the intervening period.

FIGURE 3-7: The spatial distribution of households that owned a pet other than a dog or cat, in relation to postcode sector deprivation in Strathclyde Region, Scotland.



This work is based on data provided with the support of the ESRC and JISC and uses boundary material which is copyright of the Crown, and the Post Office. Source: The 1991 Census, Crown Copyright. ESRC purchase.

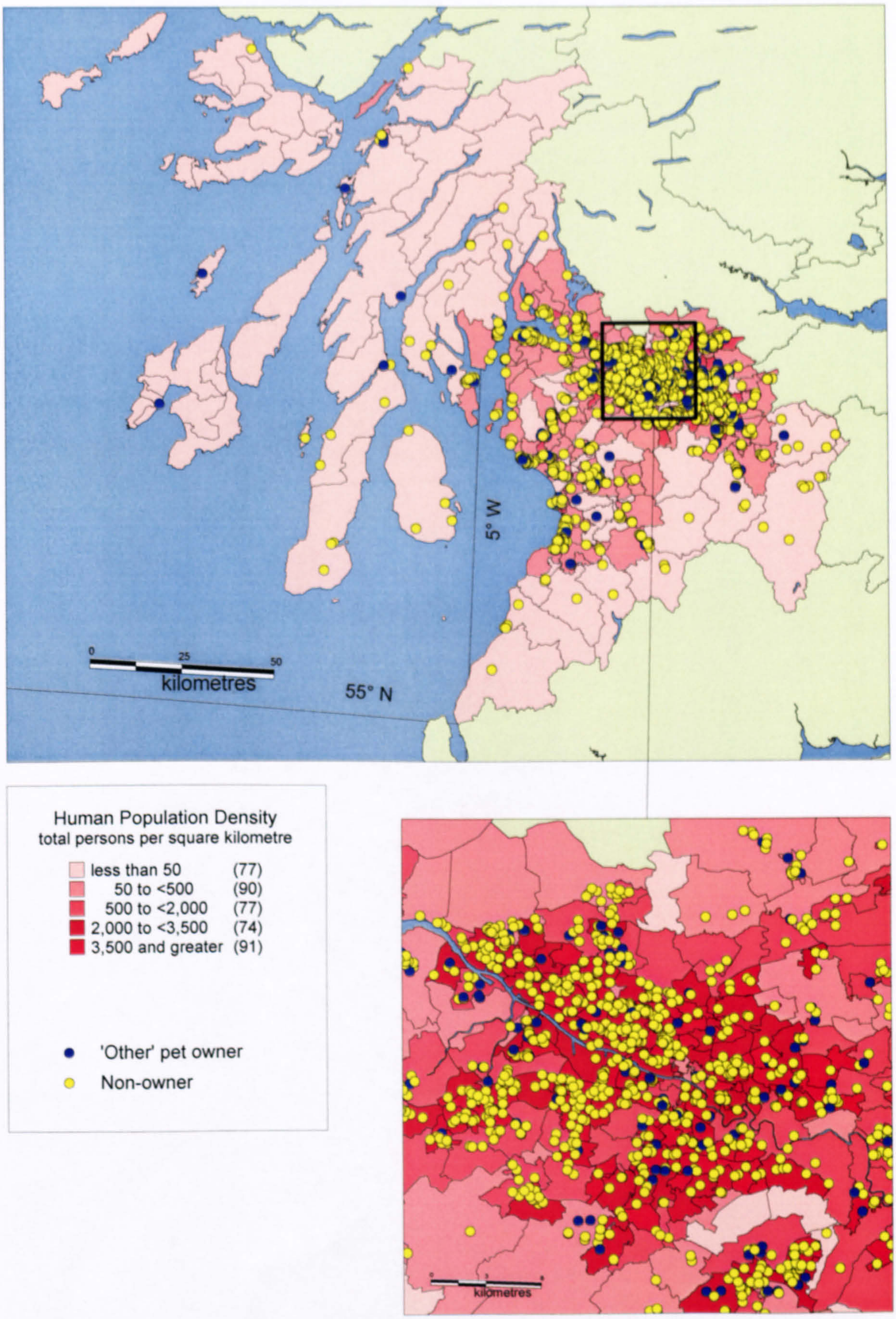
TABLE 3.4: The number of pet owning and non-pet owning households (%) in each postcode sector deprivation category in Strathclyde Region, Scotland, and chi-square comparison between pet owners and non-owners.

HOUSEHOLD TYPE	DEPRIVATION SCORE CATEGORY				*P*-VALUE
	2 to < 6	6 to < 10	10 to < 14	14 or >	
Pet owner	295 (47.7)	178 (28.8)	99 (16.0)	46 (7.4)	<0.01
Non-pet owner	440 (39.7)	343 (30.9)	244 (22.0)	82 (7.4)	
Dog owner	172 (49.9)	92 (26.7)	50 (14.5)	31 (9.0)	<0.01
Non-dog owner	563 (40.7)	429 (31)	293 (21.2)	97 (7.0)	
Cat owner	110 (49.1)	68 (30.4)	34 (15.2)	12 (5.4)	0.08
Non-cat owner	610 (41.7)	441 (30.1)	300 (20.5)	112 (7.7)	
Other pet owner	104 (49.3)	58 (27.5)	34 (16.1)	15 (7.1)	0.19
Non-other pet owner	616 (41.7)	451 (30.6)	300 (20.3)	109 (7.4)	

TABLE 3.5: The number of pet owning and non-pet owning households (%) in each postcode sector population density category in Strathclyde Region, Scotland, and chi-square comparison between pet owners and non-owners.

HOUSEHOLD TYPE	POPULATION DENSITY CATEGORY			*P*-VALUE
	0 to < 3600	3600 to < 7200	7200 or >	
Pet owner	482 (78.0)	116 (18.8)	20 (3.2)	0.01
Non-pet owner	814 (73.4)	225 (20.3)	70 (6.3)	
Dog owner	278 (80.6)	63 (18.3)	4 (1.2)	<0.001
Non-dog owner	1018 (73.7)	278 (20.1)	86 (6.2)	
Cat owner	169 (75.4)	45 (20.1)	10 (4.5)	0.82
Non-cat owner	1098 (75.1)	285 (19.5)	80 (5.5)	
Other pet owner	175 (82.9)	30 (14.2)	6 (2.8)	0.02
Non-other pet owner	1092 (74.0)	300 (20.3)	84 (5.7)	

FIGURE 3-8: The spatial distribution of households that owned a pet other than a dog or cat, in relation to the population density of postcode sectors in Strathclyde Region, Scotland.



This work is based on data provided with the support of the ESRC and JISC and uses boundary material which is copyright of the Crown, and the Post Office. Source: The 1991 Census, Crown Copyright. ESRC purchase.

Area based socio-economic analysis was used in the present investigation to discriminate between pet owning and non-pet owning households, based on characteristics of the area of residence as opposed to the individual household. This analysis was conducted at the postcode sector level, as this was the smallest feasible geography to enable census, non-census and the aforementioned telephone survey data to be matched on a consistent and comparable basis. However, area based methods have been criticised, as they are based on the assumption that the population within an area is homogeneous and shares equally in characteristics observed (Carstairs and Morris, 1991). This is obviously not the case, with some mis-identification inevitably occurring. Considering deprivation, for example, it is conceivable that a deprived community contains a combination of deprived and non-deprived households. Nevertheless, the prevalence of deprivation within households has been reported to be strongly correlated with postcode sector deprivation, with an increasing proportion of deprived households found in areas where the severity of deprivation increases and vice versa at the affluent end of the spectrum (Carstairs and Morris, 1991; Gibb *et al*, 1998). Analysis at a smaller area level, for example, 'output areas' which contain approximately 40 households or 'enumeration districts' which incorporate two or three output areas, would intuitively suggest populations that were less diverse in their characteristics and conform more closely to the local community. However, these alternative area levels suffers from their own problems and like postcode sectors, are unlikely to consistently contain individuals or households which are unambiguously alike.

The most overwhelming benefit of the area based approach is the opportunity offered to examine, in relation to area characteristics, a wide range of outcomes that contain a postcode reference (Carstairs and Morris, 1991). Considering pet ownership, a number of household demographic factors have been found to be important determinants of pet ownership and assessment of these, may contribute to the understanding of community pet populations and ownership patterns. Family structure, presence of children, type of home, home ownership compared with rental and community setting have consistently been reported to have an effect on pet ownership (Marx and Furcolow, 1969; Dorn, 1970; Franti and Kraus, 1974; Godwin, 1975; Griffiths and Brenner, 1977; Heussner *et al.*, 1978; Franti *et al.*, 1980; Selby *et al.*, 1980; Anderson, 1983; Wise, 1984a; Wise, 1984b; Wise and Kushman, 1984a; Wise, 1987; Troutman, 1988b; Troutman, 1988c;

Troutman, 1988d; Troutman, 1988e; Nassar and Mosier, 1991; Wise and Yang, 1992; Teclaw *et al.*, 1992; Leslie *et al.*, 1994; Melson, Schwarz and Beck, 1997). Analysis of these variables, in relation to pet ownership in Strathclyde Region, would have been advantageous. The census records information pertaining to these characteristics and theoretically, could have served as the source of data. However, family structure, the presence of children, type of home and home ownership represent truly individual household characteristics. Thus it was believed, that such information could not be generalised to the postcode sector level to permit area based analysis. In contrast, measures which describe the area of residence in terms of deprivation and community setting are more valid analyses to perform on an area based approach. The urban or rural characteristics of an area, in itself, represent a community phenomenon and not an individual household attribute. Likewise, household deprivation, as discussed above, is highly correlated with the level of postcode sector deprivation. Accordingly, these two characteristics were chosen as the basis of this analysis.

3.4.2 Pet ownership, deprivation and community setting

In agreement with previous reports (Marx and Furcolow, 1969; Franti and Kraus, 1974; Griffiths and Brenner, 1977; Wise and Kushman, 1984a; Troutman, 1988b; Troutman, 1988c; Troutman, 1988d; Brooks, 1990; Leslie *et al.*, 1994; Melson, Schwarz and Beck, 1997), the present study found that pet owning households were more likely to be located in communities with lower population densities. Intuitively, one might expect people residing in rural environments to be more inclined to own a companion animal. Pet ownership is consistent with rural lifestyle, with people from rural backgrounds often viewing animals as peripheral to their homes and lives. In the rural environment, we find larger homes and open landscapes that are particularly conducive to dog ownership, with ample countryside for pet exercise and owner pleasure in dog walking. In addition, those living on farms are likely to have livestock commitments that demand continual supervision, thus easily incorporating the ownership of pets. This suggestion is supported by reports that the problems created by pets when an owner chooses to go away, is an important reason cited for reluctance to own a pet (Leslie *et al.*, 1994).

While pet ownership, dog ownership and ownership of a pet other than a dog or cat were found to be correlated with lower postcode sector population density, ownership of a cat

was not found to be associated with this variable. As discussed in Chapter 2, Section 4, cats have become a popular pet in urban communities, where hectic working lifestyles and dual income families favour the independent cat which requires less maintenance and allows owners greater personal freedom compared to dogs (Arkow, 1991, PFMA, 1999). High housing costs in large cities have also forced many people into smaller homes, limiting the feasibility of dog ownership which is then substituted with the smaller and less boisterous cat. One would not necessarily expect the ownership of pets other than a dog or cat i.e. small mammals, birds and fish to be related to community setting. However, this category also included the ownership of horses, ponies and donkeys which by their very physical size and requirement for facilities such as grazing or stabling, means that ownership is beyond the reach of the majority of urban dwellers.

In the present study, the level of postcode sector deprivation was lower in pet owning households compared to households that did not own any pets, and this finding was consistent for pet owners, dog owners and cat owners. This finding is in agreement with other investigators, with reports that pet ownership is more prevalent in households with higher incomes (Dorn, 1970; Franti and Kraus, 1974; Beck, 1975; Beck, 1980; Franti *et al.*, 1980; Wise, 1984a; Wise, 1984b; Troutman, 1988b; Troutman, 1988c; Teclaw *et al.*, 1992; Wise and Yang, 1992). In contrast, other researchers have found similar ownership rates in all social classes (Godwin, 1975; Anderson, 1983; Wise and Kushman, 1984a; Robertson *et al.*, 1990; Leslie *et al.*, 1994). As discussed previously (Section 1), these studies used the measure of social class or household income to define differences in socio-economic status between households. The non-equivalence of social class and socio-economic disadvantage may therefore explain these inconsistent findings.

Although pet ownership is clearly not just a product of material affluence, the findings of this study suggest that households that are materially poor and socially disadvantaged are less likely to own a pet. Undeniably, pet ownership can represent a significant financial burden, particularly for some of the larger species. Monetary outgoings include food, veterinary services, original purchase price, insurance, boarding, bedding, housing and other accessories (Council for Science and Society, 1988). Other types of less expensive pets, for example rabbits, guinea pigs, hamsters, gerbils, canaries, budgies and gold fish may be more appropriate for people on restricted budgets. In the present study, households that owned a pet other than a dog or cat were not found to be more

prevalent in postcode sectors with lower deprivation scores, suggesting that this may be the case. This category also included horse, pony and donkey ownership and ownership of 'exotic' pets. However, although horses and ponies are the most expensive companion animals to keep and some of the valuable 'exotic' species can be extremely costly to acquire, the prevalence of ownership of these types of pets was low and consequently did not influence the non-association between ownership and deprivation. Worthy of mention, is that the index used in this study was constructed to measure deprivation and not well being, with negative scores set at zero. Consequently, low index scores do not convey much about the least deprived small areas in Strathclyde, unlike deprived areas which have positive scores on most of the deprivation indicators (Gibb *et al.*, 1998). Accordingly, this analysis is not suggesting that pet ownership is a product of well being, simply that it is less likely in deprived areas.

The deprivation index used in this study incorporated a broad range of factors including measures of provisions, attainment and opportunity in housing, employment, education and health (Gibb *et al.*, 1998). Accordingly, deficiency of any of these factors may be impacting on the decreased propensity of households to own a pet. For example, poor health, lower education and rental housing have all been reported to be associated with lower rates of pet ownership (Griffiths and Brenner, 1977; Wise and Kushman, 1984a; Netting, Wilson and Fruge, 1988; Troutman, 1988b; Troutman, 1988c; Nassar and Mosier, 1991; Wise and Yang, 1992; PFMA, 1999). Given that these variables are used as measures of deprivation, one could hypothesise that a large proportion of any reported variation in pet ownership rates can be explained in terms of household deprivation. Alternatively, the association detected in the present analysis may reflect the independent influence that each variable has on pet ownership, with summation of these effects resulting in a significant association between deprivation and pet ownership. For example, decreased pet ownership rates in rented accommodation may reflect decrease material affluence. In support of this, is reports that area deprivation is predominately found in communities with a high proportion of rented local authority housing (Duguid, 1995). Alternatively, rented accommodation may represent an unstable housing category which is frequently changed for another. Such unstable circumstances are not conducive to pet ownership. In addition, lower pet ownership

rates in rented homes may partly reflect prohibition of pets by local authorities and private property owners (Hart and Kidd, 1994).

From previous studies, it appears that deprivation is strongly linked to the urban or rural characteristics of an area (Carstairs and Morris, 1991; Duguid, 1995). Deprivation, as measured in these studies, was predominately an urban phenomenon, with most deprived localities found in densely populated areas, whereas rural communities accounted for a low proportion of area deprivation. However, the inter-relationship between deprivation, community setting and pet ownership is obscure and it is unknown whether low pet ownership in urban environments simply reflects higher levels of deprivation or whether these two variables independently impact on the decreased propensity to own pets. The association between community setting and deprivation, while consistently reported, must be interpreted with caution. The composition of measures used to construct a deprivation index appear to be less appropriate for rural communities. Rural conditions are different from urban ones, with uniquely rural forms of deprivation implied. It has been suggested, therefore, that research is required to identify measures of deprivation in rural areas and assessment of rural deprivation could be performed as a separate analysis (Carstairs and Morris, 1991; Gibb *et al.*, 1998).

Previous studies of the distribution of deprivation within Scotland have revealed that the worst deprivation areas are wholly dominated by Glasgow (Carstairs and Morris, 1991; Duguid, 1995; Gibb *et al.*, 1998). Glasgow city has had a consistently high level of area deprivation since 1971, both in terms of the absolute number of deprived areas and the proportion of all areas within Glasgow that are deprived. On a regional basis, Strathclyde is over represented in terms of area deprivation, with reports that Strathclyde contains almost 80% of the worst 10% of Scotland's deprived enumeration districts (Duguid, 1995) and all except three of the most deprived Scottish areas are found in Strathclyde (Gibb *et al.*, 1998). It has also been reported that Scotland exhibits more adverse conditions than England and Wales in terms of excessive levels of deprivation. According to Carstairs and Morris (1991), almost 22% of the population in England and Wales live at levels of affluence which are attained by only 6% of the Scottish population and 18% of the Scottish population are living at levels of deprivation experienced by only 4 and 5% of the population in England and Wales, respectively.

Consideration of the above points, in combination with the findings of the present study concerning the relationship between area deprivation and pet ownership, may help explain the low rate of pet ownership in Strathclyde Region, as identified in the telephone survey described in Chapter 2. While most reports have suggested that approximately half of all households own companion animals, only 36% of households were found to own pets in Strathclyde Region. Such lower rates of pet ownership may partly reflect the high levels of deprivation experience by households in this region. Estimates of pet ownership rates in the UK have been derived from national surveys. Although the proportional representation of Scottish households in such surveys is unknown, it is feasible that under representation of the Scottish population, which as mentioned above are experiencing higher levels of deprivation than those in England, may bias results and suggest higher national rates of pet ownership. A 36% pet ownership rate may therefore, accurately represent ownership patterns in Strathclyde, despite the higher figures reported for the UK. This point emphases the importance of conducting community pet ownership studies because of local variations in demographic and socio-economic factors which influence the ownership of pets.

3.4.3 Summary

This report outlines an analysis to identify any relationship between pet ownership, deprivation and community setting in Strathclyde Region, Scotland. An area based approach was used at the postcode sector level, with information collected during a telephone survey supplemented by data retrieved from the small area statistics of the 1991 census, together with non-census indicators of deprivation. Postcodes provided a convenient means of allocating an area reference to each household, as well as the opportunity to create maps using GIS software. These maps demonstrated the spatial distribution of pet ownership in relation to area deprivation and the urban or rural characteristics of an area. Results revealed that deprivation and urban communities were negatively associated with pet ownership. While statistically significant associations, similar to previous reports, were identified in this study, it is acknowledged that area based analysis is far from ideal in assessing the association between pet ownership and household demographic and socio-economic factors. Given that households within an area are not unambiguously alike imposes the most important limitations; however, an area based approach offers potential for future epidemiological investigations.

CHAPTER IV

RISK FACTORS FOR CANINE RELINQUISHMENT TO ANIMAL WELFARE CENTRES - PART I

CHAPTER IV

RISK FACTORS FOR CANINE RELINQUISHMENT TO ANIMAL WELFARE CENTRES - PART I

4.1 INTRODUCTION

4.1.1 Introduction

Animal welfare groups continue to struggle against the problem of pet overpopulation and the destruction of healthy but unwanted companion animals. Although a reasonable decrease in euthanasia rates has occurred over the last 30 years, (Rowan, 1992a; Patronek and Glickman, 1994), euthanasia is still a significant cause of death for dogs and cats, with reports from North America that the estimated numbers destroyed approximate to a third of all deaths (Patronek and Rowan, 1995; Patronek, 1996; Patronek *et al.*, 1996a; Patronek *et al.*, 1996b). As reviewed in Chapter 1, increasing evidence has indicated that most unwanted pets result from casual, inappropriate acquisition in combination with careless and irresponsible pet ownership as opposed to overbreeding of dogs and cats. Many factors have been found to influence an owner's decision to discard their pet. Results of surveys have suggested that cost, source, age and neutering status of the animal, behavioural problems and the owner's perception and tolerance of these problems, income, family structure and other household demographic factors, attachment to the pet and the expectation of the pets role in the house are associated with pet neglect and abandonment (Bailey, 1992; Kidd *et al.*, 1992a; Kidd *et al.*, 1992b; Alexander and Shane, 1994; Hart and Kidd, 1994; Scarlett, Saidla and Pollock, 1994; Houpt, Honig and Reisner, 1996; Miller *et al.*, 1996; Patronek *et al.*, 1996a; Patronek *et al.*, 1996b; Ledger, 1997; National Council on Pet Population Study and Policy, 1997; Salman *et al.*, 1997; Digiacomo, Arluke and Patronek, 1998).

4.1.2 Purpose

To extend the findings from previous surveys, this report describes an epidemiological study designed to characterise the human population relinquishing dogs to an animal welfare centre and describe the profile of dogs that are surrendered. The objective was to define further, in a UK context, the reported human and animal characteristics that may influence canine relinquishment. In addition, these characteristics were to be compared with a control sample of 'successful' owners and their dogs to establish risk factors that contribute to owner dissatisfaction and the decision to relinquish a pet.

4.2 MATERIALS AND METHODS

4.2.1 Research Design

A non-experimental, case-control study was conducted between February 1997 and February 1998. The study was undertaken by the author in collaboration with the Scottish Society for the Prevention of Cruelty to Animals.

4.2.2 Study population and collaborators

The study was conducted in Strathclyde Region, Scotland. Characteristics of the study region have been described previously (Chapter 2). Households that relinquished a pet dog to an animal welfare centre within the study region, comprised the population from which the case sample was selected. The control sample was randomly selected from current dog owning households within the same community.

The Scottish Society for the Prevention of Cruelty to Animals (SSPCA) is a private, non-profit organisation which exists to 'prevent cruelty to animals and to promote kindness and humanity in their treatment'. The society was founded 158 years ago. In 1997, the SSPCA was composed of 65 fund raising branches, 49 uniformed inspectors, 14 AWCs and five education officers in operation throughout Scotland. The AWCs offer temporary refuge to abandoned, injured or abused animals. The centres primarily deal with dogs and cats but also care for other domestic pets, farm animals and wildlife.

The number of animals entering the 14 AWCs, either by inspectorates or by the public, totalled 17,973 in 1997. Companion animals represented 15,782 of these, which was an increase of seven per cent over the figure for 1996. Of these companion animals, 12,309

were rehomed or returned to their owners, while the remainder had to be euthanatised. Despite an increase in the number of animals handled, an encouraging response was that eight per cent fewer animals were euthanatised in 1997 compared to the previous year.

Four SSPCA animal welfare centres operate within the study region, namely, Bothwell Bridge Animal Welfare Centre (AWC), Glasgow Dog and Cat Home, Milton AWC and Quarantine Kennels and Stirling AWC. All four of these centres were included in the study. A summary of the animals handled, their disposition and eventual outcome for each centre during the year 1997, are presented in Table 4-1, Table 4-2 and Table 4-3. Definition of the categories used to classify animals within the AWC environment is outlined in Appendix VI.

4.2.3 Sampling criteria and procedure

4.2.3.1 Case sample

A case household was defined as an owner that relinquished a pet dog to one of the four SSPCA animal welfare centres within the study region, between February 1997 and February 1998. Stray dogs that were impounded, dogs that were rescued by the inspectorate or dogs transferred from another AWC were not included. Relinquished litters of puppies were also excluded from the case sample. Relinquishment of a dog acquired with the intention of keeping it as a pet was considered to be a companion animal that was no longer wanted and represented failure of the human-companion animal bond. Relinquishment of a litter of puppies does not necessarily fulfil these criteria and therefore, surrendered litters were not eligible for cases. Racing greyhounds that were surrendered as they had outgrown their full racing potential, were also excluded for the same reason.

Case households were selected directly by animal welfare centre staff over a twelve month period. The desired size of the case sample was dictated by the size of the previously selected control sample (Chapter 2), the aim being that the four centres would collectively yield a similar number of cases as controls. To achieve this, each participating centre was provided with full written instructions on how to select a case household from the entire eligible population of relinquished dogs by means of a random selection process.

TABLE 4-1: The number of dogs handled by four SSPCA animal welfare centres, the disposition of these dogs and their eventual outcome, during the year 1997.

CATEGORY	ANIMAL WELFARE CENTRE				TOTAL
	Bothwell Bridge AWC	Glasgow Dog and Cat Home	Milton AWC	Stirling AWC	
Incoming dogs					
Held over from 1996	48	154	37	14	253
Strays	1945	2939	350	0	5234
Surrendered	597	879	389	346	2211
Temporary refuge*	78	30	44	19	171
Transferred**	29	11	75	306	421
Total received	2649	3859	858	671	8037
Total in centre	2697	4013	895	685	8290
Outcome					
Adopted/sold	1083	2048	533	639	4303
Reclaimed	574	797	194	11	1576
Euthanatised	685	676	120	14	1495
Died	8	20	0	1	29
Transferred**	268	305	7	5	585
Total dealt with	2618	3846	854	670	7988
Held over to 1998	79	167	41	15	302

* Represents animals picked up by the inspectorate as they were injured, abused or sick.

** Represents animals transferred from/to another SSPCA animal welfare centre.

TABLE 4-2: The number of cats handled by four SSPCA animal welfare centres, the disposition of these cats and their eventual outcome, during the year 1997.

CATEGORY	ANIMAL WELFARE CENTRE				TOTAL
	Bothwell Bridge AWC	Glasgow Dog and Cat Home	Milton AWC	Stirling AWC	
Incoming cats					
Held over from 1996	5	11	14	3	33
Strays	354	461	144	125	1084
Surrendered	317	373	212	255	1157
Temporary refuge*	26	7	54	18	105
Transferred**	11	0	0	45	56
Total received	708	841	410	443	2402
Total in centre	713	852	424	446	2435
Outcome					
Adopted/sold	542	690	304	400	1936
Reclaimed	20	9	19	17	65
Euthanatised	81	119	83	7	290
Died	3	17	12	4	36
Transferred**	55	2	0	5	62
Total dealt with	701	837	418	433	2389
Held over to 1998	12	15	6	13	46

* Represents animals picked up by the inspectorate as they were injured, abused or sick.

** Represents animals transferred from/to another SSPCA animal welfare centre.

TABLE 4-3: The number of animals (excluding dogs and cats) handled by four SSPCA animal welfare centres and the eventual outcome for these animals, during the year 1997.

CATEGORY	ANIMAL WELFARE CENTRE				TOTAL
	Bothwell Bridge AWC	Glasgow Dog and Cat Home	Milton AWC	Stirling AWC	
Incoming animals					
Held over from 1996	9	0	10	8	27
Received	282	136	248	201	867
Total in centre	291	136	258	209	894
Outcome					
Adopted/sold	114	66	62	152	394
Reclaimed	30	15	27	14	86
Released	14	0	37	1	52
Euthanatised	90	9	66	1	160
Died	15	11	60	4	90
Transferred**	10	25	1	14	50
Total dealt with	273	126	253	186	838
Held over to 1998	18	10	5	23	56

* Represents animals picked up by the inspectorate as they were injured, abused or sick.

** Represents animals transferred from/to another SSPCA animal welfare centre.

4.2.3.2 Control Sample

The criteria and methods used for selection of control households has been described previously (Chapter 2). In brief, a random sample of residential telephone numbers (n=2000) were selected from five British Telecommunications (BT) phone books which listed telephone numbers for households within the study region. This sample was then used to solicit control households by means of a telephone survey. Eligible control households were those that currently owned at least one pet dog. All eligible households were invited to participate in the study by sharing their experience of dog ownership. If a household agreed to participate, their name and address listed within the BT phone book was quoted to confirm that it was correct. If correct, this information was carefully copied from the BT phone book and manually written into the researchers list of control households. If incorrect, this information was requested from the respondent. Due to reasons already discussed (Chapter 2), the interview was terminated at this stage after it was explained that the remainder of the study would be conducted by means of a mail questionnaire. Once the control sample was complete (n=360), the written list of names and addresses of all control households was transferred to pre-prepared tables, designed and stored using Microsoft Word for Windows '95, Version 7 (Appendix VII). These tables were subsequently used during implementation of the mail survey.

4.2.4 Data Collection

4.2.4.1 Questionnaire

Data were secured by use of a carefully designed, self-administered questionnaire (Appendix VIII). An adaptation of the total design method (TDM), a questionnaire design and implementation procedure developed to increase the quality and quantity of response in mailed surveys (Dillman, 1978), was used. The design and production of questionnaires was carried out solely by the author. The questionnaires were designed using a computer software package (Microsoft Word for Windows '95, Version 7).

Each questionnaire consisted of 41 questions pertaining to the attributes, attitudes, beliefs and behaviour of case and control households and the characteristics of their dogs. A combination of close-ended and partially close-ended questions were mainly used, with either ordered or unordered choices. Such questions offered a series of forced choice answers and the option of 'Other (please specify)' in the case of partially close-

ended questions. Some open-ended questions were also used when a numerical response was requested. Careful attention was paid to the wording of each question keeping phrases short, simple and specific and avoiding vagueness, possible misunderstanding and objectionable, biased or irrelevant questions.

Dog variables investigated included age, sex, breed and neuter status. If more than one dog was currently owned, one of these dogs was arbitrarily selected by the respondent. Additional areas investigated included previous pet ownership, other pets currently owned, the origin of the dog, the reason it had been obtained and the original purchase price, reasons for or against neutering, expectations of the dogs role in the house, dog behaviour and training, the interaction of household members with the dog and veterinary attendance. The final section of the questionnaire consisted of seven questions designed to ascertain household demographic data including family structure, type of housing, highest level of education achieved and annual household income. Two separate questionnaires were designed, each applying to a case or a control household, respectively. These questionnaires were almost identical to each other apart from some minor adjustments in tense used within some questions and a difference in the front cover attached to the questionnaire (Appendix VIII).

Questionnaires were printed on standard A4 (210 x 297 mm) paper. Both sides of the paper had questions printed (portrait) on them. No questions were printed on the reverse side of the front cover or on the back of the last page, both of which were left blank. Contrary to common procedure, the questionnaire was not folded into booklet form. Instead, the final printed A4 sheets were stapled together at the upper left hand corner. Each final questionnaire consisted of a total of 6 pages including the front cover.

4.4.2.2 Pre-testing

A pre-test of the questionnaire was undertaken, the objective of which was to identify any construction defects of the questionnaire and assess the degree of understanding and completion of each question. The pre-test questionnaire was distributed to three groups of people; colleagues working at the University of Glasgow Veterinary School who owned dogs (n=8); a sample of dog owning clients attending the University of Glasgow Veterinary School Hospital Clinic (n=10); a sample of dog owning clients attending a People's Dispensary for Sick Animals (PDSA) Veterinary Clinic, located in the city

centre of Glasgow (n=12). This latter organisation is a private, non-profit charitable group that provides free veterinary service for low income households. The above three groups were believed to represent a cross-section of potential respondents. Although the pre-test questionnaire was self-administered, each participant answered the questions in the presence of the researcher and comments were collected immediately after completion of the questionnaire. The questionnaire was subsequently modified according to any observed problems and the participants comments. Completion of the questionnaire during the pre-test averaged ten to fifteen minutes for each participant.

4.2.4.3 Case households

Eligible case households were recruited throughout a one year period to accommodate for any seasonal variation in responses. Each household was canvassed directly at the time of relinquishing their dogs. It was anticipated that people in the process of surrendering a pet may be uncertain of their true motives, or may decline to reveal the genuine reasons behind their action and instead fabricate an alternative excuse. Due to this, explanation of the study to participants emphasised an interest in the experience of dog owning and the interactions with their dog. The reasons for relinquishment as such were not questioned. Each participant was assured of complete confidentiality.

The distribution, completion and collection of questionnaires was supervised by animal welfare centre staff. Participation in the study was voluntary. Although no statistics were kept, staff reported that only a small number of persons approached declined to complete the questionnaire while they waited for their surrender forms to be processed. One questionnaire was administered to each household in the process of relinquishing their dog. If several persons brought in the dog together, only one questionnaire was administered. If a household was relinquishing more than one dog then one of these dogs was arbitrarily selected and a questionnaire was completed with regard to this dog only.

4.2.4.4 Control households

As discussed above, eligible control households were pre-contacted by telephone, identifying the researcher and the purpose of the study and was accompanied by a request to participate in the study. Subsequent contact was by a mail survey, the administration of which closely followed the Total Design Method (Dillman, 1978). Implementation of the mail survey was carried out solely by the author.

Initially, all control households were sent a copy of the questionnaire accompanied by a cover letter (Appendix VIX). Each questionnaire was clearly identified by an identification number printed on the front cover, an explanation of which was included in the cover letter. This identification system facilitated the sending of follow-up correspondence only to non-responding households and avoided the possibility of households completing multiple questionnaires. The design and printing of cover letters utilised the 'mail merge' tools option in Microsoft Word for Windows '95, Version 7. All cover letters were printed on standard A4 (210 x 297 mm) paper and were headed with the University of Glasgow logo and the name and title of the author. Each letter was personally addressed to individual participants, was dated relevant to the mailing date and was hand-signed by the author. The printing of names and addresses of each control household on to individual cover letters was facilitated by use of 'mail merge' and the pre-prepared name and address tables (Appendix VII) acting as the data source. As well as outlining the purpose of the research, each cover letter contained a statement ensuring confidentiality and asking the person to whom the questionnaire was mailed to respond. If this was not possible, another adult in the same household was acceptable.

Cover letter, questionnaire and a prepaid reply envelope were carefully folded together in a predetermined fashion and placed for mailing into a regular manila business envelope (165 x 240 mm). Prepaid reply envelopes were self-addressed using self-adhesive FREEPOST address labels (Avery A4, L7160 Address labels, 3.81 x 6.35 cm), which were designed and printed using the 'envelopes and labels' tools option in Microsoft Word for Windows '95 Version 7. These reply envelopes were also regular manila business envelopes (165 x 240 mm). All outgoing mail was addressed using self-adhesive address labels (Avery A4, L7160 Address labels, 3.81 x 6.35 cm) affixed to the mailing envelopes and franked first class rate. Again, the printing of individualised labels for each control household was facilitated by use of 'mail merge' and the pre-prepared name and address tables acting as the data source.

The follow-up procedure consisted of three carefully timed mailings. A follow-up letter (Appendix X) was sent to the entire research sample exactly seven days after the initial mailing date. This served to thank those members of the research sample who had already returned a completed questionnaire and as a reminder to those who had not. The format of this letter and all subsequent cover letters was identical to the first cover letter.

A second follow-up was sent to all non-responding households exactly three weeks after the first mailing. This follow-up consisted of a cover letter (Appendix XI) which reiterated the original appeal from the first correspondence and informed the respondent that their questionnaire had not yet been received. This was accompanied by a replacement questionnaire and another prepaid reply envelope. A final follow-up copy of the questionnaire, with cover letter (Appendix XII) and a prepaid reply envelope, was sent to all non-respondents seven weeks after the original mailing.

The whole implementation procedure emphasised personalisation throughout to convey the message that each respondents' participation in the study was critical to its success. Throughout implementation of the mail survey, returned questionnaires were scrutinised on a daily basis. This facilitated the identification of any problems encountered by respondents during completion and immediate intervention if necessary. In addition, the identification number on the returned questionnaire allowed exclusion of the corresponding control households from subsequent mailings, this task being achieved by deleting these households from the pre-prepared tables of names and addresses of control households. The number of questionnaires returned each day was recorded and related to the mailing date (Chapter 4, Section 3.1).

Reliability of the questionnaires was not measured. Validity was assessed by comparison of the breed data obtained from the questionnaire study with an independent measure of the same variable. Information relating to breeds of dogs from the entire canine population of the United Kingdom was acquired from The Kennel Club, who provided details of voluntary registrations of pedigree litters for the year 1997.

4.2.4.1 Data storage

Data from completed questionnaires were edited and a format for entry into a computer determined. The data were then transferred to a computer database (Microsoft Access for Windows '95 Version 7). The properties of this database management system have been described previously (Chapter 2, Section 2.5.1). Two tables were designed by the author, each corresponding to the storage of data from case and control questionnaires, respectively. To facilitate entry of data, two 'forms' were also constructed and linked to their reference table (Appendix VII). 'Combo boxes' were frequently incorporated into the design of the form. These were embedded in the data entry form with easy access to

lists that could be scrolled through and the appropriate categorical variable selected. In addition, 'check boxes' were used, which permitted a tick to be entered into a box to record that a characteristic was present or could be left blank when the characteristic being measured was absent.

4.2.5 Statistical analysis

Simple descriptive analysis was carried out in Microsoft Access using specifically designed 'queries'. Further descriptive statistics were compiled using Microsoft Excel for Windows '95, Version 7, after data were imported from the Microsoft Access database. More sophisticated statistical analysis were performed using Minitab for Windows, 9.2, Statistix Version 4 and Epicalc 2000, Version 1.01 Analytical Software Packages. The two sample t test was used to compare continuous variables. The chi-square test for independence was used to evaluate categorical variables (Dawson-Saunders and Trapp, 1994). Bivariate associations between levels within a categorical variable were also assessed using the chi-square test. In the case of two by two contingency tables where expected cell frequencies were small (25% of expected cell counts less than five), an adjusted value of the chi-square statistic, the Yates' corrected chi-square, was used. This corrected value has been reported to produce *P*-values similar to those that would be calculated by the Fisher's exact test (PROPHET StatGuide, 1998). If expected cell frequencies were less than one, the Fisher's exact test was performed. A significance level of 5% ($\alpha = 0.05$) was used throughout.

With regard to categorical variables, due to the multiple comparisons that were carried out, an *ad hoc* correction was made to the significance level to reduce the probability of a type I error. This involved dividing 0.05 by the number of bivariate comparisons made, with the value obtained representing the adjusted level of significance. For example, a categorical variable with four levels, primarily analysed in a four by two contingency table, with a significance level of five per cent, had each level of this variable evaluated with respect to all other levels, in two by two contingency tables. The significance level for these bivariate associations was adjusted to 0.05 divided by four.

4.3 RESULTS

4.3.1 Response from mail survey

During implementation of the mail survey, the number of questionnaires returned each day was recorded. Figure 4-1 graphically displays these data in relation to the days when the original questionnaire and cover letter, and subsequent follow-up correspondence were mailed to control households. Of the 360 control households that were included in the mail survey, a total of 321 of the recipients returned usable questionnaires. This represented a 89.2% response rate (Figure 4-2). Table 4-4 summarises the response obtained after each mailing. These were calculated on the basis that households received questionnaires and/or cover letters one day after they were mailed. A total of 170 completed questionnaires were returned after the first correspondence, 276 after the first follow-up, 306 after the second follow-up and the final total of 321 was reached after the third follow-up (Figure 4-3).

Considering non-response, four questionnaires were returned not completed after the first follow-up. Two of these were returned by non-dog owning households, one household declined to participate in the survey as their dog had a terminal illness and the fourth household was unwilling to participate for no specified reason. A further three questionnaires were returned by the postal service marked 'addressee unknown' after the second follow-up. The remaining 32 non-responses were households that failed to return a questionnaire. Adjustment for the two non-eligible and three non-contactable households prior to response rate calculation resulted in a 90.4% response rate. With the above information, Figure 4-4 displays the relative response rate obtained for each mailing. The characteristics of non-respondents were not assessed.

4.3.2 Descriptive analysis

Data were successfully obtained from a total of 49 case households and 321 control households. With respect to these households, a small number of respondents inadvertently omitted one or more of the 41 questions included in the questionnaire. The proportion of case and control households that omitted each question (item non-response) was calculated. With respect to all 41 questions, the mean ± sd (median) item non-response was 1.2% ± 2.5% (0.0%) for case households and 1.6% ± 3.3% (0.3%) for

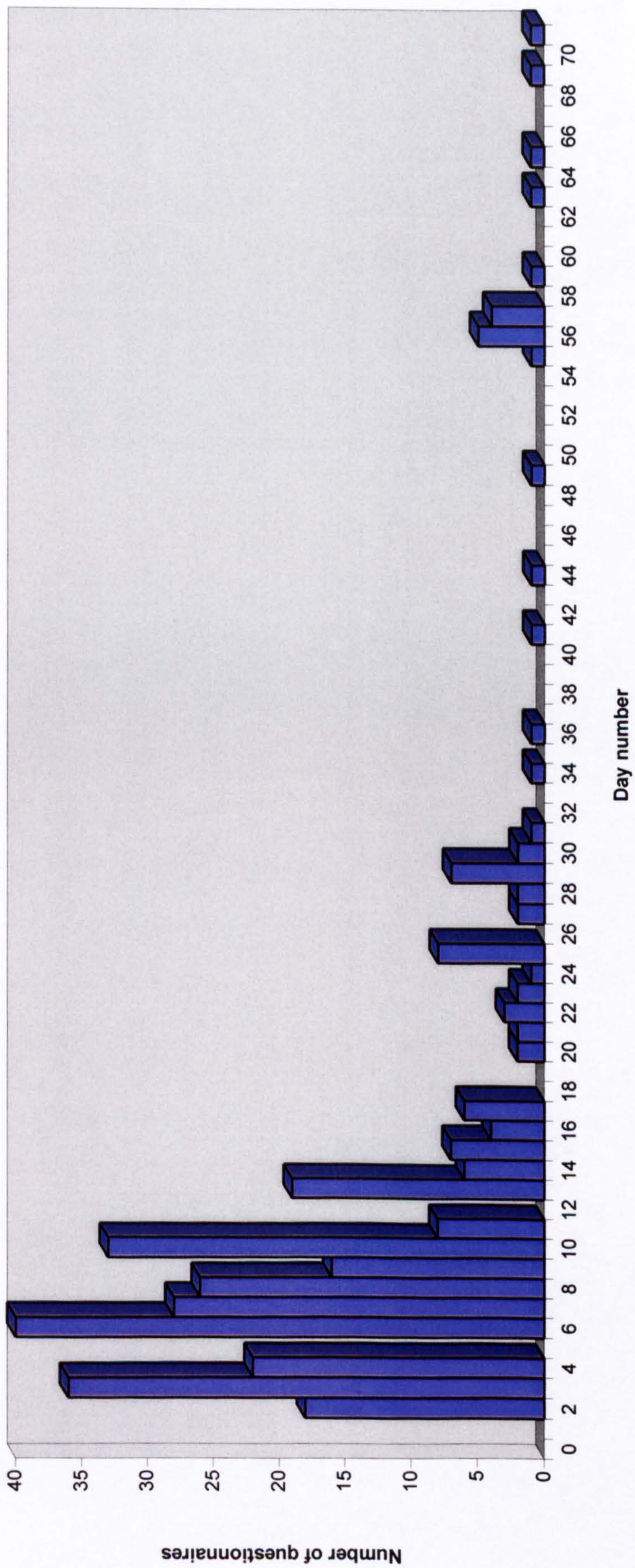


FIGURE 4-1: Number of completed questionnaires returned each day, in relation to mailing dates, during implementation of a mail survey of 360 dog owning households in Strathclyde Region, Scotland.

Note Day numbers **1** - first correspondence, **7** - first follow-up, **21** - second follow-up, **49** - third follow-up.
Day numbers **5, 12, 19, 26, 33, 40, 47, 54, 61, 68** - Sunday (no mail delivered).

FIGURE 4-2: Response rate obtained from a mail survey of 360 dog owning households in Strathclyde Region, Scotland.

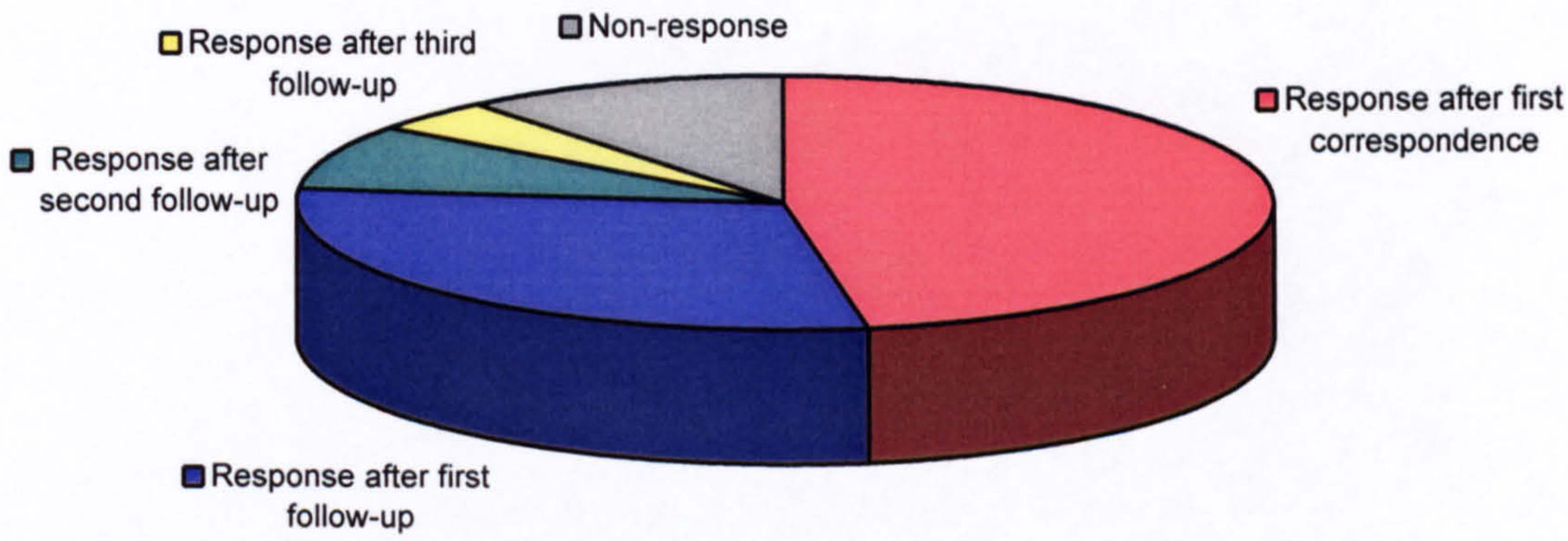


TABLE 4-4: Response obtained from a mail survey of 360 dog owning households in Strathclyde Region, Scotland.

CATEGORY	NUMBER OF QUESTIONNAIRES	PERCENTAGE OF SAMPLE
Response after first correspondence	170	47.22
Response after first follow-up	106	29.44
Response after second follow-up	30	8.33
Response after third follow-up	15	4.17
Total response	321	89.17
Questionnaires returned not completed after first follow-up	4	1.11
Questionnaires returned not completed after second follow-up	3	0.83
No response after third follow-up	32	8.89
Total non-response	39	10.83

FIGURE 4-3: Cumulative percentage of completed questionnaires returned after each correspondence, during implementation of a mail survey of 360 dog owning households in Strathclyde Region, Scotland.

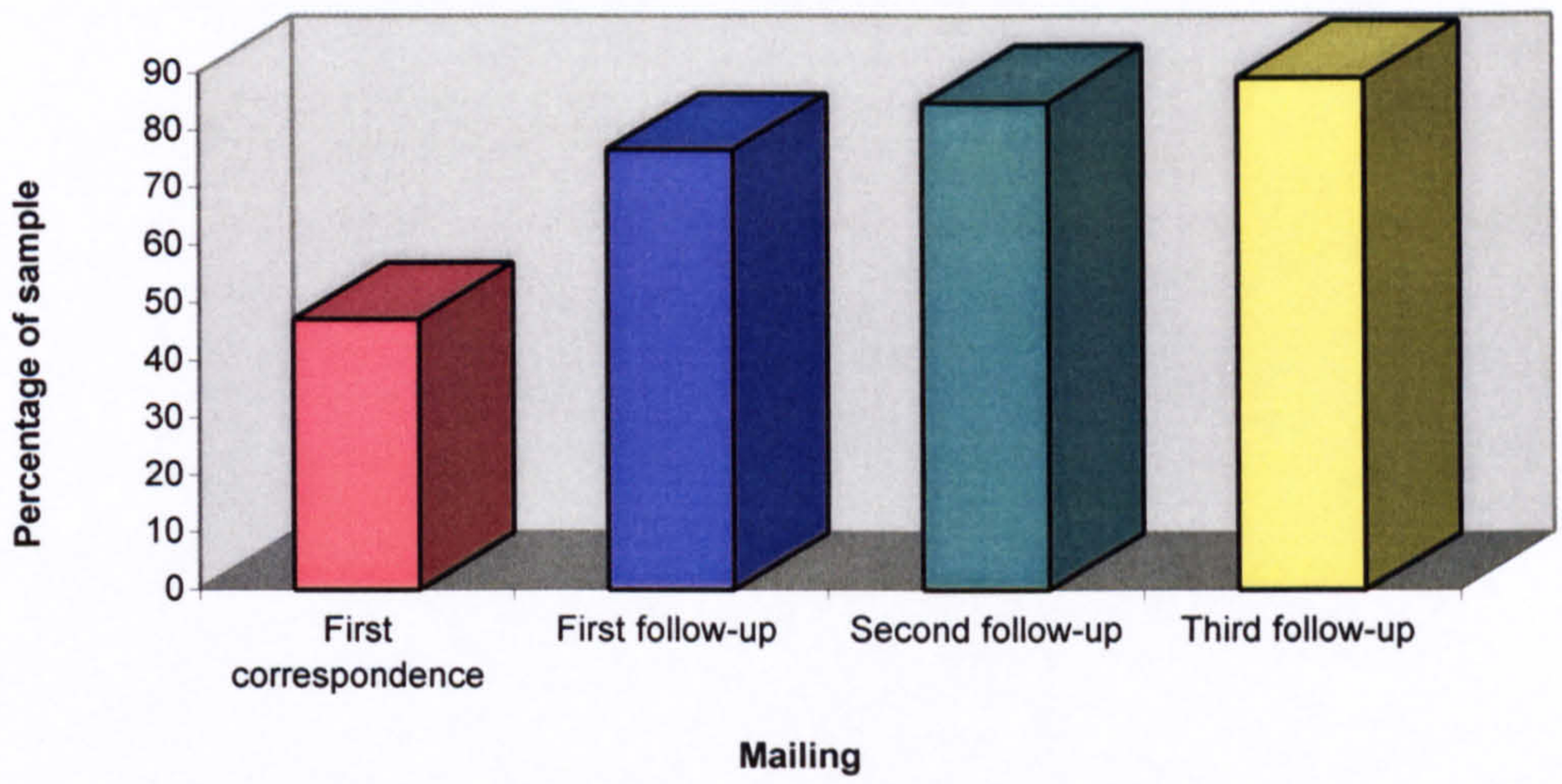
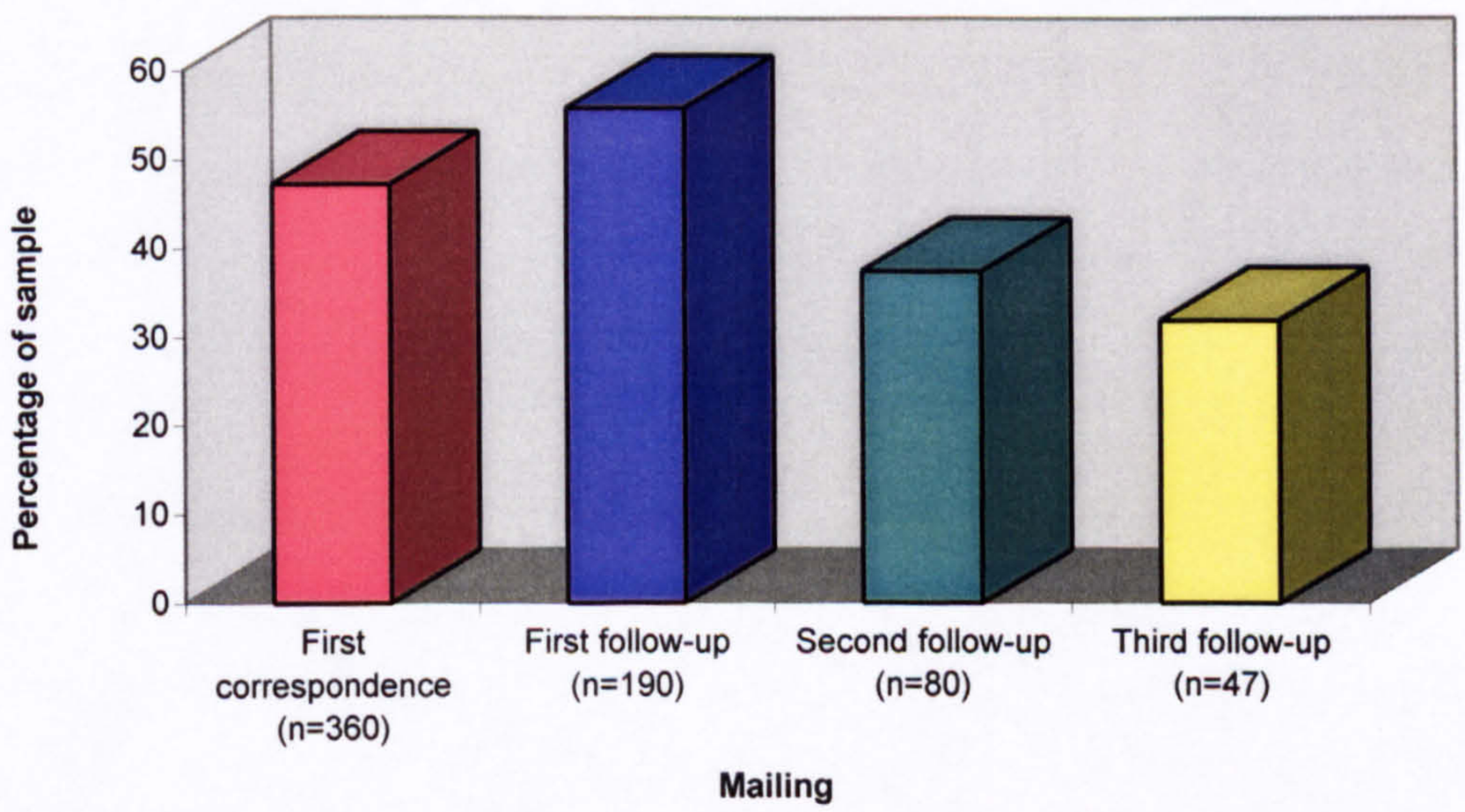


FIGURE 4-4: Relative response rate obtained after each correspondence, during implementation of a mail survey of 360 dog owning households in Strathclyde Region, Scotland.



control households (t=0.68, P=0.50). Females represented 59.2% (29) and 64.7% (207) of the respondents from case and control households, respectively. The sex of the household member that completed the questionnaire was not significantly different between case and control households (Yates' corrected χ^2=0.35, P=0.56).

4.3.2.1 Dog characteristics

Age was specified for 49 dogs from case households and 319 dogs from control households. Age data showed a significant difference between dogs from case and control households (t=16.41, P<0.001). Mean ± sd (median) age of dogs were 1.9 ± 1.7 (1.2) years and 7.3 ± 4.0 (7.2) years for case and control households, respectively (Figures 4-5 and 4-6). Descriptive statistics from analysis of age data are listed in Appendix XIII.

These age data were also coded into categorical variables. Puppies were defined as dogs less than four months of age, juveniles as dogs between four to eleven months of age, young adults as dogs between one to less than three years, adults as dogs between three to ten years and geriatrics as dogs greater than ten years. Figures 4-7 and 4-8 display the proportion of dogs from case and control households in each age category. Chi-square analysis of these proportions confirmed a significant difference in age (Pearson χ^2=95.63, P<0.001) between dogs from case and control households (Table 4-5).

With regard to gender, females represented 55.1% (27) and 50.8% (163) of dogs from case and control households, respectively (Yates' corrected χ^2=0.17, P=0.68). Sexual status was specified for 49 dogs from case households and 319 dogs from control households. Eighteen (36.7%) dogs from case households were neutered, which represented 48.2% (13) of the female members and 22.7% (5) of the male members of the case sample. With respect to dogs from control households, 45.1% (144) were neutered, which represented 66.9% (109) of the female members and 22.4% (35) of the male members of the control sample. Although a higher proportion of dogs from control households were neutered compared to dogs from case households (attributable to the increased rate of speying), this was not statistically significant (Yates' corrected χ^2=0.90, P=0.34). In addition, after elimination of dogs that were less than 6 months of age (conventionally too young to be neutered in the UK), the difference in neutering rates was almost eliminated (45.0% versus 45.9% of dogs from case and control

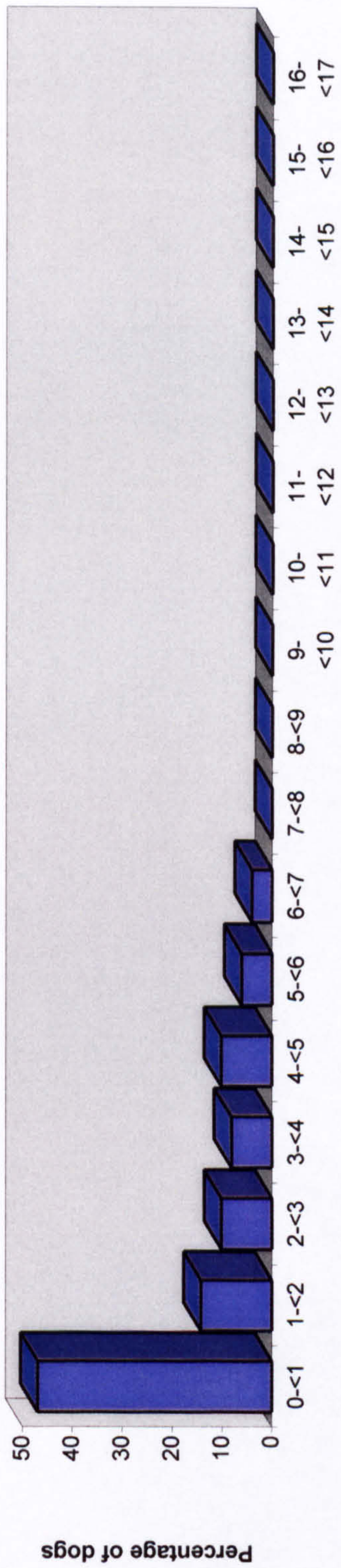


FIGURE 4-5: Age distribution of 49 dogs relinquished to an animal welfare centre in Strathclyde Region, Scotland.

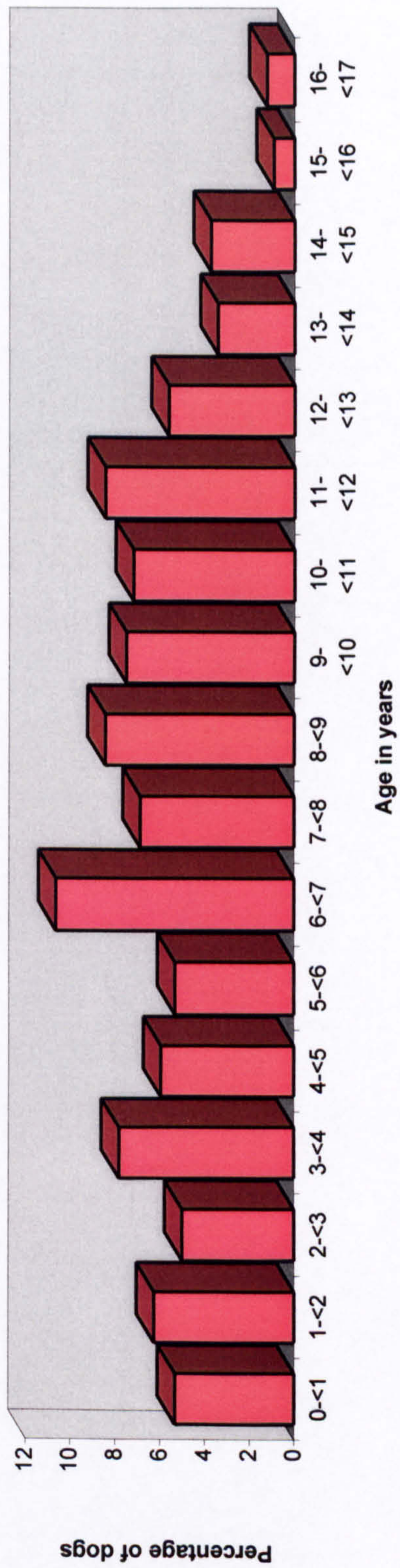


FIGURE 4-6: Age distribution of dogs from 319 dog owning households in Strathclyde Region, Scotland.

FIGURE 4-7: Age distribution of 49 dogs relinquished to an animal welfare centre in Strathclyde Region, Scotland, after age data were coded into categorical variables.

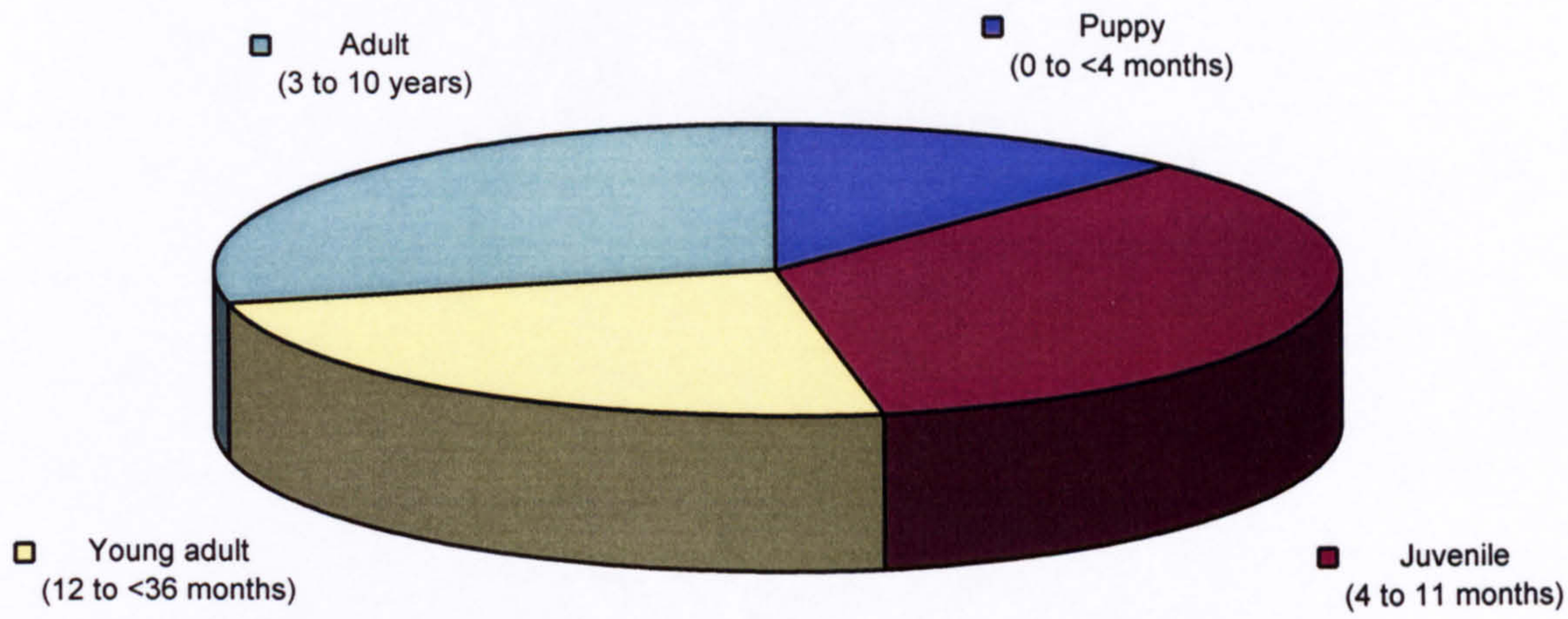


FIGURE 4-8: Age distribution of dogs from 319 dog owning households in Strathclyde Region, Scotland, after age data were coded into categorical variables.

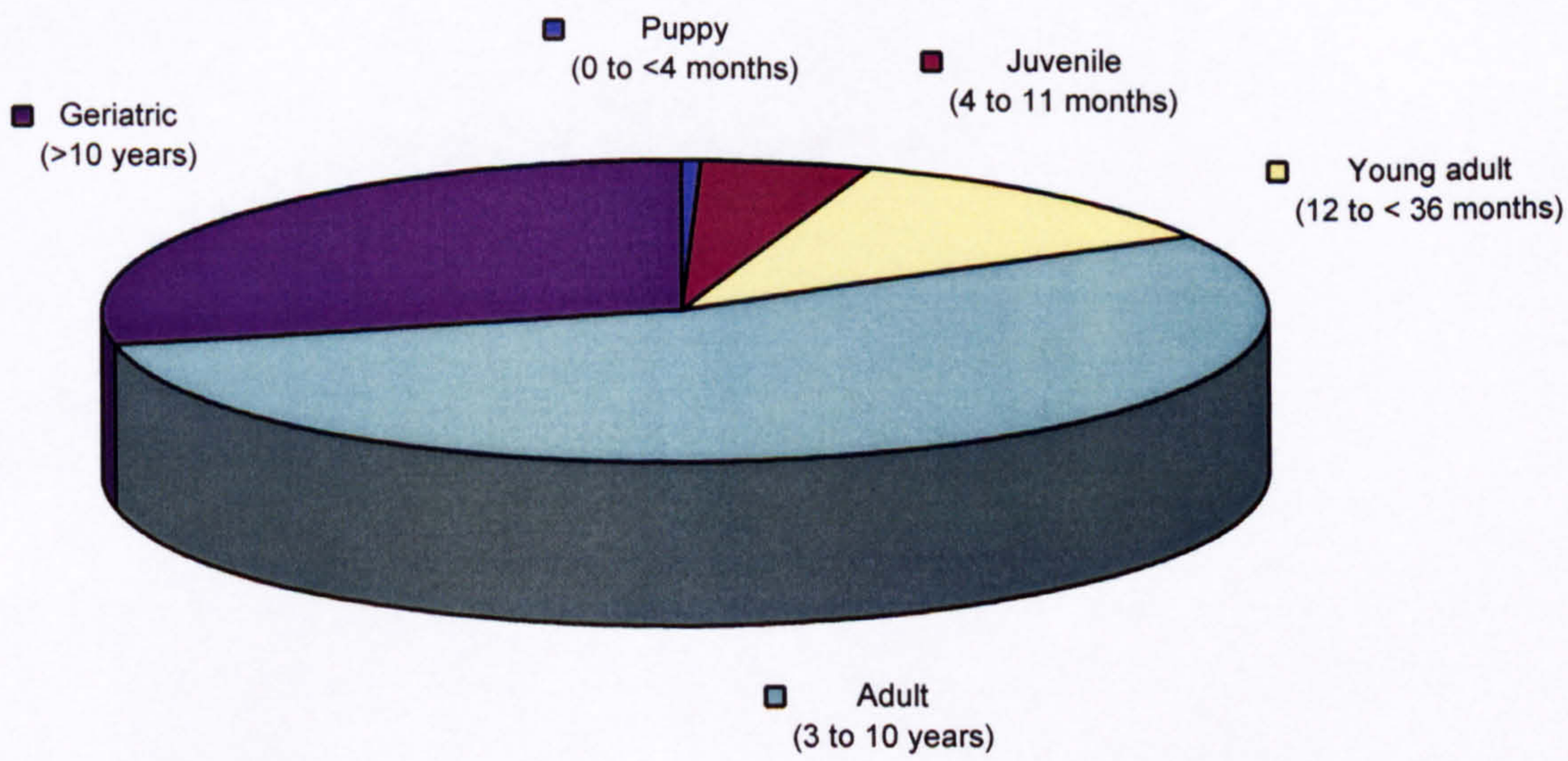


TABLE 4-5: Age distribution of 49 dogs from case households and 319 dogs from control households in Strathclyde Region, Scotland and chi-square analysis of bivariate associations between each age category.

AGE CATEGORY	CASES (%)	CONTROLS (%)	χ^2	*P*-VALUE*
Puppies (<4 mths)	6 (12.24)	2 (0.63)	21.77	<0.001
Juveniles (4 to 11 mths)	17 (34.69)	15 (4.70)	44.42	<0.001
Young adults (1 to <3 yrs)	12 (24.49)	36 (11.29)	4.70	0.03
Adults (3 to 10 yrs)	14 (28.57)	176 (55.17)	10.99	<0.001
Geriatric (>10 yrs)	0 (0.00)	90 (28.21)	16.80	<0.001

* level of significance reduced to 0.01 due to multiple comparisons

Note

Bivariate associations - two by two contingency tables

Number of puppies - cases	Number of puppies - controls
Number of all non-puppies - cases	Number of all non-puppies - controls

Likewise,

Number of juveniles - cases	Number of juveniles - controls
Number of all non-juveniles - cases	Number of all non juveniles - controls

All other categories were evaluated in the same manner.

Evaluating bivariate associations between levels of categorical variables, using the above method, continued throughout this report.

households, respectively). Considering age when neutered, the mean (± sd) age of dogs were 11.9 (± 12.7) months and 29.1 (± 30.0) months for dogs from case and control households, respectively. The lower neutering age for dogs from case households was significant (t=4.36, $P<0.001$). Descriptive statistics from analysis of neutering age data, are listed in Appendix XIII.

Figures 4-9 and 4-10 present the reasons given by 30 case households and 171 control households for not neutering their dogs. For this question, several respondents selected more than one answer. In these instances, an ordering system was used to indicate first choice, second choice and so on. To allow comparison between case and control households, only the first choice of these respondents was considered. Comparison between the reasons given by case and control households for not neutering their dogs showed a significant difference (Pearson $\chi^2=55.52$, $P<0.001$). Bivariate comparison of each reason, among all reasons, is summarised in Table 4-6. The reasons given by 18 case households and 143 control households for neutering their dogs are presented in Figures 4-11 and 4-12. Again comparison between case and control households showed a significant difference (Pearson $\chi^2=18.57$, $P<0.01$) Although, 'to prevent unwanted pregnancies' was the most popular reason given by both case (44.4%) and control (58.7%) households, significantly more case households had their dog neutered after being instructed or advised to when they acquired the dog (Yates' corrected $\chi^2=12.28$, $P<0.001$). Bivariate comparison of each reason among all reasons is shown in Table 4-7.

Twenty-seven case households and 162 control households that owned a female dog, specified the reproductive history of their pet. Four (14.8%) dogs from these case households and 21 (13.0%) dogs from these control households had previously whelped a litter of pups. Of the 21 control households, three respondents commented that their dog had a litter of pups, or was pregnant, prior to their ownership. With this knowledge, the number of control households who allowed their female dog to have a litter of pups was adjusted to 18 (11.1%). Comparison between these final figures for case and control households showed no significant difference (Yates' corrected $\chi^2=0.05$, $P=0.82$). The reason given by these households for allowing their dog to have a litter of pups significantly differed between case and control households (Fisher's exact test, $P=0.02$). All four case households reported that the litter of pups was accidental with an unknown mate, whereas only 27.8% (5) of the control households selected this reason. The

FIGURE 4-9: Reasons given by 30 households relinquishing their dog to an animal welfare centre in Strathclyde Region, Scotland for not neutering their dog.

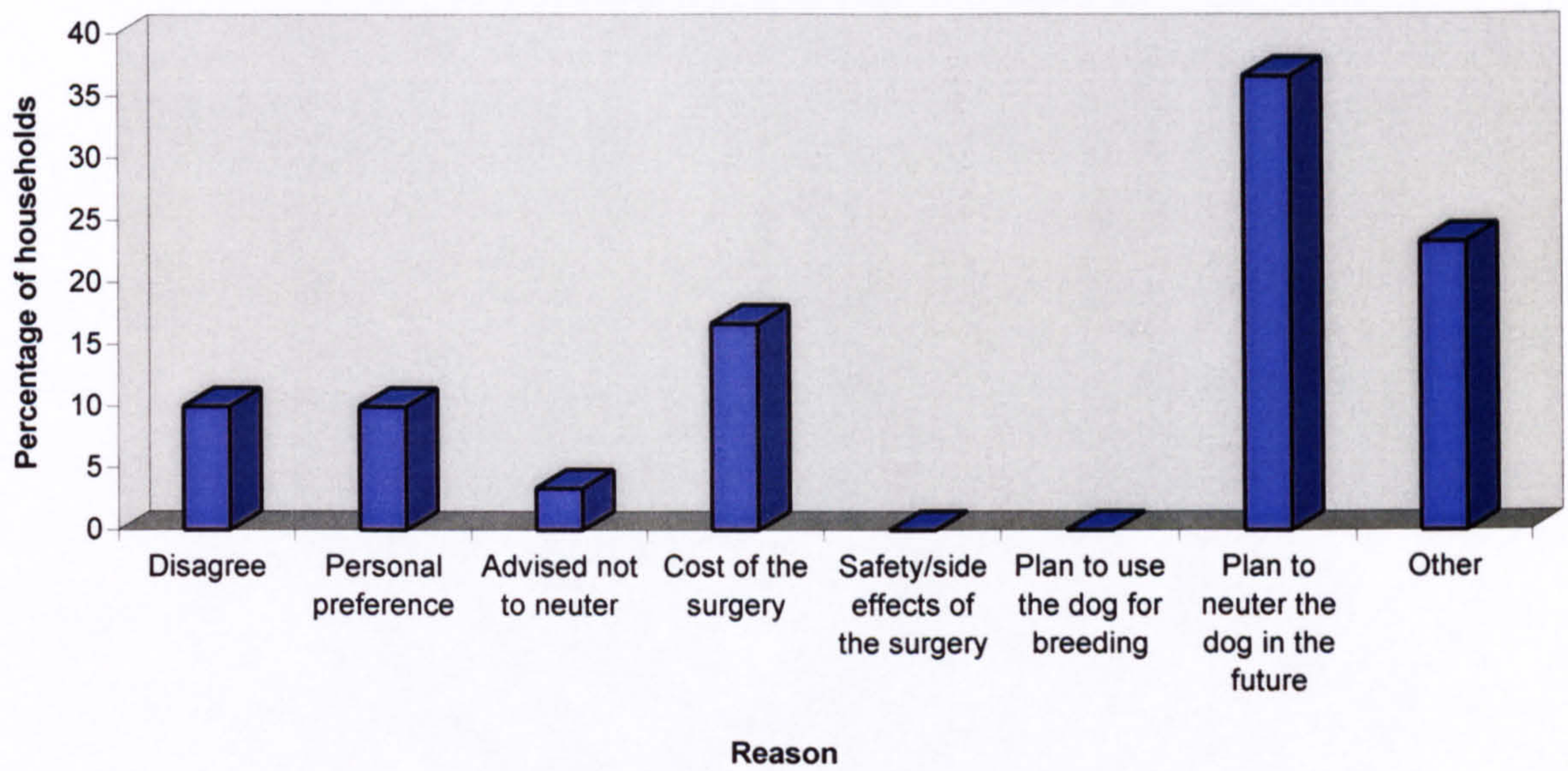


FIGURE 4-10: Reasons given by 171 dog owning households in Strathclyde Region, Scotland for not neutering their dog.

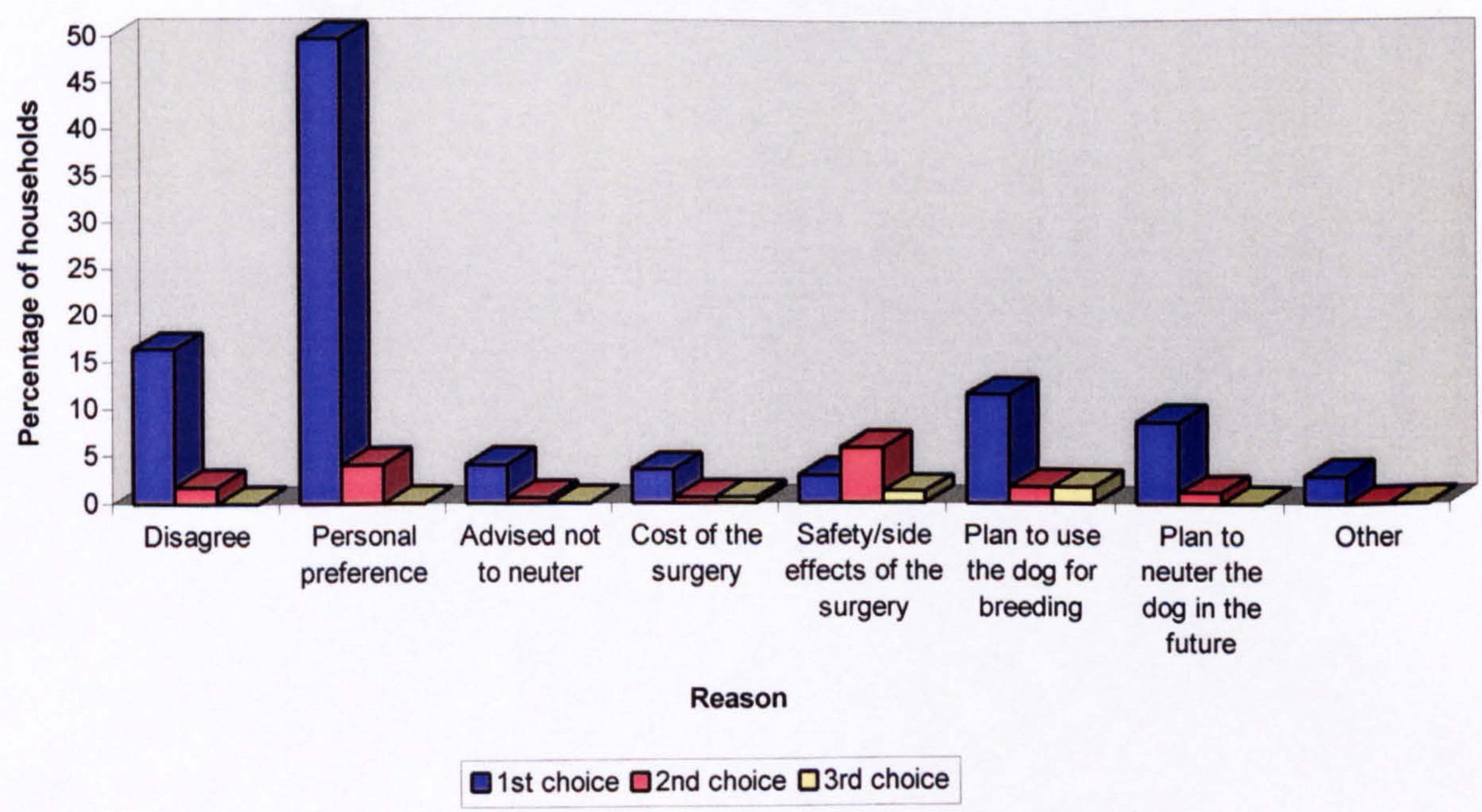


TABLE 4-6: Reasons given by 30 case households and 171 control households in Strathclyde Region, Scotland for not neutering their dogs (first choices only) and chi-square analysis of bivariate associations for each reason.

REASON	CASES (%)	CONTROLS (%)	YATES' CORRECTED χ^2	*P*-VALUE*
Disagree with neutering	3 (10.00)	28 (16.37)	0.38	0.54
Personal preference	3 (10.00)	85 (49.71)	14.78	<0.001
Advised not to neuter	1 (3.33)	7 (4.09)	0.10	0.76
Cost of the surgery	5 (16.67)	6 (3.51)	6.19	0.01
Safety/side effects	0 (0.00)	5 (2.92)	**	**
Plan to breed in the future	0 (0.00)	20 (11.70)	2.70	0.10
Plan to neuter in the future	11 (36.67)	15 (8.77)	15.24	<0.001
Other◊	7 (23.33)	5 (2.92)	15.48	<0.001

* level of significance reduced to 0.006 due to multiple comparisons

** 25% of cells had expected counts less than 1.0, Fisher's exact test, *P*=1.00

◊ Case households - dog is too young to neuter (n=4), subject never been an issue (n=1), dog has never come into season (n=1), did not have the dog long enough (n=1)

Control households - did not know it was necessary (n=1), never thought about it or subject never been an issue (n=3), dog has never come into season (n=1)

FIGURE 4-11: Reasons given by 18 households relinquishing their dog to an animal welfare centre in Strathclyde Region, Scotland for neutering their dog.

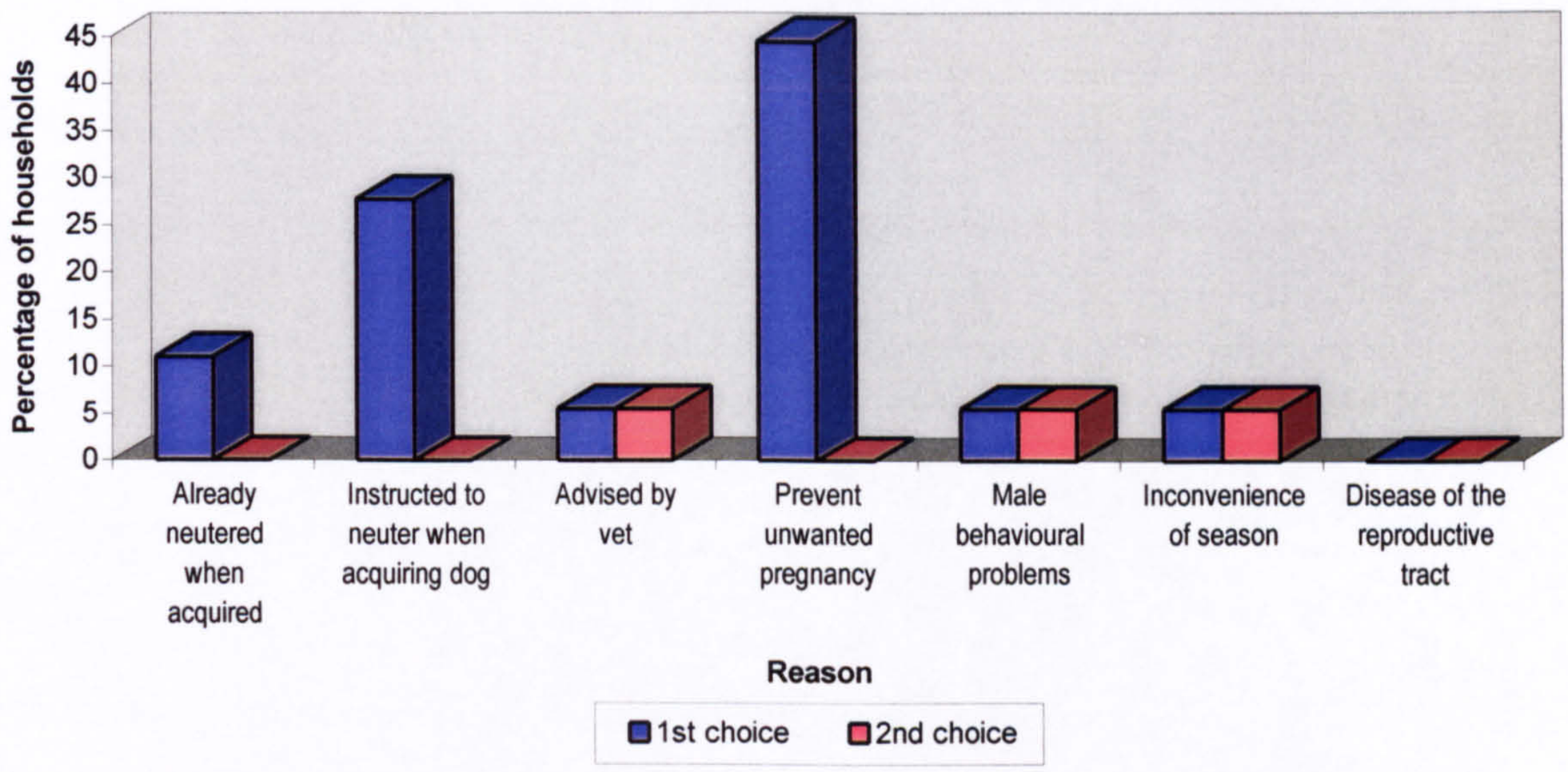


FIGURE 4-12: Reasons given by 143 dog owning households in Strathclyde Region, Scotland for neutering their dog.

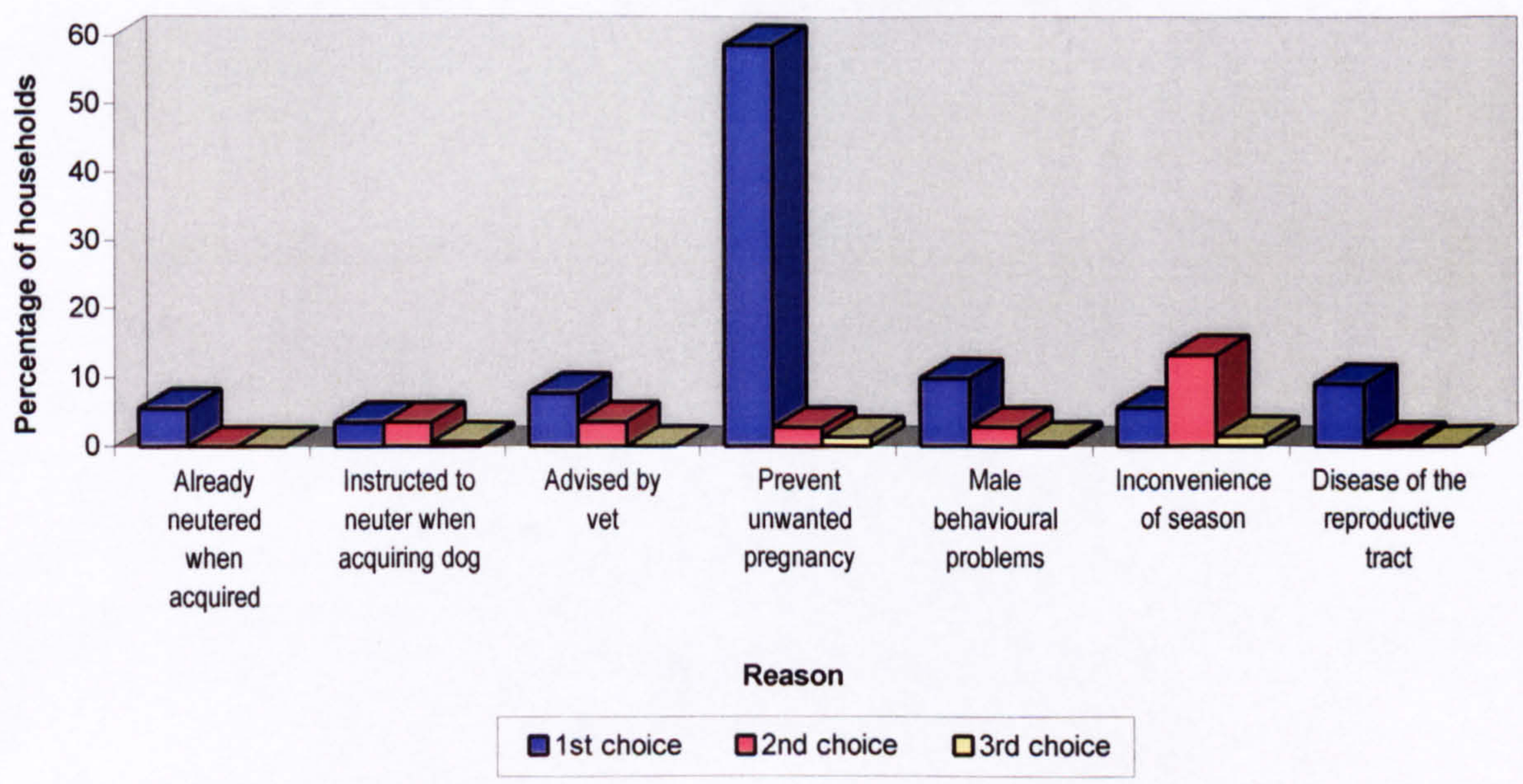


TABLE 4-7: Reasons given by 18 case households and 143 control households in Strathclyde Region, Scotland for neutering their dogs (first choices only) and chi-square analysis of bivariate associations for each reason.

REASON	CASES (%)	CONTROLS (%)	YATES' CORRECTED χ^2	*P*-VALUE*
Already neutered when acquired	2 (11.11)	8 (5.59)	0.16	0.69
Instructed/advised by source	5 (27.78)	5 (3.50)	12.28	<0.001
Advised by vet	1 (5.56)	11 (7.69)	0.02	0.88
Prevent unwanted pregnancies	8 (44.44)	84 (58.74)	0.81	0.37
Male behavioural problems	1 (5.56)	14 (9.79)	0.02	0.88
Inconvenience of season	1 (5.56)	8 (5.59)	0.00	1.00
Disease of the reproductive tract	0 (0.00)	13 (9.09)	0.77	0.38

* level of significance reduced to 0.007 due to multiple comparisons

remaining 13 control households had carefully planned and timed the breeding of their female dog. A variety of reasons were selected for this planned breeding including; for the benefit of the dog (n=6), for the benefit of family members (n=1), to make money from the sale of the pups (n=2), to produce healthy pups capable of being both companion and show dogs (n=2), to produce a pup from the bitch as a replacement in case she died (n=1), to continue a blood line (n=1).

Mixed breeds represented 89.8% (44) of the dogs from case households compared to 31.8% (102) of the dogs from control households (Yates' corrected χ^2=57.50, P<0.001). The remaining five (10.2%) dogs from case household were pure-bred, of which 3 (60.0%) were Kennel Club registered and 2 (40.0%) were not. The remaining 219 (68.2%) dogs from control households were pure-bred, of which 120 (54.8%) were Kennel Club registered and 99 (45.2%) were not. The proportion of pure-bred dogs from case and control households that were Kennel Club registered, was not significantly different (Yates' corrected χ^2=0.05, P=0.82). Due to the low number of pure-bred dogs from case households and the high proportion of respondents that did not indicate the breed mixture of their mixed breed dogs, analysis of breed type was not performed. Table 4-8 lists the ten most commonly reported breeds from 203 pure-bred dog owning control households and the position of these breeds in the British Kennel Club litter registration order for 1997. The proportion of pure-bred dogs from these households in each Kennel Club breed group is presented in Figure 4-13. As can be seen, these proportions are very similar to the proportion of all Kennel Club litter registrations in each breed group, for the year 1997.

4.2.2.2 Factors associated with acquiring the dog

Age at acquisition was available for 47 dogs from case households and 316 dogs from control households. The mean (±sd) age at acquisition was 6.4 ± 10.9 months and 7.7 ± 17.6 months for dogs from case and control households, respectively. The lower acquisition age for dogs from case households was not significantly different from the controls (t=0.65, P=0.52). Descriptive statistics from analysis of age at acquisition are listed in Appendix XIII. These age data were also coded into four categorical variables.

TABLE 4-8: Top ten breeds among dogs from a sample of 203 pure-bred dog owning households in Strathclyde Region, Scotland and British Kennel Club litter registration order for these breeds.

BREED	NUMBER OF DOGS	% OF SAMPLE	KC LITTER REGISTRATION ORDER
1. Labrador Retriever	24	11.82	1
2. English Springer Spaniel	19	9.36	6
3. Cavalier King Charles Spaniel	18	8.87	7
4. German Shepherd Dog	14	6.90	2
5. Yorkshire Terrier	13	6.40	9
6. Border Collie	11	5.42	24
7. Golden Retriever	11	5.42	4
8. West Highland White Terrier	11	5.42	3
9. Boxer	7	3.45	8
10.Cairn Terrier	7	3.45	25

FIGURE 4-13: Proportion of pure-bred dogs from 203 dog owning households in Strathclyde Region, Scotland in each British Kennel Club breed group, compared to the proportion of all Kennel Club litter registrations within these breed groups.

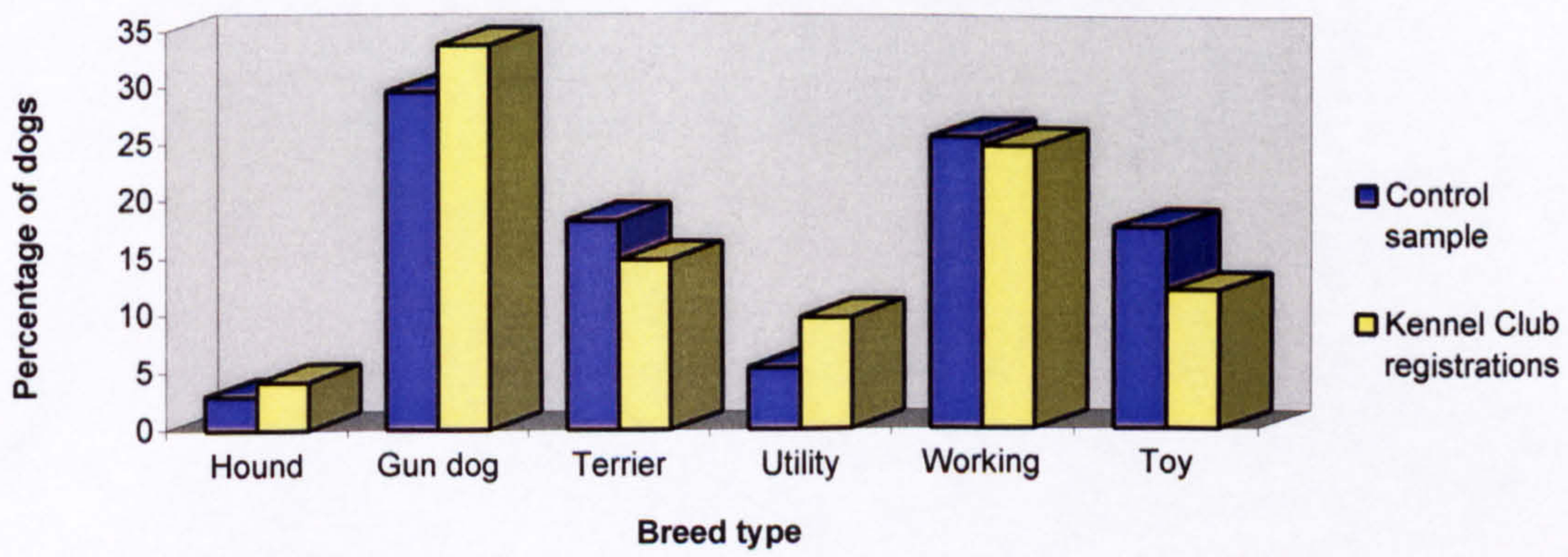


Table 4-9 presents the proportion of dogs from case and control households in each category. Comparisons of these proportions confirmed no significant difference in age at acquisition (Pearson χ^2=4.31, P=0.23).

Table 4-10 presents the source of dogs from case and control households. Analysis of these data revealed a significant difference between case and control households (Pearson χ^2=53.5, P<0.001). When comparing dogs obtained from each source among all sources, the lower proportion of case households obtained from professional show breeders and the higher proportion obtained from an AWC were significant (Table 4-10). With regard to households that obtained their dog from a private owner, when this source was subdivided into 'dogs bought from a private owner' or 'dogs given away free', no significant difference between cases and control households was found (Yates' corrected χ^2=0.02, P=0.88).

Analysis of data pertaining to the original purchase cost of dogs revealed a significant difference between case and control households (t=5.98, P<0.001). Considering the 42 case households and the 257 control households that specified this figure, mean cost (± sd) of dogs was £39.50 (± £48.00) and £100.70 (± £112.88), respectively. Descriptive statistics from analysis of these cost data are listed in Appendix XIII. Figure 4-14 presents the original purchase cost of dogs from case and control households, after cost data were coded into categorical variables. Chi-square analysis of these categories confirmed a significant difference (Pearson χ^2=29.618, P<0.001) between case and control households (Table 4-11). Worthy of mention here, is that although dogs from case households cost significantly less than dogs from control households, comparison of the number of dogs obtained at no cost revealed no significant difference.

The members of case and control household that were responsible for the decision to acquire a dog are presented in Table 4-12. Bivariate comparisons of these data suggested that the increased proportion of case households that selected 'a child member alone' for this parameter, was statistically significant (Fisher's exact test, P<0.01). Considering the 49 case households, the decision to acquire a dog was carefully planned by 36.7% (18) of households, vaguely discussed but not planned for a specific time by 30.6% (15) of households and not planned but a spur of the moment decision by 32.6% (16) of households. With respect to the 318 control households, the above proportions were

TABLE 4-9: Age at acquisition for 47 dogs from case households and 316 dogs from control households in Strathclyde Region, Scotland and chi-square analysis of bivariate associations between each age category.

AGE CATEGORY	CASES (%)	CONTROLS (%)	YATES' CORRECTED χ^2	*P*-VALUE*
< 6 months	34 (72.34)	252 (79.75)	0.94	0.33
6 months - > 1 year	6 (12.77)	21 (6.65)	1.43	0.23
1 year - < 2 years	5 (10.64)	19 (6.01)	0.77	0.38
2 years or >	2 (4.26)	24 (7.59)	0.28	0.60

* level of significance reduced to 0.01 due to multiple comparisons

TABLE 4-10: Source of 49 dogs from case households and 321 dogs from control households in Strathclyde Region, Scotland and chi-square analysis of bivariate associations between each source.

SOURCE	CASES (%)	CONTROLS (%)	YATES' CORRECTED χ^2	*P*-VALUE*
Born at home	1 (2.04)	11 (3.43)	0.01	0.94
Gift (unknown source)	7 (14.29)	21 (6.54)	2.62	0.11
Found as a stray	4 (8.16)	8 (2.49)	2.74	0.10
AWC	23 (46.94)	46 (14.33)	27.68	<0.001
Private owner	10 (20.41)	49 (15.26)	0.50	0.48
Amateur breeder	1 (2.04)	54 (16.82)	6.22	0.01
Commercial breeder/ pet store	0 (0.00)	35 (10.90)	4.70	0.03
Show/hobby breeder	3 (6.12)	97 (30.22)	11.32	<0.001

* level of significance reduced to 0.006 due to multiple comparisons

FIGURE 4-14: Original purchase cost of 42 dogs from case households and 257 dogs from control households in Strathclyde Region, Scotland.

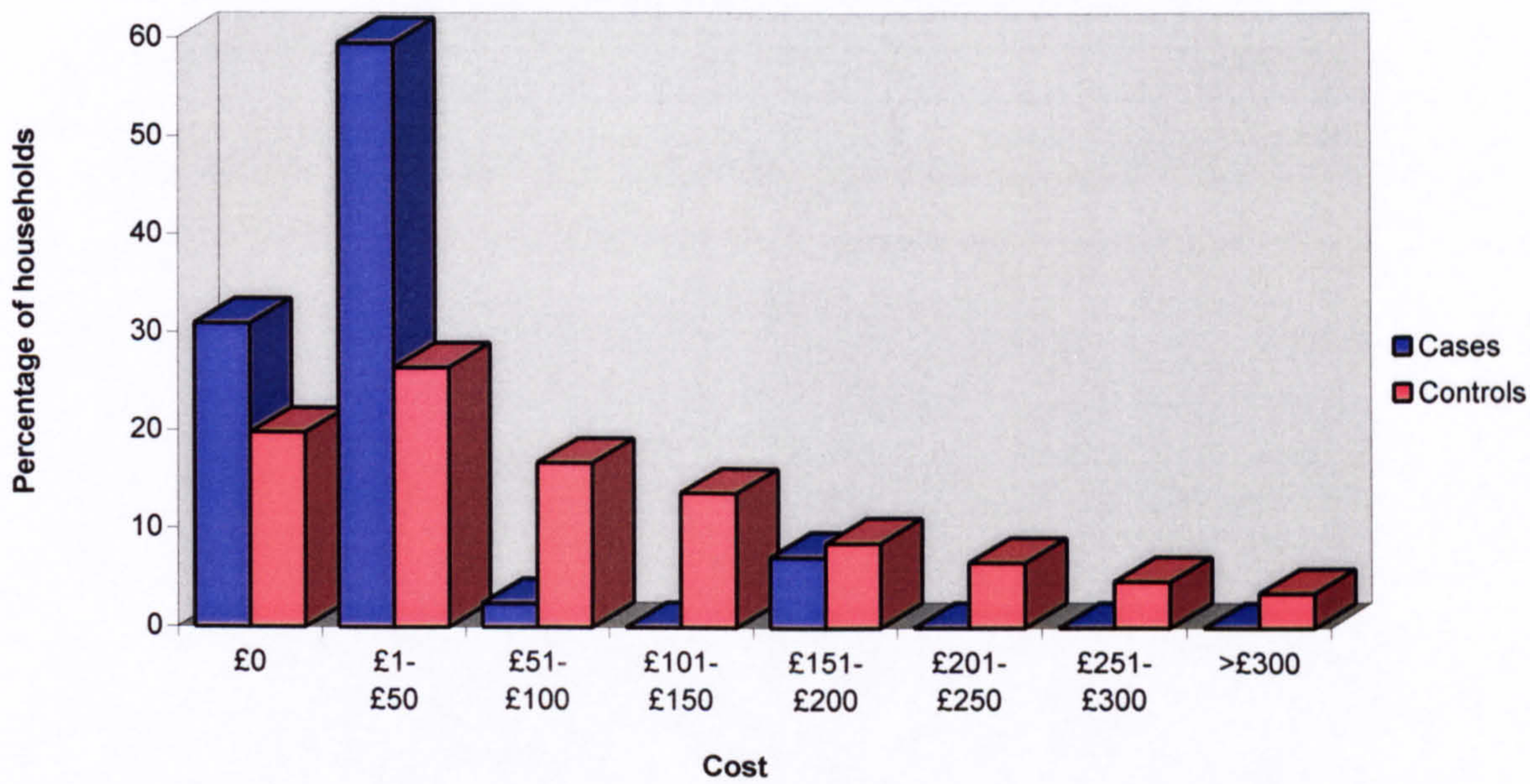


TABLE 4-11: Original purchase cost of 42 dogs from case households and 257 dogs from control households in Strathclyde Region, Scotland and chi-square analysis of bivariate associations between each cost.

PURCHASE COST	CASES (%)	CONTROLS (%)	YATES' CORRECTED χ^2	*P*-VALUE*
£0.00	13 (30.95)	51 (19.84)	2.03	0.15
£1 to £50	25 (59.52)	68 (26.46)	16.91	<0.01
£51 to £100	1 (2.38)	43 (16.73)	4.84	0.03
> £100	3 (7.14)	95 (36.96)	13.25	<0.01

* level of significance reduced to 0.01 due to multiple comparisons

63.8% (203), 23.9% (76) and 12.3% (39), respectively. Significantly more case households acquire their dog after a spur of the moment decision (Yates' corrected χ^2=12.30, P<0.001) whereas significantly more control households carefully planned to acquire their dog (Yates' corrected χ^2=11.91, P<0.001).

Factors that were most influential on the decision by 47 case and 306 control households to obtain their dog are presented in Figures 4-15 and 4-16. For this question, several respondents selected more than one answer. In these instances, an ordering system was used to indicate first choice, second choice, third choice and so on. To allow comparison between case and control households, only the first choice of these respondents was considered. Physical characteristics of the dog was the most important factor for both case and control households, with approximately a third of both groups selecting this category as their first choice. Despite this similarity, a significant difference was found in the factors that influenced the decision by case and control households to obtain their dog (Pearson χ^2=22.59, P<0.001). This was due to the higher proportion of case households that obtain their dog because it was homeless/abandoned and the higher proportion of control households that obtained their dog because of the reputation of a particular breed (Table 4-13).

4.3.2.3 Factors associated with ownership of the dog

Information pertaining to where dogs spent most of their time (excluding when it was out for walks) was available for 48 case and 319 control households. The majority of dogs from both groups spent most of their time unrestrained in some living portion of the home, with 66.7% (32) of case households and 80.6% (257) of control households having selected this option. For the remaining dogs from case households, 20.8% (10), spent most of their time inside the home but confined to a specific area, 2.1% (1) spent most of their time locked in a dog kennel, 6.2% (3) spent most of their time outside in an enclosed garden and 4.2% (2) spent most of their time roaming loose outside. Considering dogs from control households, the above proportions were 14.4% (46), 1.2% (4) and 3.8% (12), respectively, with no dogs spending most of their time roaming loose outside. Bivariate comparisons of these data suggested that the increased proportion of dogs from case households that spent most of their time roaming loose outside showed a trend towards statistical significance (Fisher's exact test, P=0.02).

FIGURE 4-15: Factors that influenced the decision by 47 households that relinquished their dog to an animal welfare centre in Strathclyde Region, Scotland to obtain their dog.

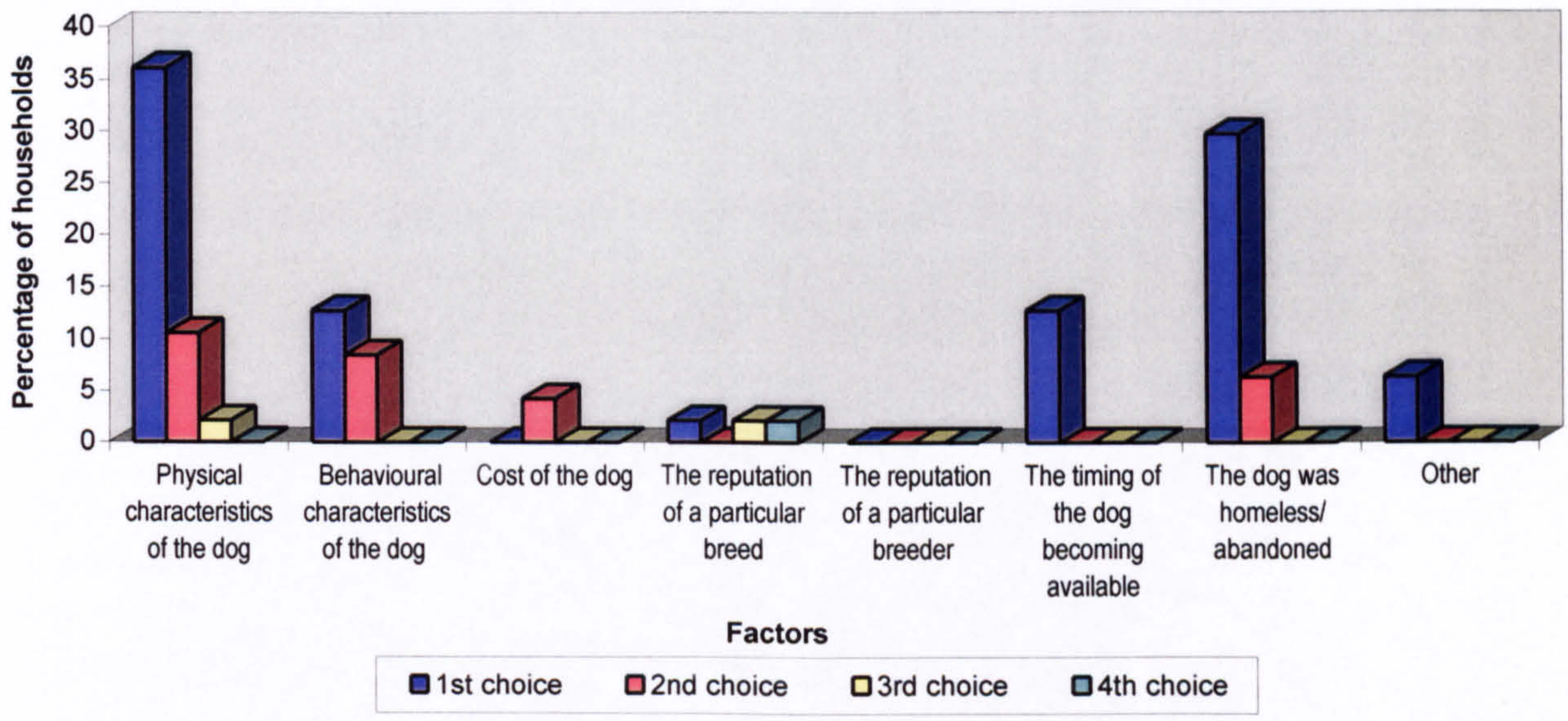


FIGURE 4-16: Factors that influenced the decision by 306 dog owning households in Strathclyde Region, Scotland to obtain their dog.

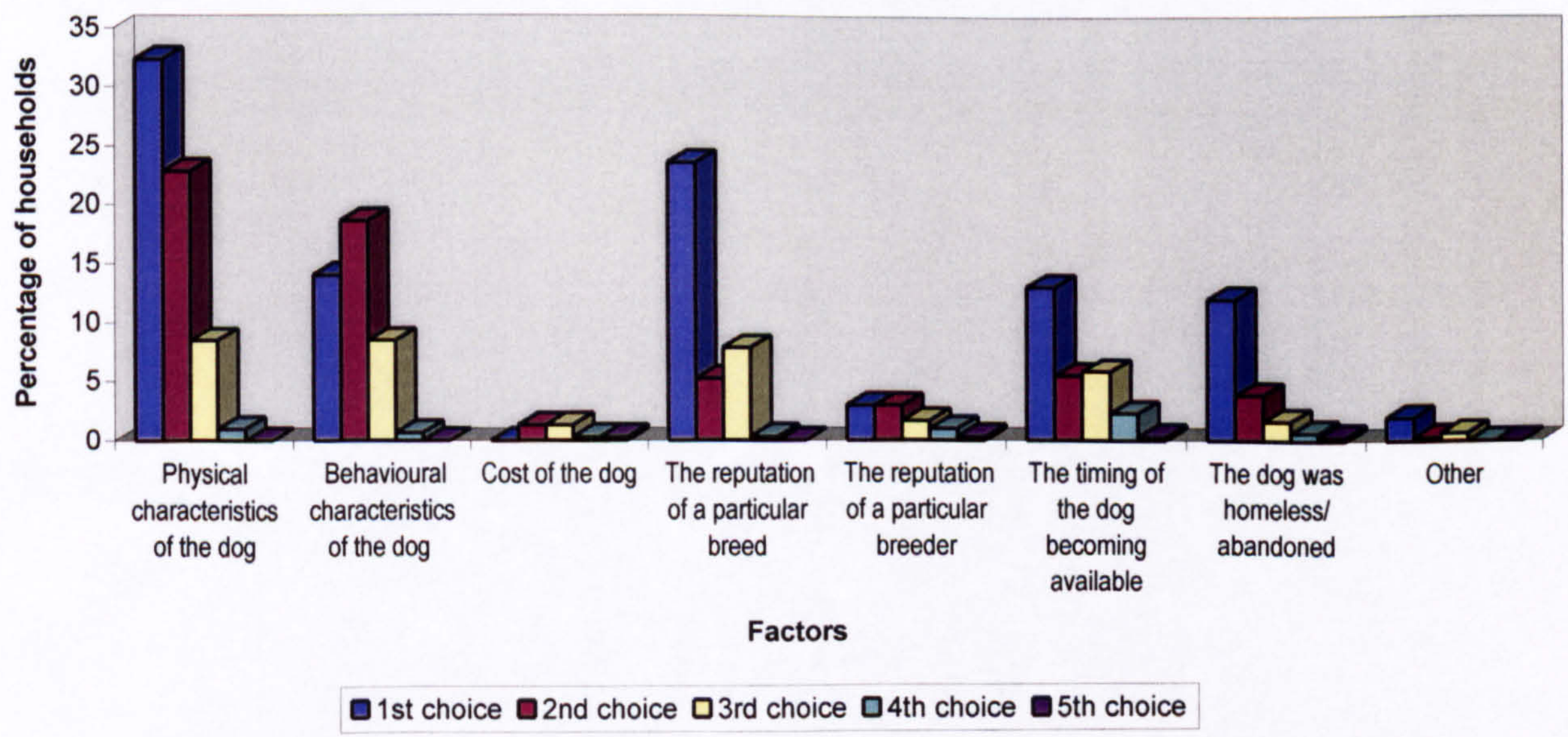


TABLE 4-12: Member(s) of 48 case households and 320 control households in Strathclyde Region, Scotland who were responsible for the decision to acquire a dog and chi-square analysis of bivariate associations between each category.

MEMBER OF HOUSEHOLD	CASES (%)	CONTROLS (%)	YATES' CORRECTED χ^2	*P*-VALUE*
Everyone	29 (60.42)	233 (72.81)	2.55	0.11
Most members	2 (4.17)	26 (8.12)	0.45	0.50
Respondent alone	8 (16.67)	41 (12.81)	0.26	0.61
Another adult alone	6 (12.50)	19 (5.94)	1.90	0.16
A child alone	3 (6.25)	1 (0.31)	**	**

* level of significance reduced to 0.01 due to multiple comparisons

** 25% of cells had expected counts less than 1.0. Fisher exact test, $p<0.01$

TABLE 4-13: Most important factors that influenced the decision by 47 case households and 306 control households in Strathclyde Region, Scotland to obtain their dog (first choices only) and chi-square analysis of bivariate associations between each factor.

FACTOR	CASES (%)	CONTROLS (%)	YATES' CORRECTED χ^2	*P*-VALUE*
Physical characteristics of dog	17 (36.17)	99 (32.35)	0.12	0.72
Behavioural characteristics of dog	6 (12.77)	43 (14.05)	0.00	0.99
Reputation of breed	1 (2.13)	72 (23.53)	10.11	<0.001
Reputation of breeder	0 (0.00)	9 (2.94)	0.48	0.49
Timing of dog becoming available	6 (12.77)	40 (13.07)	0.03	0.86
The dog was homeless/abandoned	14 (29.79)	37 (12.09)	8.94	<0.001
Other[◊]	3 (6.38)	6 (1.96)	1.67	0.20

* level of significance reduced to 0.007 due to multiple comparisons

◊ Cases - given as gift (n=1), own dam/sire of bitch (n=1), reason not specified (n=1)
Controls - owner was giving the dog away (n=2), replacement for lost dog (n=4)

The lower proportion of dogs from case households that spent most of their time unrestrained in some living portion of the home, showed a trend towards statistical significance (Yates' corrected χ^2=4.02, P=0.05, level of significance reduced to 0.01 due to multiple comparisons).

Forty-eight case households and 315 control households provided details of how they knew where their dog was when it was outside. Most respondents supervised their dog at all times, with 75.0% (36) of case and 69.2% (218) of control households having selected this option (Yates' corrected χ^2=0.42, P=0.52). Two (4.2%) case households and seven (2.2%) control households knew where their dog was when it was outside, as it was restrained by a chain (Yates' corrected χ^2=0.10, P=0.76) and eight (16.7%) dogs from case households and 85 (27.0%) dogs from control households were confined in an enclosed garden (Yates' corrected χ^2=1.82 P=0.18). Two (4.2%) case households and five (1.6%) control households commented that they were unaware of where their dog was when it was outside, as the dog was free to roam (Fisher's exact test, P=0.23).

The average amount of time that 48 case and 313 control households spent interacting with their dog, either walking playing or training, on a daily basis is presented in Figure 4-17. Chi-square comparison of these data, revealed that the difference between case and control households showed a trend towards statistical significance (Pearson χ^2=7.37, P=0.06). This was due to the finding that 16.7% (8) of case households reported that they spent less than one hour a day interacting with their dog compared to only 7.4% (23) of control households (Yates' corrected χ^2=3.49, P=0.06). Forty-nine case households and 317 control households also specified whether they had attended obedience training classes with their dog after acquiring it. Those households that had not attended obedience training represented 91.8% (45) of case households compared to only 78.9% (250) of control households. This difference was of borderline significance (Yates' corrected χ^2=3.78, P=0.05). With respect to case households that had attended obedience training classes with their dog, 25.0% (1) had attended classes regularly until the dog was fully trained and 75.0% (3) had attended classes on a few occasions only. While a higher proportion of control households that had attended obedience training with their dog, had done so regularly (52.2%) until the dog was fully trained, as opposed to on a few occasions only (47.8%), this was not statistically significant (Yates' corrected χ^2=0.30, P=0.59).

Forty-nine case households and 317 control households reported on the behaviour of their dog. Approximately a third of both case (34.7%) and control (34.7%) households thought that their dog behaved or had previously behaved in an undesirable or problematic way. With respect to the 110 control households, 6.4% (7) used the pluperfect tense as the undesirable behaviour that had been displayed was no longer a problem. This effectively lowered the proportion of dogs that currently behaved undesirably to 32.5%. None of the 17 case households had used the pluperfect tense. Chi-square comparison of these amended data showed no significant difference between case and control households (Yates' corrected χ^2=0.02, P=0.89).

Figure 4-18 presents the behavioural problem(s) displayed by dogs from 15 case and 110 control households. Five (33.3%) of the dogs from case households displayed more than one type of behavioural problem compared to only 28 (25.4%) of the dogs from control households, however this was not statistically significant (Yates' corrected χ^2=0.11, P=0.74). Chi-square comparisons between case and control households of the number of dogs with or without each behavioural problem, showed no significant difference for any of the undesirable behaviours (Table 4-14). All 15 of the above case households and 105 of the control households specified the frequency with which their dog displayed behavioural problems. Of these, 86.7% (13) and 76.2% (80) of dogs from case and control households, respectively, displayed the undesirable behaviour daily or weekly. For the remaining households, this behaviour was displayed either two to three times a month, occasionally or only once. Chi-square comparison showed no significant difference between case and control households with regard to the frequency with which their dog displayed behavioural problems (Pearson χ^2=3.34, P=0.34).

Of the 49 case households, only 28.8% (14) had gained information or sought advice on dog behaviour and training compared to 49.2% (157) of the 319 control households that provided this information (Yates' corrected χ^2=6.47, P=0.01). Information or advice on canine behaviour was obtained from a variety of sources, including a book or video, a special class, a veterinary surgeon or veterinary nurse, a breeder or trainer, a friend or neighbour and an animal welfare centre. Chi-square comparison of the number of households that gained information or sought advice on dog behaviour and training from each of these sources, showed no significant differences between case and control households.

FIGURE 4-17: Average amount of time that 48 case households and 313 control households in Strathclyde Region, Scotland spent interacting with their dog on a daily basis.

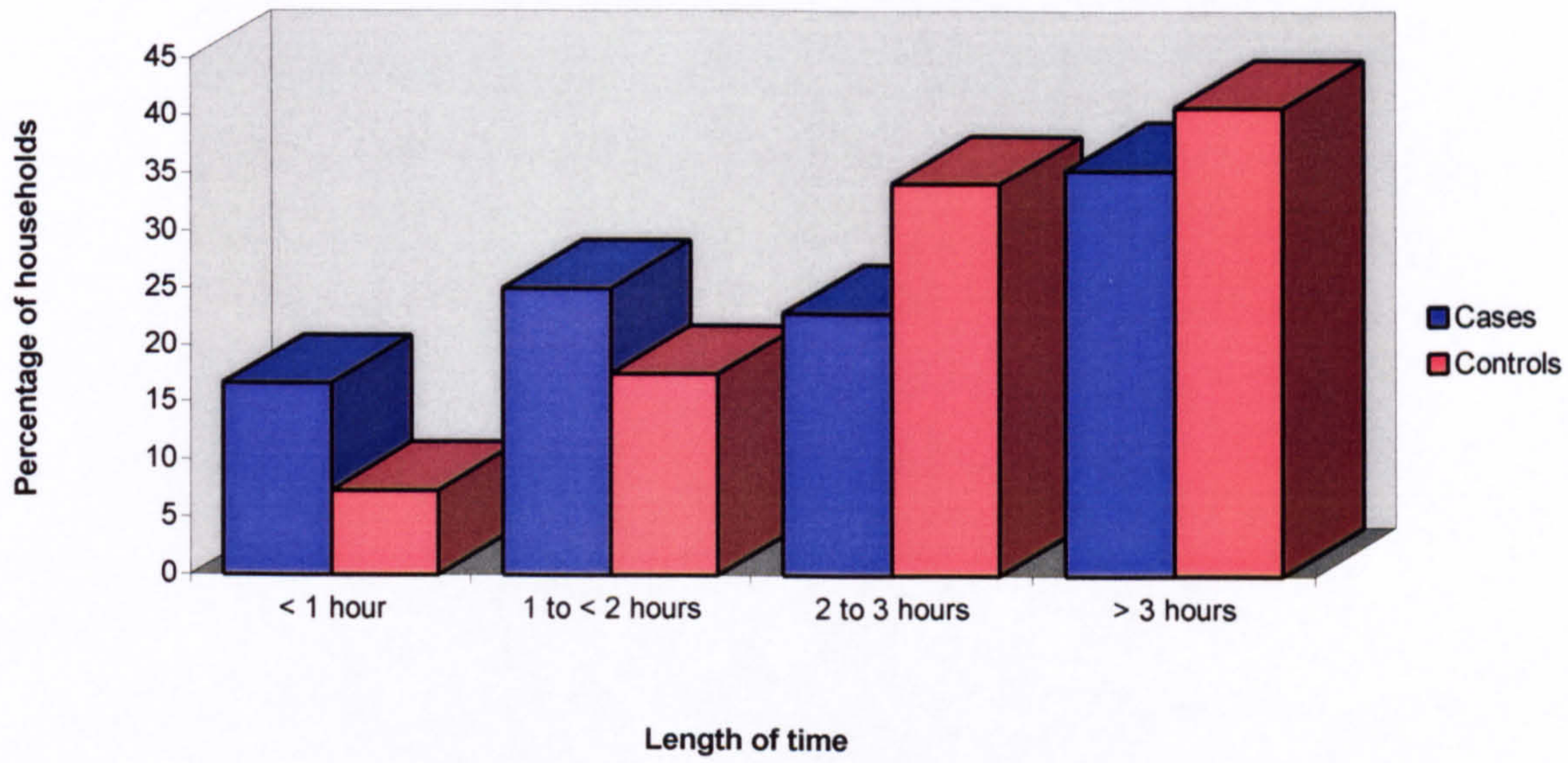


FIGURE 4-18: Undesirable behaviour displayed by dogs from 15 case households and 110 control households in Strathclyde Region, Scotland.

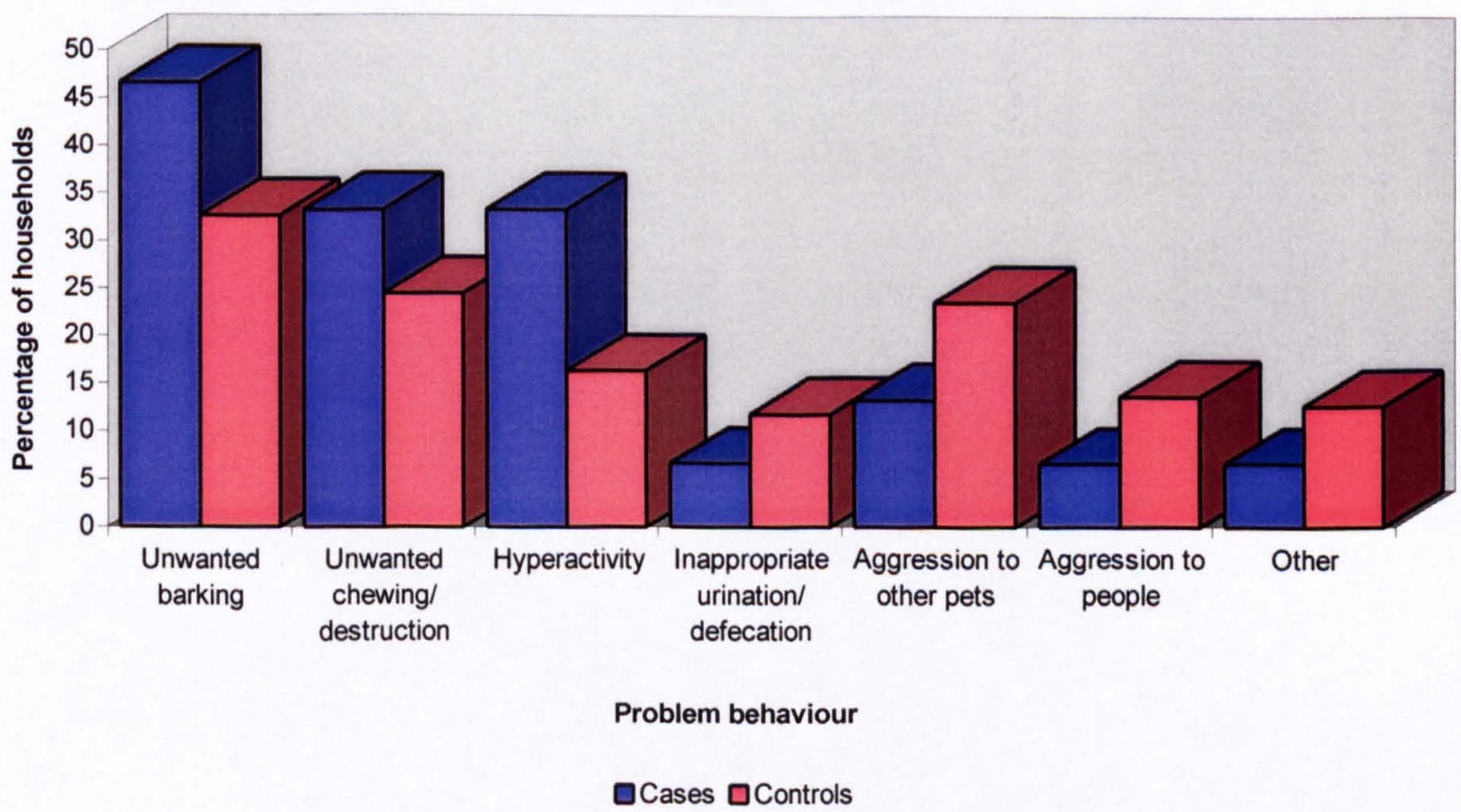


TABLE 4-14: Behavioural problems in 15 dogs from case households and 110 dogs from control households in Strathclyde Region, Scotland and chi-square comparison between these two groups.

BEHAVIOURAL PROBLEM	CASES (%)	CONTROLS (%)	YATES' CORRECTED χ^2	*P*-VALUE
Unwanted barking	7 (46.67)	36 (32.73)	0.60	0.44
Unwanted chewing	5 (33.33)	27 (24.55)	0.17	0.68
Hyperactivity	5 (33.33)	18 (16.36)	1.53	0.22
Urination/defecation in the house	1 (6.67)	13 (11.82)	0.02	0.88
Aggression to other pets	2 (13.33)	26 (23.64)	0.32	0.57
Aggression to people	1 (6.67)	15 (13.64)	0.12	0.73
Other[◊]	1 (6.67)	14 (12.73)	0.06	0.80

[◊] Aggressiveness only when on lead, aggressiveness towards the respondent only, attempts to mate male dogs, climbs on chairs/beds and under duvet, inclined to chase sheep, jumps on visitors, over excited in car, over excited when family returns home, over friendly, pulls on lead, rakes in bins, roaming/running off, tunnels in flower beds.

The above case and control households were also asked to provide details regarding when this information or advice was gained. Of the 14 case households that provided these details, 28.6% (4) obtained this information before acquiring their dog, 50.0% (7) waited until after acquiring their dog to obtain this information and 21.4% (3) obtained this information before and after acquiring their dog. Of the 153 control households that provided these details, the above proportions were 9.8% (15), 35.3% (54) and 54.9% (84), respectively. For comparison between case and control households, the above three categories were transformed into two dichotomous variables. These were 'obtained information before acquiring the dog' or 'obtained information after acquiring the dog' as this was the prime interest of the author. A total of seven (50.0%) case households and 99 (64.7%) control households obtained information before acquiring their dog (Yates' corrected χ^2=0.65, P=0.42), whereas ten (71.4%) case households and 138 (90.2%) control households obtained this information after acquiring their dog (Yates' corrected χ^2=2.81, P=0.09).

Information pertaining to the average frequency of veterinary care was available for 49 dogs from case households and 320 dogs from control households (Figure 4-19). Chi-square comparison of this parameter revealed a significant difference between these two groups (Pearson χ^2=110.34, P<0.001). Bivariate comparison of each frequency of veterinary care, among all frequencies, is presented in Table 4-15. These comparisons revealed that significantly more dogs from case households had either never attended a veterinary surgery (Yates' corrected χ^2=84.03, P<0.001), or had attended a veterinary surgery when first acquired only (Yates' corrected χ^2=11.32, P<0.001).

A further comparison was made after the six categories for frequency of veterinary care were combined to form a dichotomous variable. The new options for frequency of veterinary care were 'less than once a year' or 'once a year and greater'. A total of 33 (67.4%) dogs from case households attended a veterinary surgery less than once a year, compared to only 92 (28.8%) dogs from control households. This difference was significant (Yates' corrected χ^2=26.56, P<0.001).

Figures 4-20 and 4-21 presents the length of time dogs from case households were owned before being relinquished. The mean ± sd (median) duration of ownership was 15.4 ± 18.1 (8.0) months. Over half (26, 55.3%) dogs from case households were

FIGURE 4-19: Average frequency of veterinary care for 49 dogs from case households and 320 dogs from control households in Strathclyde Region, Scotland.

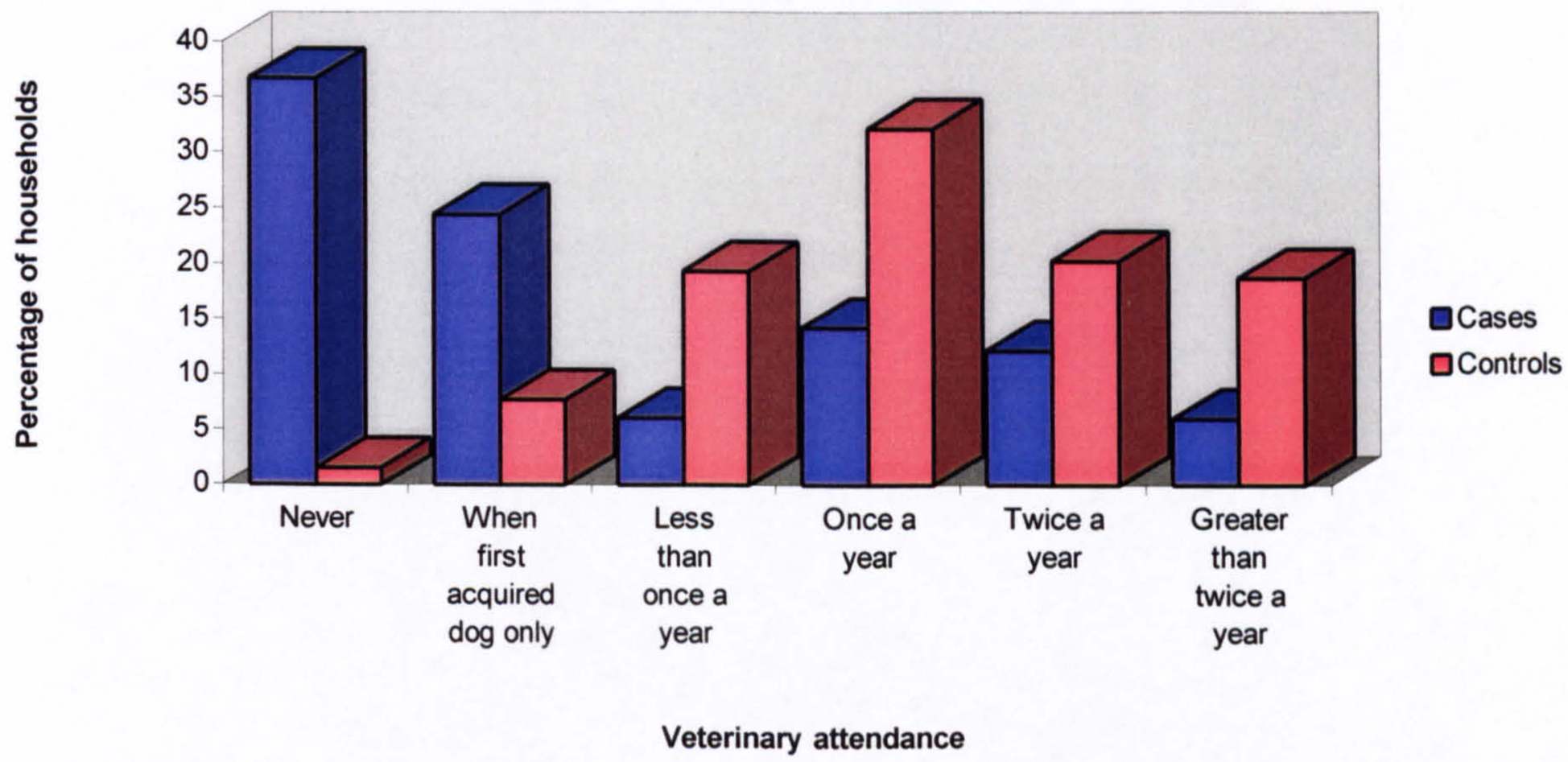


TABLE 4-15: Average frequency of veterinary care for 49 dogs from case households and 320 dogs from control households in Strathclyde Region, Scotland and chi-square analysis of bivariate associations between each frequency.

VETERINARY ATTENDANCE	CASES (%)	CONTROLS (%)	YATES' CORRECTED χ^2	*P*-VALUE*
Never	18 (36.73)	5 (1.56)	84.03	<0.001
When first acquired dog	12 (24.49)	25 (7.81)	11.32	<0.001
Less than once a year	3 (6.12)	62 (19.38)	4.27	0.04
Once a year	7 (14.29)	103 (32.19)	5.68	0.02
Twice a year	6 (12.24)	65 (20.31)	1.30	0.25
Greater than twice a year	3 (6.12)	60 (18.75)	3.94	0.05

* level of significance reduced to 0.008 due to multiple comparisons

FIGURE 4-20: Duration of ownership for 47 dogs that were relinquished to an animal welfare centre in Strathclyde Region, Scotland.

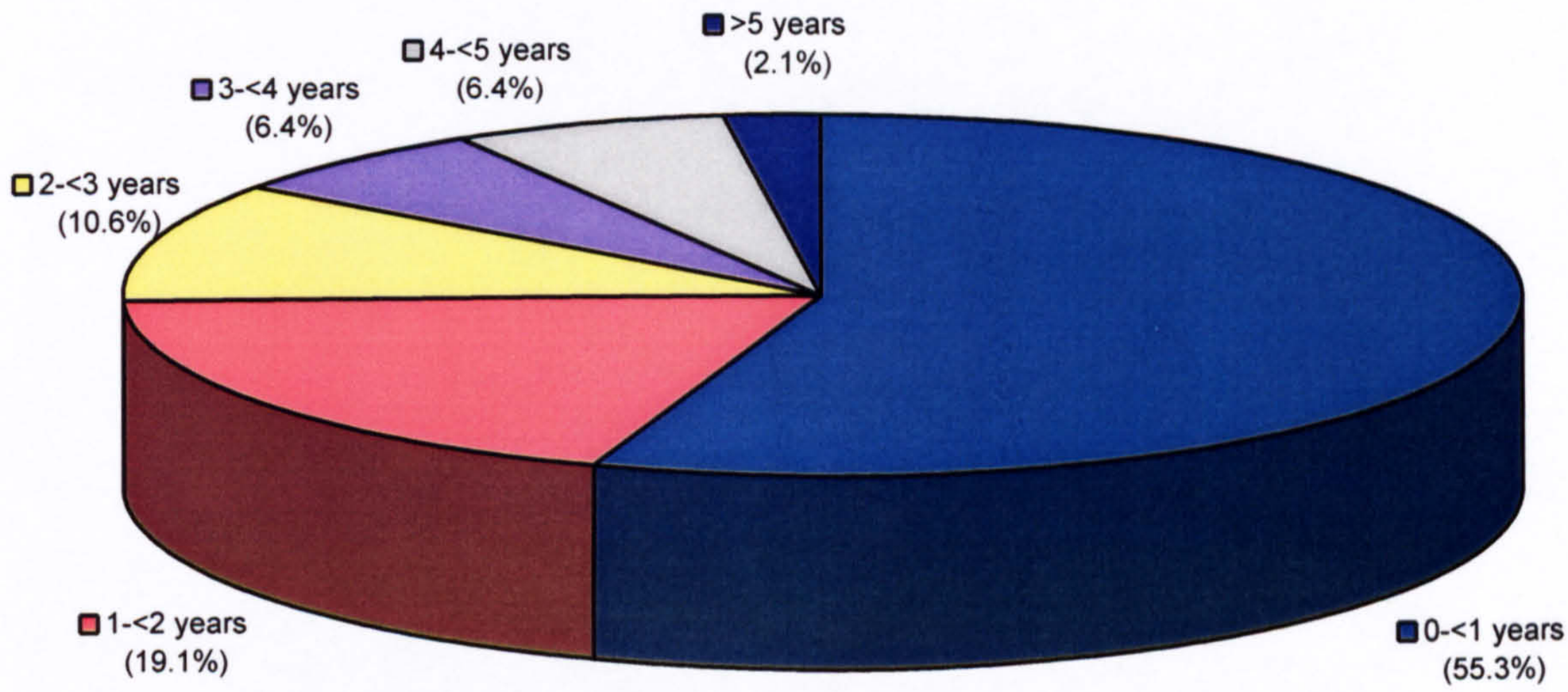
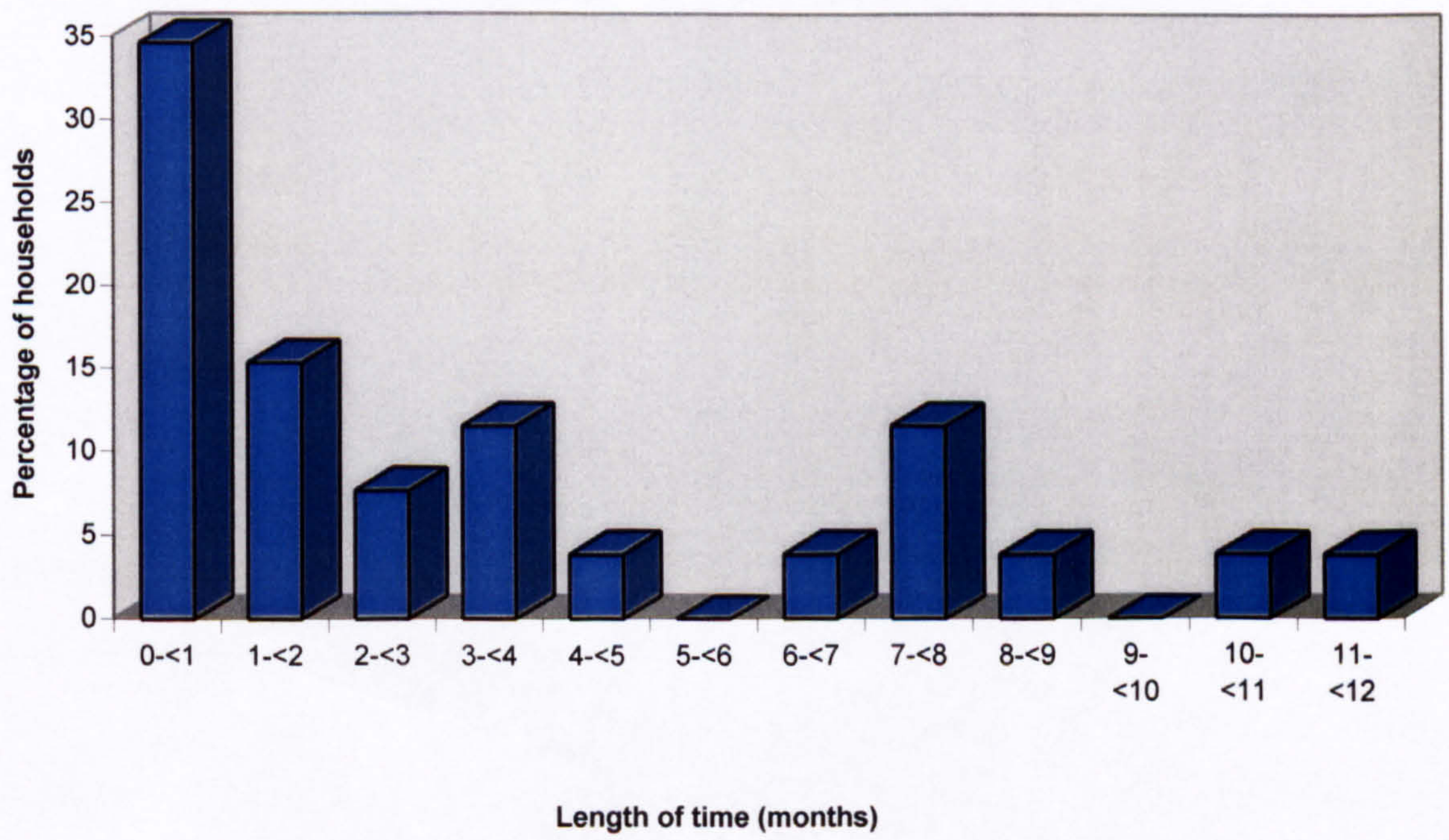


FIGURE 4-21: Duration of ownership for 24 dogs that were owned for less than one year, before relinquishment to an animal welfare centre in Strathclyde Region, Scotland.



relinquished to an animal welfare centre after less than one year of ownership and just under half (19, 40.4%), were owned for less than six months.

4.3.2.4 Human expectations, attitudes and beliefs

Forty-eight case households and 314 control households provided details of their expectations from owning a dog (Figure 4-22 and 4-23). For this question, several respondents selected more than one category. In these instances, an ordering system was used to indicate first choice, second choice and so on. To allow comparison between case and control households, only the first choice of these respondents was considered (Table 4-16). The commonest role a dog was expected to play was as a companion to household members for both case (87.5%) and control (90.5%) households. With the knowledge that the majority of respondents expected their dog to be a companion to household members, the remaining categories were collapsed into one category. Comparison of this amended variable showed no significant difference in the role a dog was expected to play in case or control households (Yates' corrected χ^2=0.28, P=0.60).

When respondents were asked how often their dog met these expectations and fulfilled the desired role, a significant difference was found between the 48 case and 320 control households that answered this question (Pearson χ^2=66.94, P<0.001). Considering case households, 41.7% (20) selected always, 41.7% (20) selected most of the time, 14.6% (7) selected occasionally and 2.1% (1) selected rarely. In comparison, the above proportions for control households were 82.5% (264), 17.2% (55) and 0.3% (1), respectively, with none of the control households selecting rarely.

Figure 4-24 presents how 49 case households and 320 control households described the time and work involved in keeping their dog. Chi-square comparison of this parameter revealed a significant difference between these two groups (Pearson χ^2=69.16, P<0.001). A significantly higher number of case households thought that their dog required much more time and work than expected (Yates' corrected χ^2=15.42, P<0.001) or more time and work than expected (Yates' corrected χ^2=41.79, P<0.001). In contrast, a significantly higher number of control households (Yates' corrected χ^2=41.13, P<0.001) thought that their dog required the same time and work as expected (Table 4-17).

FIGURE 4-22: The expected role of dogs in 48 households that relinquished their dog to an animal welfare centre in Strathclyde Region, Scotland.

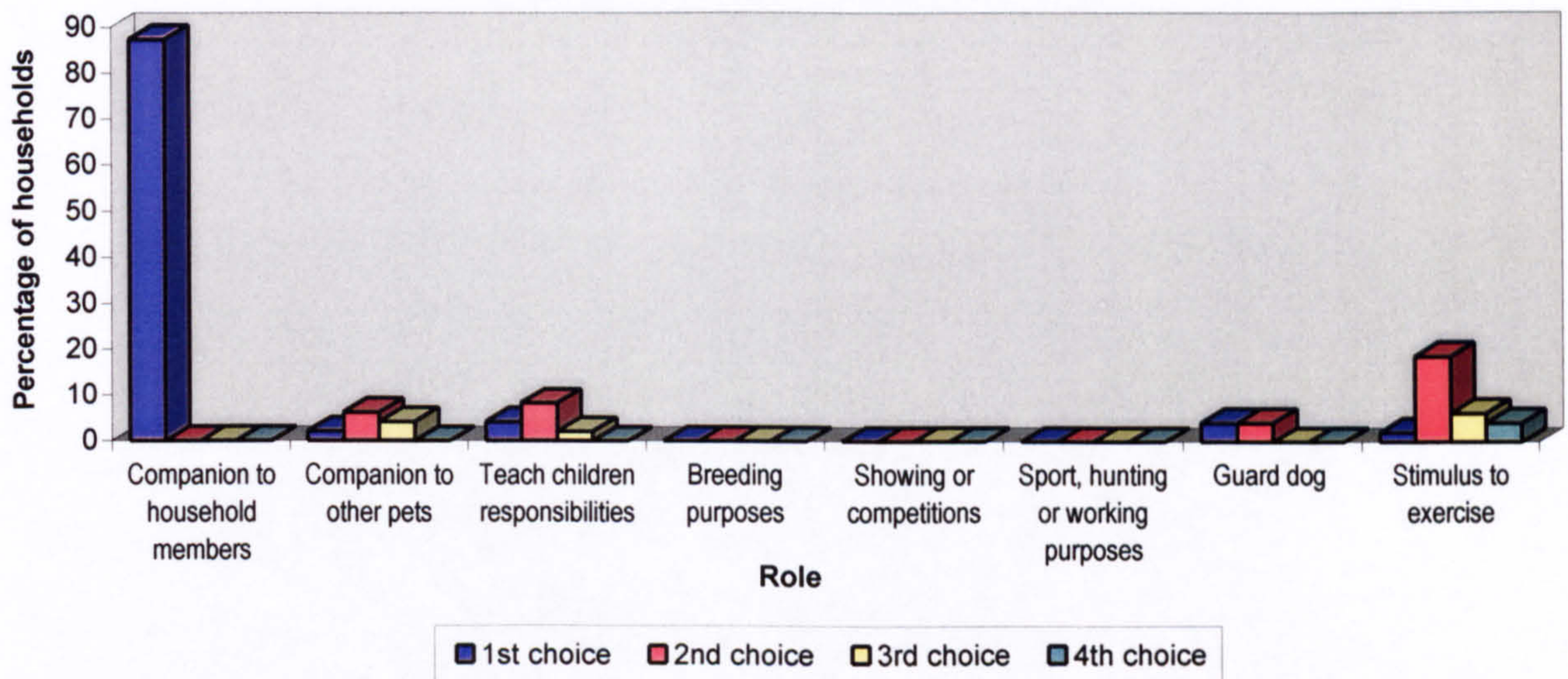


FIGURE 4-23: The expected role of dogs in 314 dog owning households in Strathclyde Region, Scotland.

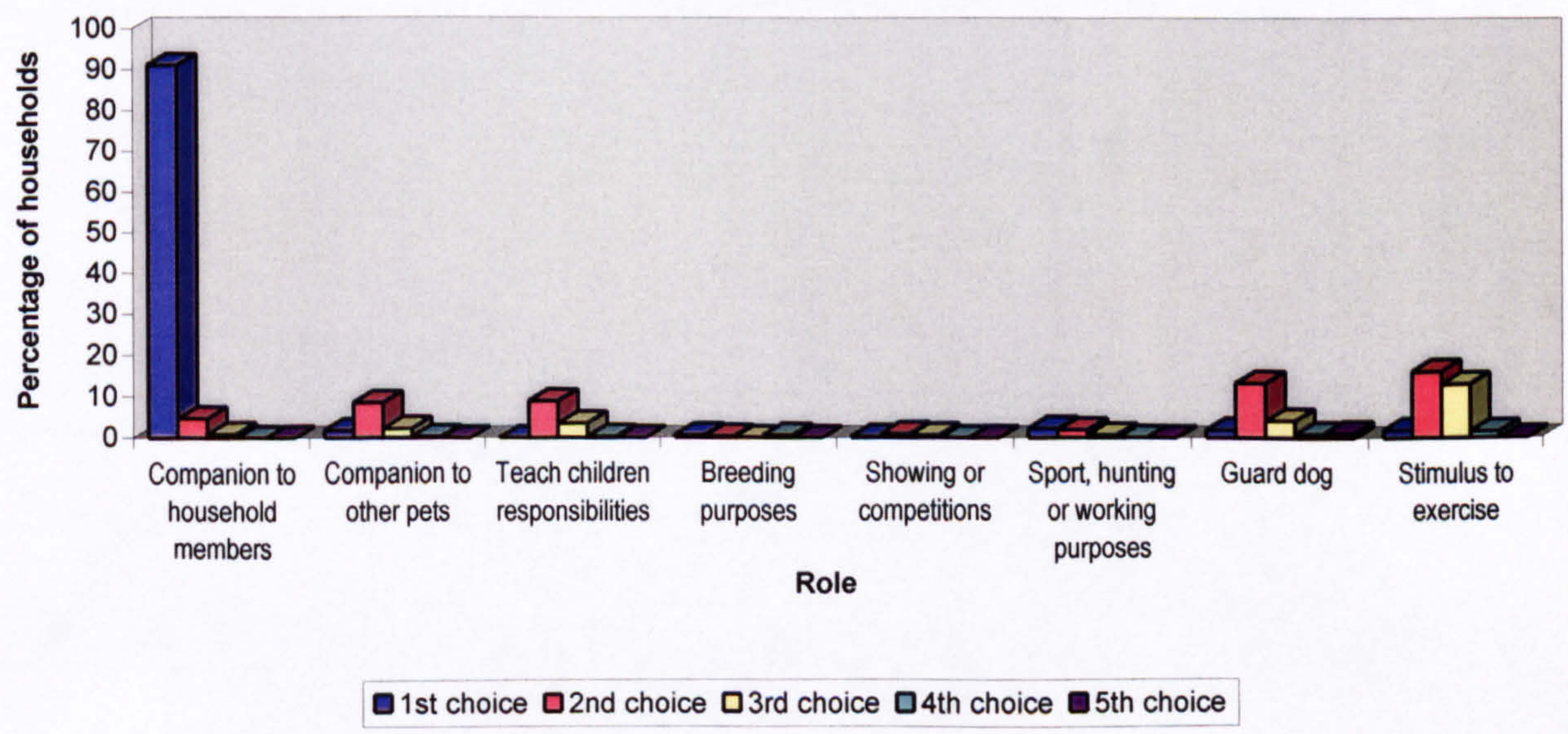


TABLE 4-16: The expected role of dogs in 48 case households and 316 control households in Strathclyde Region, Scotland (first choices only).

ROLE	CASES (%)	CONTROLS (%)
Companion to household members	42 (87.50)	286 (90.51)
Companion to other pets	1 (2.08)	6 (1.90)
Teach children responsibilities	2 (4.17)	0 (0.00)
Breeding purposes	0 (0.00)	2 (0.63)
Showing or competitions	0 (0.00)	1 (0.32)
Sport, hunting or work purposes	0 (0.00)	7 (2.22)
Guard dog	2 (4.17)	6 (1.90)
Stimulus to exercise	1 (2.08)	6 (1.90)

TABLE 4-17: How 49 case households and 320 control households in Strathclyde Region, Scotland, described the time and work involved in keeping their dog and chi-square analysis of bivariate associations between each category.

CATEGORY	CASES (%)	CONTROLS (%)	YATES' CORRECTED χ^2	*P*-VALUE*
Much more than expected	10 (20.41)	14 (4.38)	15.42	<0.001
More than expected	20 (40.82)	24 (7.50)	41.79	<0.001
Same as expected	18 (36.73)	258 (80.63)	41.13	<0.001
Less than expected	1 (2.04)	24 (7.50)	1.23	0.27

* level of significance reduced to 0.01 due to multiple comparisons

Figure 4-25 presents whether members of 49 case households and 320 control households believed that dogs were family members. Of all households, 95.9% (354) believed that dogs were family members which represented 83.7% (41) of case households, compared to 97.8% (313) of control households (Yates' corrected χ^2=18.31, P<0.001). Considering these respondents, only 56.1% of case households strongly believed, whereas 75.7% of control households strongly believed. This difference was of borderline significance (Yates' corrected χ^2=6.19, P=0.01, level of significance reduced to 0.01 due to multiple comparisons). For the remaining respondents, 16.3% (8) of case households were not sure whether they believed dogs were family members, whereas only 0.9% (3) of control households selected this option (Yates' corrected χ^2=29.68, P<0.001). While no case households reported that they did not believe dogs were family members, 1.2% (4) of control households reported non-belief, however, this difference was not significant (Fisher's exact test, P=1.00).

4.3.2.5 Household demographic characteristics

Figures 4-26 and 4-27 presents the profile of 49 case and 320 control households on the basis of family composition. The most common family structure among both types of household was 'family with children', with 46.9% (23) of case households and 51.6% (165) of control households selecting this category (Yates' corrected χ^2=0.20, P=0.65). With regard to this family structure, an average of two children were found in both case and control households. The second most common type of family composition were the 'adult couple only' households which represented 32.6% (16) and 25.3% (81) of case and control households, respectively (Yates' corrected χ^2=0.83, P=0.36). Next were the 'single adult only' households which represented 16.3% (8) and 13.1% (42) of case and control households, respectively (Yates' corrected χ^2=0.15, P=0.70). The remaining 4.1% (2) of case households and 10.0% (32) of control households selected the 'multiple adults but not couple' category to classify themselves (Yates' corrected χ^2=1.14, P=0.28). The profile of case and control households on the basis of family composition was not significantly different.

Figure 4-28 presents the living accommodation for 49 case households and 315 control households. Chi-square analysis of this parameter revealed a significant difference between these two groups (Pearson χ^2=48.05, P<0.001). The highest proportion of case

FIGURE 4-24: How 49 case households and 320 control households in Strathclyde Region, Scotland described the time and work involved in keeping their dog.

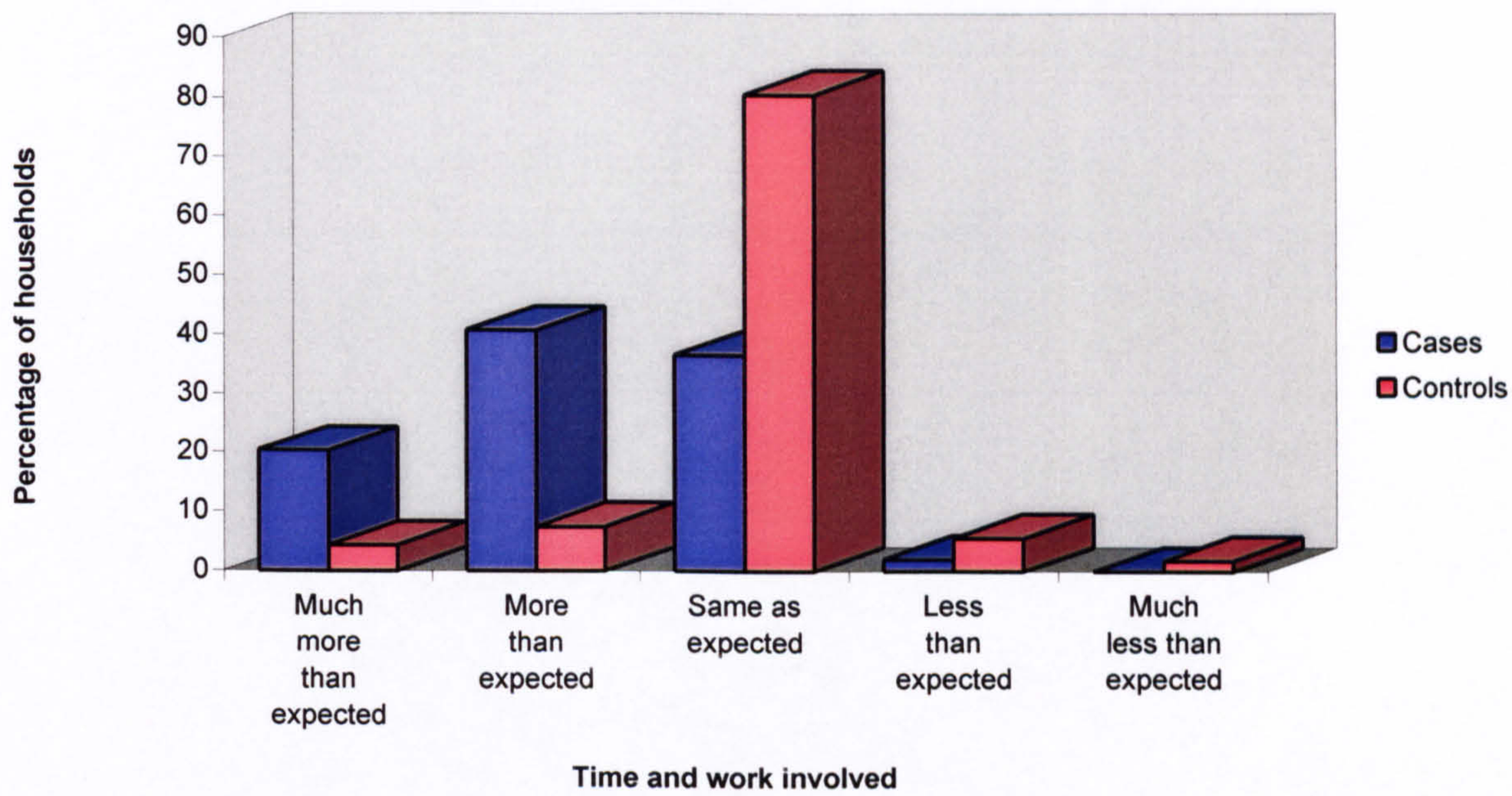


FIGURE 4-25: Whether respondents from 49 case households and 320 control households in Strathclyde Region, Scotland regarded dogs as members of the family.

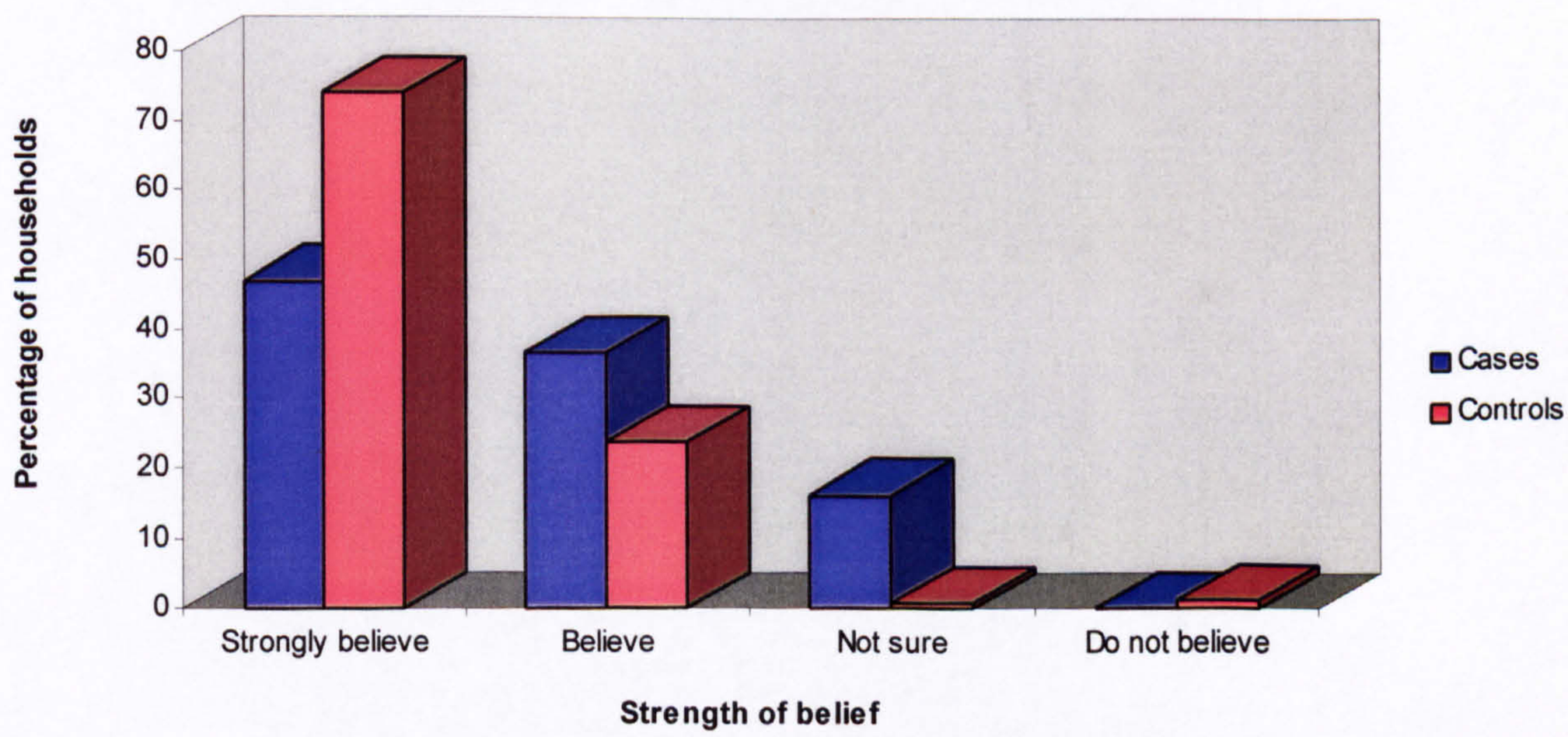


FIGURE 4-26: The household members of 49 households that relinquished their dog to an animal welfare centre in Strathclyde Region, Scotland.

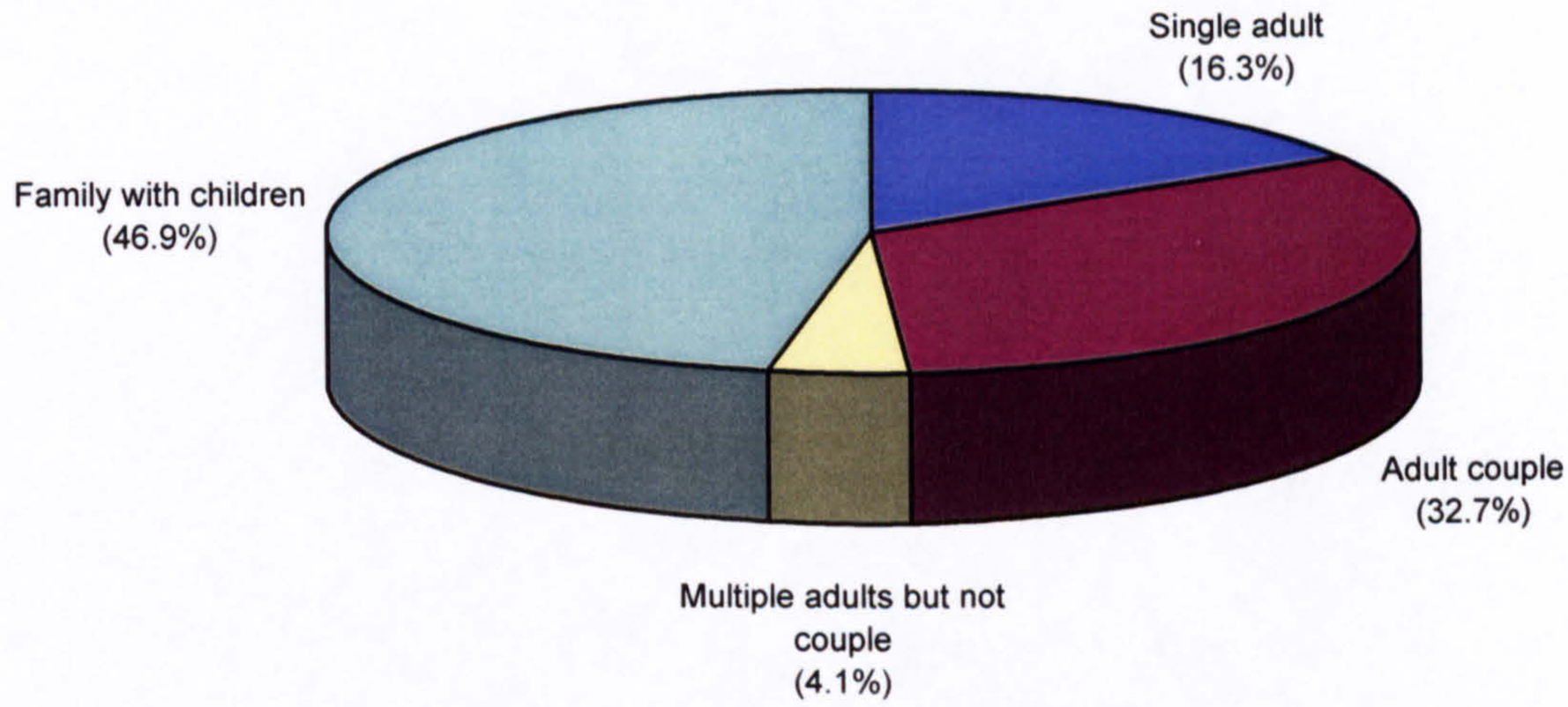
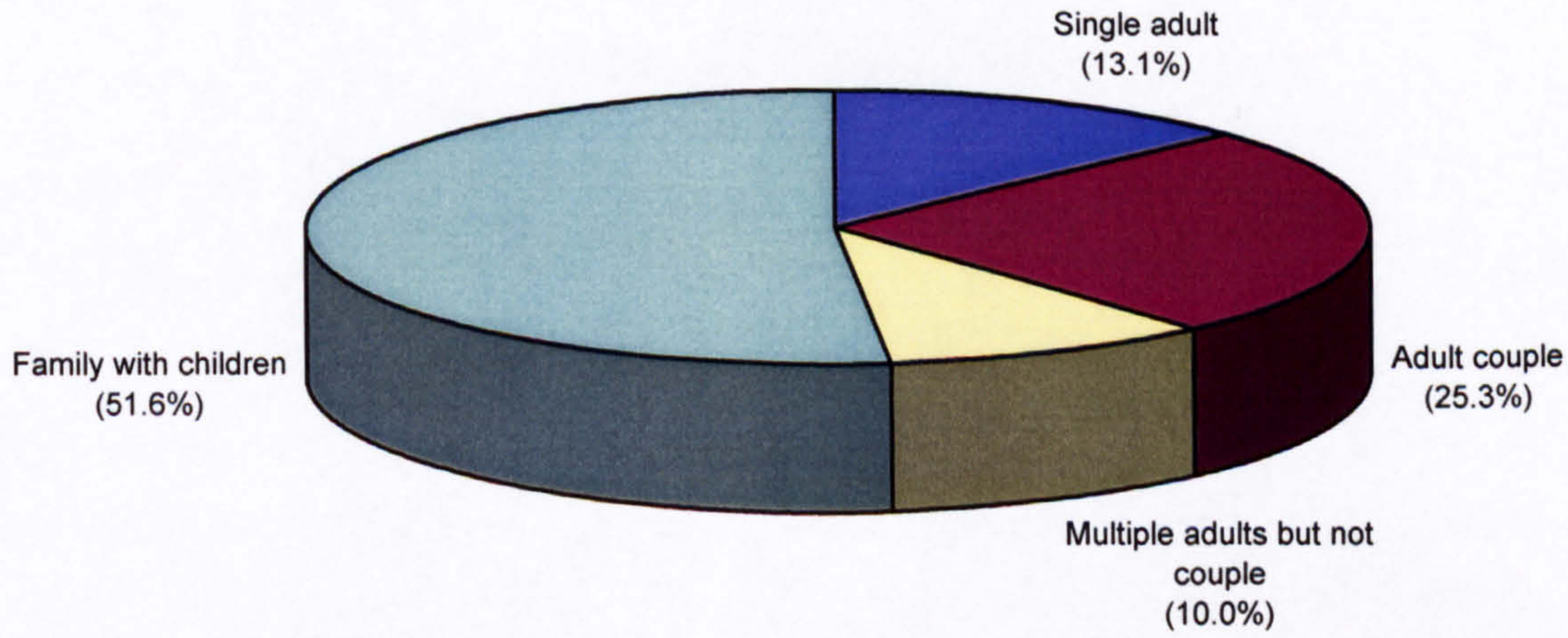


FIGURE 4-27: The household members of 320 dog owning households in Strathclyde Region, Scotland.



households lived in a rented house, whereas only 16.2% of control households resided in this type of accommodation. In comparison, the majority of control households lived in their own, bought house whereas less than one fifth of case households had purchased their home. With regard to households that lived in a flat, although a similar proportion of case and control households lived in a flat that they had purchased, significantly more case households lived in a rented flat compared to control households. Similar proportions of case and control households lived on a farm. Chi-square analysis of bivariate associations between each type of living accommodation, among all types, is presented in Table 4-18.

Further analysis of the above data pertaining to the living accommodation for case and control households, revealed that the total proportion of case households that lived in a house (53.1%) was significantly lower than the proportion (82.2%) of control households living in a house (Yates' corrected χ^2=19.54, P<0.001). In comparison, the total proportion of case households that lived in a flat (40.8%) was significantly greater than the proportion of control households (15.9%) that lived in a flat (Yates' corrected χ^2=15.42, P<0.001). Living accommodation data were also analysed with regard to home ownership status. As respondents that selected 'farm' as their living accommodation did not indicate whether the farm was owned or rented, these respondents were eliminated from this analysis. The proportion of case households that rented or owned their home was 65.2% (30) and 34.8% (16), respectively. In comparison, the proportion of control households that rented or owned their home was 22.6% (70) and 77.4% (239), respectively (Figure 4-29). This difference in home ownership status was significant (Yates' corrected χ^2=33.78, P<0.001).

Respondents were also asked to specify whether their living accommodation included access to a garden. Twelve (24.5%) case households did not have access to any garden compared to only sixteen (5.0%) control households without a garden (Yates' corrected χ^2=20.32, P<0.001). For the remaining 37 case households and 304 control households with access to a garden, respondents were asked to specify whether the garden was enclosed or not. While a lower proportion of case households (70.3%) reported that the garden was enclosed compared to control households (85.9%), this information was considered to be unreliable.

FIGURE 4-28: Living accommodation for 49 case households and 315 control households in Strathclyde Region, Scotland.

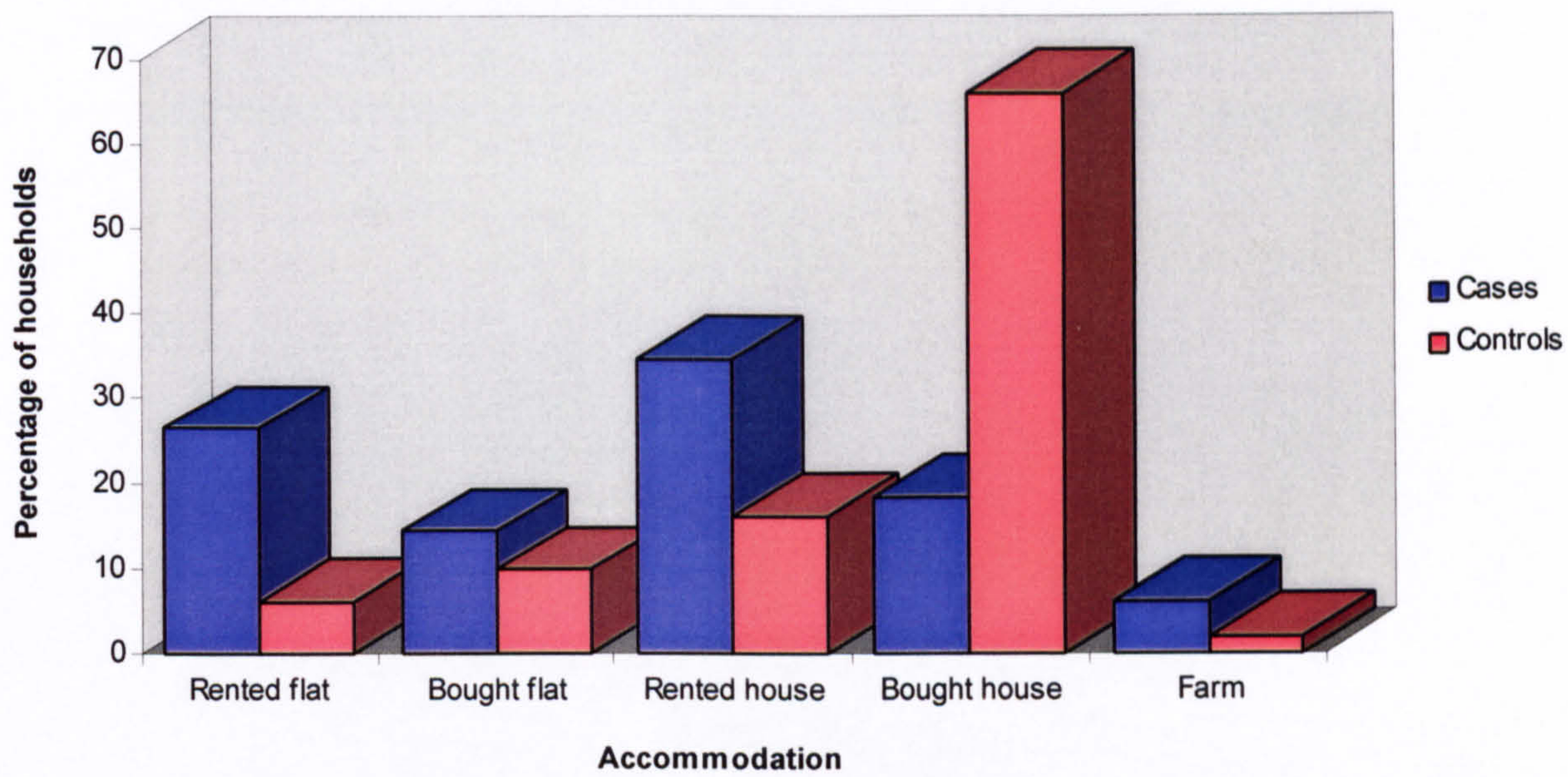
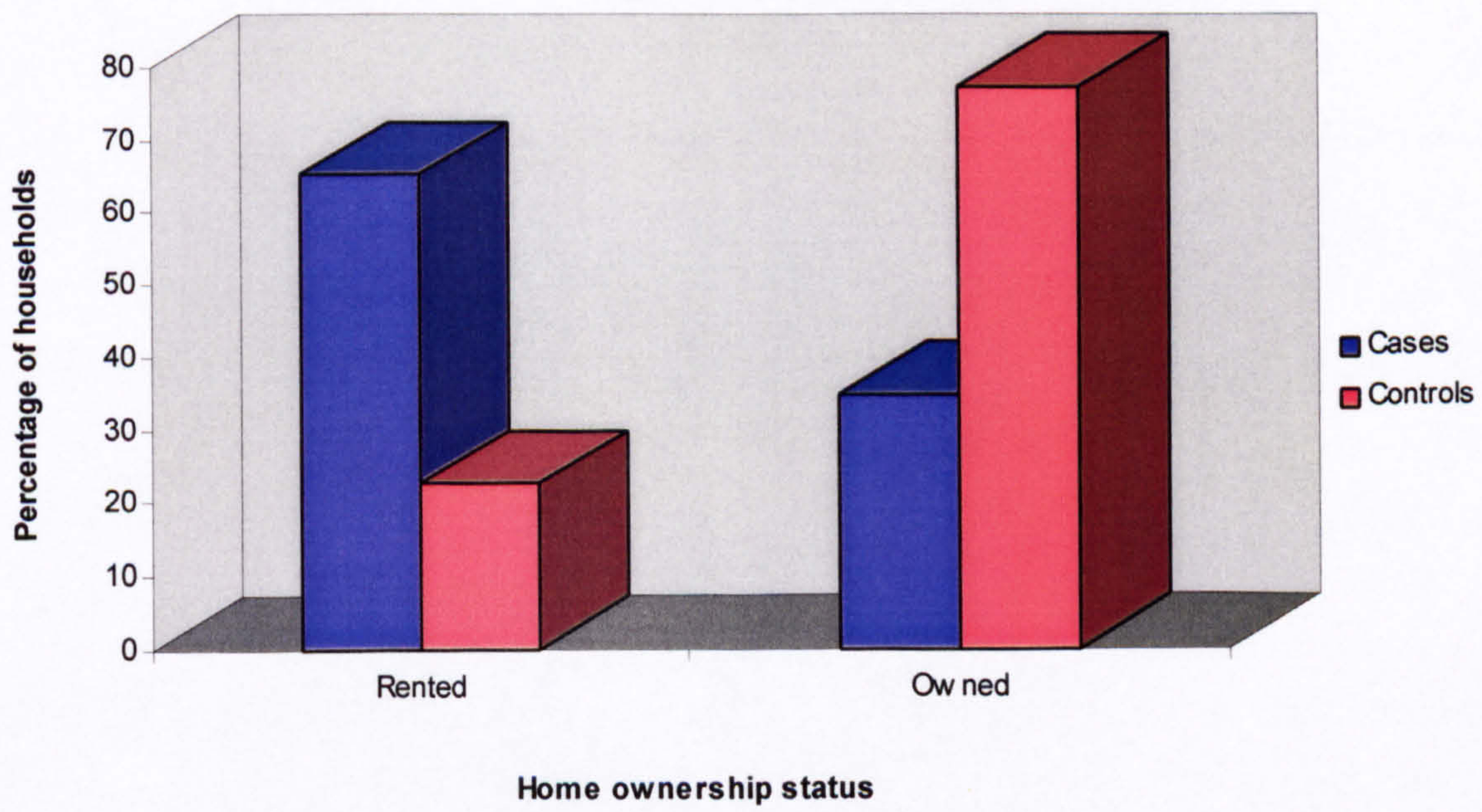


FIGURE 4-29: Home ownership status for 46 case households and 309 control households in Strathclyde Region, Scotland.



Forty-nine case households and 319 control households provided details regarding the length of time they had lived in their present accommodation (Table 4-19). Chi-square comparison of these data revealed a significant difference between these two groups (Pearson χ^2=51.82, P<0.001). Analysis of Table 4-19 reveals that more than one third of case households had lived in their present accommodation for less than two years compared to 6.6% of control households. In comparison, over three quarters of control households had resided in their present accommodation for five years or more, whereas less than half of case households had spent five years or more in their present home. The higher proportion of case households that had lived in their present accommodation for shorter periods (less than one year, one year to less than two years) and the lower proportion that had lived in their present accommodation for longer periods (greater than ten years), compared to control households, was significant.

Table 4-20 presents details of the highest level of education achieved by members of 47 case households and 304 control households. Chi-square comparison of these educational levels revealed a significant difference between these two groups (Pearson χ^2=27.12, P=<0.001). More case households had gained no qualifications, achieved 'O' grades or had attended further education but without gaining a formal qualification compared to control households. In comparison, over one half of control households had attended further education and gained a formal qualification, whereas less than one quarter of case households had attained this level of education.

Annual (gross) household income for 48 case households and 289 control households are presented in Figures 4-30 and 4-31. Chi-square comparison of these data showed a significant difference between case and control households (Pearson χ^2=31.610, P<0.001). In general, more case households were unemployed or in the low income bracket compared to control households, whereas significantly more control households were in the high income bracket compared to case households. In addition, a higher proportion of control households reported that they were pensioners/retired compared to the proportion of case households that were pensioners (Table 4-21).

Table 4-22 summarises the other pets found in case and control households (i.e. excluding the dog respondents were referring to when answering the questionnaire). More than half of the case households owned another pet compared to less than half

TABLE 4-18: Living accommodation for 49 case households and 315 control households in Strathclyde Region, Scotland and chi-square analysis of bivariate associations between each type of accommodation.

ACCOMMODATION	CASES (%)	CONTROLS (%)	YATES' CORRECTED χ^2	*P*-VALUE*
Flat	20 (40.82)	50 (15.87)	15.42	<0.001
Rented Flat	13 (26.53)	19 (6.03)	19.74	<0.001
Bought Flat	7 (14.28)	31 (9.84)	0.48	0.49
House	26 (53.06)	259 (82.22)	19.54	<0.001
Rented House	17 (34.69)	51 (16.19)	8.38	0.004
Bought House	9 (18.37)	208 (66.03)	38.06	<0.001
Farm	3 (6.12)	6 (1.90)	1.62	0.20

* level of significance reduced to 0.006 due to multiple comparisons

TABLE 4-19: The number of years that 49 case households and 319 control households in Strathclyde Region, Scotland have lived in their present accommodation and chi-square analysis of bivariate associations between each time period.

NUMBER OF YEARS	CASES (%)	CONTROLS (%)	YATES' CORRECTED χ^2	*P*-VALUE*
< 1 year	8 (16.33)	10 (3.13)	13.18	<0.001
1year to < 2 years	11 (22.45)	11 (3.45)	24.01	<0.001
2 years to < 5 years	6 (12.24)	51 (15.99)	0.21	0.64
5 years to < 10 years	13 (26.53)	64 (20.06)	0.72	0.40
10 years or >	11 (22.45)	183 (57.37)	19.40	<0.001

* level of significance reduced to 0.01 due to multiple comparisons

FIGURE 4-30: Annual household income for 48 households that relinquished their dog to an animal welfare centre in Strathclyde Region, Scotland.

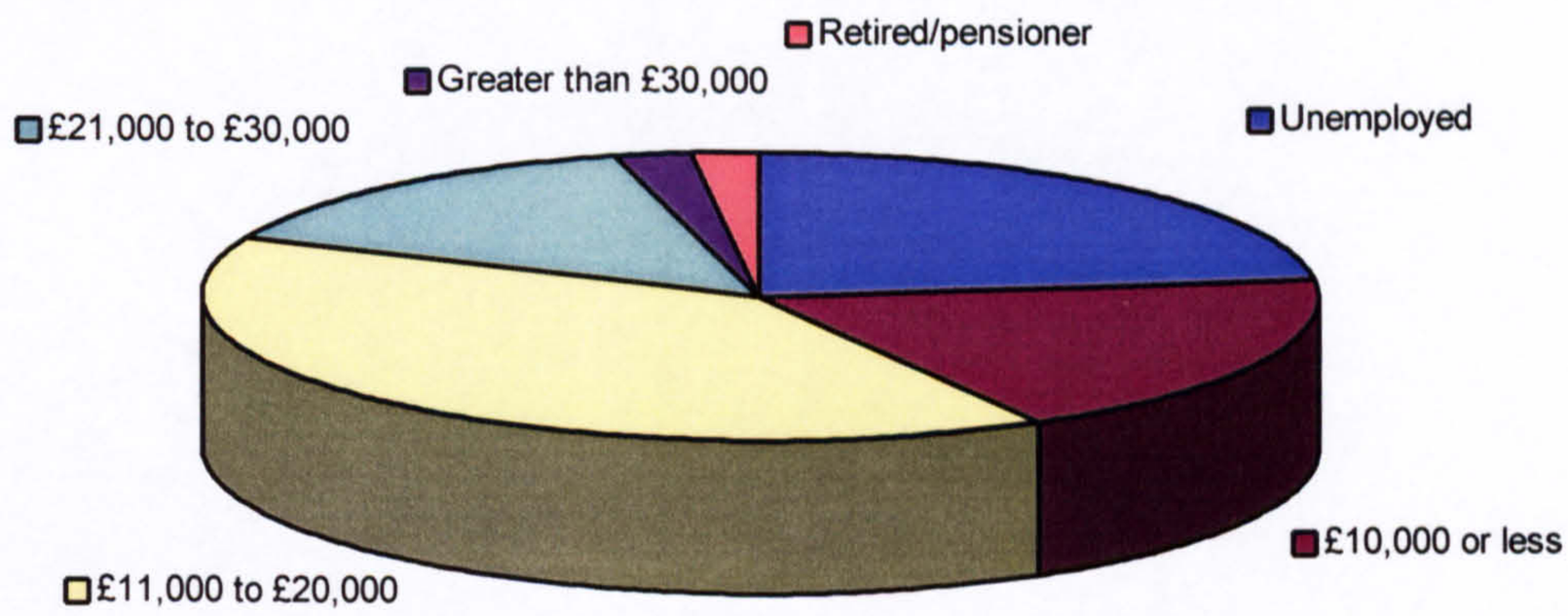


FIGURE 4-31: Annual household income for 289 dog owning households in Strathclyde Region, Scotland.

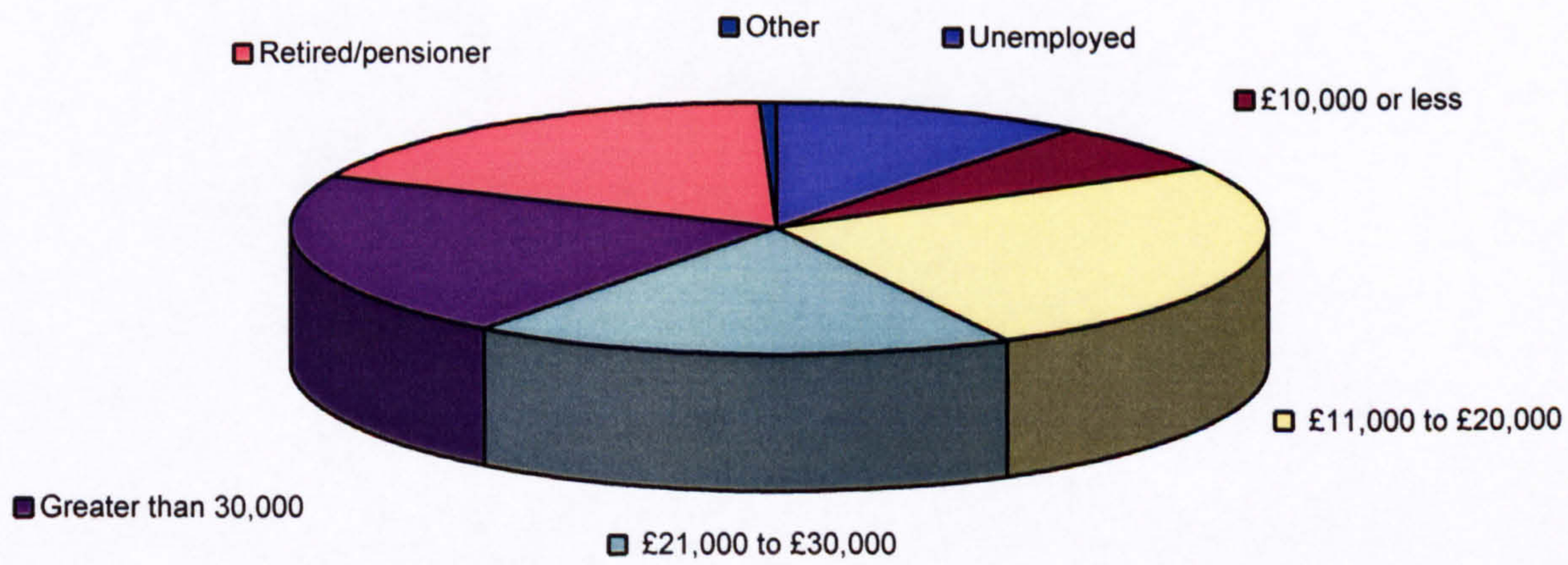


TABLE 4-20: The highest education level achieved in 47 case households and 304 control households in Strathclyde Region, Scotland and chi-square analysis of bivariate associations between each level.

QUALIFICATION	CASES (%)	CONTROLS (%)	YATES' CORRECTED χ^2	*P*-VALUE*
No qualifications	11 (23.40)	35 (11.52)	4.06	0.04
'O' Grades	13 (27.66)	48 (15.79)	3.21	0.07
'H' Grades	5 (10.64)	32 (10.53)	0.00	1.00
Further education◊	7 (14.89)	11 (3.62)	8.45	<0.01
Formal qualification	11 (23.40)	178 (58.55)	18.85	<0.001

* level of significance reduced to 0.01 due to multiple comparisons

◊ Attended further education but no formal qualification gained

TABLE 4-21: Annual household income for 48 case households and 289 control households in Strathclyde Region, Scotland and chi-square analysis of bivariate associations between each income.

GROSS INCOME	CASES (%)	CONTROLS (%)	YATES' CORRECTED χ^2	*P*-VALUE*
Unemployed	11 (22.92)	30 (10.38)	4.94	0.03
< £10,000	9 (18.75)	18 (6.23)	7.14	0.008
£11 to £20,000	19 (39.58)	74 (25.61)	3.36	0.07
£21 to £30,00	7 (14.58)	52 (17.99)	0.14	0.71
>£30,000	1 (2.08)	62 (21.45)	8.93	0.002
Other◊	1 (2.08)	53 (18.34)	6.92	0.008

* level of significance reduced to 0.008 due to multiple comparisons

◊ Case - pensioner
Control - pensioners/retired (n=52), receiving incapacity benefit due to ill health (n=1)

TABLE 4-22: Pets owned (excluding dog respondents referred to in a questionnaire) in 49 case households and 321 control households in Strathclyde Region, Scotland and chi square comparison between these two groups.

OTHER PETS OWNED	CASES (%)	CONTROLS (%)	YATES' CORRECTED χ^2	*P*-VALUE
Own another pet	30 (61.22)	148 (46.11)	3.31	0.07
Do not own another pet	19 (38.78)	173 (53.89)		
Dog	2 (4.08)	46 (14.33)	3.10	0.08
Cat	14 (28.57)	65 (20.25)	1.29	0.26
Small mammal	16 (32.65)	24 (7.48)	25.40	<0.001
Rabbit	6 (12.24)	14 (4.36)	3.74	0.05
Hamster/gerbil	7 (14.29)	14 (4.36)	6.08	0.01
Mouse/rat	4 (8.16)	0 (0.00)	*	*
Guinea-pig	3 (6.12)	7 (2.18)	1.24	0.27
Bird	6 (12.24)	41 (12.77)	0.00	1.00
Fish	7 (14.29)	46 (14.33)	0.00	1.00
Miscellaneous[◊]	2 (4.08)	13 (4.05)	**	**

◊ Cases - pony (n=1), tortoise (n=1).

◊ Controls - horse, pony or donkey (n=7), horse, an iguana and a boa constrictor (n=1), stick insect (n=1), chinchilla (n=1), lizard (n=1), pet sheep (n=1) and tortoise (n=1).

* 25% of cells had expected counts less than 1.0. Fisher's exact test, $P<0.001$.

** 25% of cells had expected counts less than 1.0. Fisher's exact test, $P=1.00$.

of the control households. This difference showed a trend towards statistical significance (Yates' corrected χ^2=3.31, P=0.07) and was due to the significantly higher proportion of case households that owned a small mammal (mouse, rat, guinea-pig, rabbit, hamster or gerbil) compared to control households. With respect to households that reported ownership of another pet, 46.7% of case households owned more than one species of pet compared to only 39.2% of control households; however, this difference was not statistically significant (Yates' corrected χ^2=0.31, P=0.58). When considering ownership of another dog only, a lower proportion of case households owned another dog compared to control households. This latter finding showed a trend towards statistical significance (Yates' corrected χ^2=3.10, P=0.08).

Finally, forty-nine case households and 318 control households provided details of previous pet ownership. Excluding the pets currently owned, 49.0% (24) of case households and 81.4% (259) of control households had previously owned a pet. This lower rate of previous pet ownership in case households was significant (Yates' corrected χ^2=23.55, P<0.001).

4.4 DISCUSSION

This study was designed to determine human and dog characteristics that contribute to owner dissatisfaction and the decision to surrender a pet dog to an AWC. However, it is worthy of note that households relinquishing litters of pups were excluded from this study. Similarly, this investigation focused on relinquished dogs and ignored the stray dog population within the AWC. Therefore, the results can not be extrapolated to these two groups.

4.4.1 Data collection

Questionnaires were used in this study to elicit data from both case and control households. Despite an identical data collection tool, the method by which questionnaires were administered to respondents varied between the two research samples. Case households were solicited by AWC staff at the time of relinquishing their dog, whereas control households were contacted by a mail survey. Such a disparity in data collection may act as a source of possible bias. For example, control households completed the questionnaire in the comfort of their own home, with no time constraints,

allowing respondents to consider each answer carefully, reflect on questions, consult others and adjust their response where appropriate. In comparison, case households completed the questionnaire in an unfamiliar environment, during what was likely to be a stressful and inconvenient time and consequently, may have hastily completed the questionnaire. Time to think over questions has been suggested as a factor that may affect response validity (Siemiatycki, 1979). Fortunately, both research groups self-administered the questionnaire limiting any bias attributable to data collection methods, related to prompting by an interviewer.

Due to several problems encountered with regard to case sample recruitment, a disappointingly low number of case households were included in this study. Collectively, the four participating animal welfare centres recruited a total of 49 case households. Of these households, 22 were selected by Bothwell Bridge AWC, 15 were selected by Stirling AWC, seven were selected by Milton AWC and the remaining two case households were selected by Glasgow Dog and Cat Home. This sample of case households was considerably less than the anticipated case sample size and fell notably short of the number of control households available for comparison.

Explanation given by AWCs managers centred around the recent contractual agreement between the SSPCA and Strathclyde Region local authorities which gave responsibility for the capture and custody of all stray dogs to the SSPCA. As a result, centre managers expressed that a low number of unwanted dogs were handled during 1997 due to overcrowding within these centres with a large number of impounded strays. Decreasing contact with relinquishing owners was proposed as causing a lack of consistent opportunity for staff to distribute questionnaires. However, the figures outlined in Table 4-1 do not support attrition of relinquished dogs, with a total of 2211 eligible case households handled by the four participating AWCs during 1997.

Potential solutions were proposed when the above problem became apparent, the most viable of which involved mail contact to relinquishing owners at a later date, using a similar protocol as the method described to obtain data from control households (Chapter 4, Section 2.4.4). This would have been feasible if the researcher utilised the written records kept by each AWC, detailing all relinquished animals and their owners. However, this method was not pursued as it was anticipated that a time lapse in

contacting potential case households could significantly affect the results obtained. Owners may no longer have expressed the emotions experienced, or remembered the reasons underlying relinquishment of their dog several weeks previously. Alternatively, they may have acquired another dog in the intervening period and incorrectly answered the questionnaire with regard to their new pet. Moreover, the SSPCA were unwilling to breech confidentiality by disclosing details of owners and their dog to the researcher and reiterated their dedication to the study, with reassurance that case sample selection would improve.

As discussed previously (Chapter 4, Section 2.4.3), AWC staff reported that only a small number of persons approached declined to complete the questionnaire such that refusal to participate did not appear to contribute to the low case household recruitment. Overcrowding within these centres with stray dogs, compounded by limited numbers of volunteers and workers and the fact that staff were involved in other time consuming obligations, meant that several potential case households simply left these centres without their participation in the study being requested. Staff at the SSPCA AWCs arbitrarily distributed questionnaires, at their convenience, to a small sample of the entire eligible population of relinquished dogs that were handled during the 12 month period allocated to case household recruitment. Consequently, case household selection could not be described as a random process, with the potential of selection bias acknowledged. In addition, the selected case sample represented a small percentage of the many households that were positioned on a waiting list, maintained until space was available to accept their surrendered dog. This intervening period between deciding to relinquish a pet and actually completing the surrendering process could also have biased the case sample in two ways. First, impatient households, who were possibly less attached to their pet, may not have abided by the waiting procedure and surrendered ownership of their dog by simply allowing it to stray, unidentified and thus contributing to the stray dog population. Such households may have differed in characteristics from those that awaited acceptance by an AWC. Second, with the knowledge of overcrowding within the AWCs and the lengthening waiting lists for relinquished dogs, the SSPCA introduced a new policy whereby each centre had to provide kennel space for dogs they had previously rehomed. This preferential acceptance policy could have

increased the proportion of the relinquished population that were obtained from an AWC and further contributed to any bias attributable to the selection process.

4.4.2 Mail survey

A mail survey was selected as the questionnaire strategy for control households. Although the alternative telephone survey typically achieves higher response rates, this method may have posed problems due to the length of the questionnaire. This study utilised questionnaires that consisted of 41 questions, printed on six sheets (12 pages) of paper and that took approximately 20 minutes to complete. With such an extensive questionnaire, telephone respondents may have prematurely terminated the interview, thereby reducing the effective response rate achieved. There was also concern that the quality of information may have decreased with lengthy telephone interviews (Dillman, 1978). In contrast, studies on this particular aspect of questionnaire design for mail surveys indicate that response rate is not necessarily proportional to the number of pages (Childers and Ferrell, 1979) and that length will not adversely affect response if the questionnaire does not exceed 12 to 15 pages (Dillman, 1978, Vaillancourt *et al.*, 1991). Other factors providing evidence against the use of the telephone to conduct this study were reports that validity of response and willingness to answer sensitive questions i.e. household income or acknowledge embarrassing attitudes, is greater with mail compared to telephone strategies (Siemiatycki, 1979; Siemiatycki *et al.*, 1984). This last point seemed particularly relevant for this study due to the personal questions asked within the questionnaire and the anticipated reluctance of British residents to disclose any personal information to a stranger via the telephone.

4.4.2.1 Response rate

The mail questionnaire study in this report did not incorporate all recommended aspects specified for the Total Design Method (Dillman, 1978). According to this author, no published investigation which has strictly adhered to all of the requirements of the TDM has achieved a response rate of less than 60%. The response rate achieved in the present study was considered excellent despite divergence from some recommendations of the TDM. Completed questionnaires were returned by 321 control households, representing a 89.2% response rate. If exclusion of the two non-dog owning households and the three households for which questionnaire were returned by the postal service marked

'addressee unknown' was made prior to calculation of response rate, a 90.4% rate was achieved. Adjustment for non-eligible and non-contactable households in response rate calculation has been described by Dillman (1978) and frequently appears in the literature. However, this method may underestimate the response rate achieved in mail surveys because all non-responses are considered a refusal until proven otherwise, whereas a proportion may represent non-eligible/non-contactable households (Dillman, 1978). Doherr *et al.* (1998) described the necessity of clarifying the different response rates reported as either overall return proportion, including all returns, a response proportion, including completed as well as incomplete surveys or a completion proportion, including at least partially completed surveys that were useable in the analysis, to facilitate comparison between studies.

As discussed in Chapter 2, Section 4, response rates achieved in questionnaire studies vary widely, depending on the target population, the method of questionnaire administration and the study topic (Dillman, 1978). Combined with the discrepancy in the criteria for calculating response rates, comparison with other reports in the literature can be confusing. Response rates to postal questionnaires as low as seven per cent have been reported (Thrusfield, Holt and Muirhead, 1998). Mail questionnaires involving animal owners have experienced a wide range of response, with rates between 30 to 82% reported (Schneider and Vaida, 1975; Heussner *et al.*, 1978; Nassar and Mosier, 1980; Nassar and Mosier, 1982; Charles, Charles Research groups, 1983; Nassar, Mosier and Williams, 1984; Troutman, 1988a; Vaillancourt *et al.*, 1991; Hird *et al.*, 1992; Wise and Yang, 1992; Blackshaw and Day, 1994; Leslie *et al.*, 1994; Zasloff; 1996; Gehrke, 1997; Ledger and Baxter, 1997b; Mellor, 1997; Doherr *et al.*, 1998; Wells and Hepper, 1999b).

The exceptional response rate achieved in this study can be attributable to several factors. Most importantly, the construction and administration of questionnaires relied greatly on the TDM. Dillman (1978) reported an average response rate of 74% from 48 surveys which relied on this method and suggested that response rates near 90% are not unusual when surveying specialised groups of people. Painstaking attention was paid to every detail of questionnaire construction and administration that has been reported to affect response from mail surveys (Dillman, 1978; Childers and Ferrell, 1979; Siemiatycki, 1979; Siemiatycki *et al.*, 1984; Choi *et al.*, 1990; Vaillancourt *et al.*, 1991). The shape, size and colour of stationary, inclusion of prepaid reply envelopes, postage,

content of the cover letter, whether and how names, addresses and salutation are affixed, addition of title under senders name, identification of sender with a known established organisation, reassurance of anonymity and confidentiality, emphasis of personalisation throughout the implementation process and a host of other issues were all considered. In particular, considerable planning went into questionnaire construction, both content and appearance, as this aspect has been suggested as critical in mail surveys, having an impact on both response rate and validity (Vaillancourt *et al.*, 1991).

Contrary to the opinion that questionnaire pages should be bound as a booklet (Dillman, 1978; Vaillancourt *et al.*, 1991) the questionnaire used in this study was not in booklet format. With respect to prepaid reply envelopes, the denomination of stamps can effect response rate. Choi *et al.* (1990) reported that non-stamped return envelopes obtained the lowest response rate, followed by prepaid FREEPOST return envelopes, then a standard stamp, with the highest response rate achieved when a large commemorative stamp was used on the return envelope. Mellor (1997) also reported a reduction in response rate when prepaid FREEPOST return envelopes replaced a standard stamp on the return envelope. Despite this finding, prepaid FREEPOST return envelopes were used in this present study as they tend to reduce overall survey costs (Choi *et al.*, 1990). Failure to follow the recommendation of others on both of the above aspects did not appear to adversely affect the response rate achieved here.

While all of the above mentioned study design considerations may have contributed to the response of this study, three additional aspects were believed to be crucial in producing the excellent response rate achieved. First, all eligible control households were pre-contacted by telephone (Chapter 2, Section 2) which identified the researcher, outlined the study objectives and gave households advanced notification of the impending arrival of a questionnaire. Vaillancourt *et al.* (1991) reported that such pre-contact appeared to increase response rates, especially when done by telephone. Second, the research sample consisted of a homogeneous sample of pet owners, and homogeneous samples are known to produce higher response rates to mail questionnaires compared to a sample of the general population (Dillman, 1978). In addition, people with pets enjoy telling others about their animals which the author experienced in this survey, with an abundance of stories and pictures accompanying the questionnaires that were returned. Finally, the conduction of the survey included three

carefully timed follow-up procedures. According to Vaillancourt *et al.* (1991), one of the most important factors affecting the response rate to mail surveys is the follow-up procedure. It has been reported that an investigator using a single mailing, with no incentives given to respond, can anticipate no more than a 20% response rate (Bourque and Fielder, 1995). In the present study, the first follow-up increased the response rate by 29.4%, the second by 8.3% and the final by 4.2%, emphasising their importance.

Worthy of mention, are two potential problems that stem from a mail strategy. Recipients of mail surveys have the opportunity to examine the questionnaire in its entirety before deciding to respond, increasing response selectivity (Dillman, 1978). Consequently, if response rates are low, mail surveys present the greatest potential for introducing a response bias (Dillman, 1978; Vaillancourt *et al.*, 1991; Olson *et al.*, 1992). A response bias occurs when an association between two variables reflects characteristics common to respondents but not shared by non-respondents due to inherent differences between these two groups (Cobb *et al.*, 1957; Battistutta *et al.*, 1983; Vaillancourt *et al.*, 1990). Spurious results for risk factor and disease prevalence or estimates of relative risk may then be produced (Criqui *et al.*, 1978). When response rate is under 80%, all associations are considered suspicious by some authors unless similarities between participants and non-participants are established (Doherr *et al.*, 1998). Ideally, non-respondents characteristics should be determined to exclude the possibility of a response bias. However, determining the extent of dissimilarity between respondents and non-respondents is often precluded by a lack of information on pertinent variables among the population from which the sample comes (Dillman, 1978; Olson *et al.*, 1992). In addition, as high response rates decrease the possibility of a response bias (Vaillancourt *et al.*, 1991), the characteristics of non-respondents from this study were not determined.

Lack of an interviewer in self-administered questionnaires precludes amplification of questions and probing of equivocal answers. Consequently, mail surveys have been suggested to be the most susceptible to item non-response, especially in poorly constructed questionnaires, due to misunderstood questions, skipped answers and inadvertent omission of questions (Mork, 1970; Dillman, 1978; Hartge and Cahill, 1998). O'Toole *et al.* (1986) compared the three different survey strategies and found that item non-response was confined virtually to mail surveys. In contrast, other

researchers have reported minimal differences with respect to item non-response, with high rates of completeness achieved using all three techniques (Hotchstim, 1967; Siemiatycki, 1979; Battistutta *et al.*, 1983). The mean ± sd (median) item non-response for this study was 1.6% ± 3.3% (0.3%), which was lower than the 2 to 5.5% item non-response rates reported by others (Hotchstim, 1967; Dillman, 1979; Siemiatycki, 1979; O'Toole *et al.*, 1986; Vaillancourt *et al.*, 1991). Although the mean item non-response was lower than other reports, cost of the dog and household income generated considerably higher item non-response rates. However, the high non-response rates for these questions probably reflect an inability to remember the cost of the dog and a deliberate exclusion of household income, which is a highly sensitive question, rather than a construction fault in the questionnaire.

4.4.3 Risk factors for relinquishment

4.4.3.1 Dog characteristics

A dog's age was significantly associated with relinquishment. In agreement with others (Nassar, Mosier and Williams, 1984; Rowan and Williams, 1987; Murray and Speare, 1995; Patronek *et al.*, 1996a), surrendered dogs were significantly younger than control dogs. Patronek *et al.* (1996a) reported a mean age of 2.3 years for relinquished dogs, which is comparable to the average age (1.87 years) for this study. Despite this young age, less than one eighth of relinquished dogs were puppies. Instead, juveniles between four to eleven months were the most common age category, which in combination with puppies, represented just under half of the surrendered dogs. Patronek and Glickman (1994) and Miller *et al.* (1996) reported similar proportions of relinquished dogs under one year of age. In agreement, Bailey (1992) reported that the most common age categories at which dogs are surrendered was 6 to 9 months followed by 1 to 2 years. Over representation of juvenile dogs is consistent with the average length of ownership before relinquishment. Similar to the findings of others (Arkow and Dow, 1984; Alexander and Shane, 1994), approximately 40% of dogs were owned for under six months before relinquishment. Puppies are most attractive and are readily adopted into new homes. Six months later, when they have outgrown their 'cuteness' or the owner has tired of their caretaker responsibilities, the animal may no longer be wanted. During such a short period, the novelty has declined but no bond has been formed.

It has been reported that roughly half of the canine population in the UK are pure-bred, of which approximately half are kennel club registered (Council for Science and Society, 1988, PFMA, 1999), similar to the control dog population of the present study. In contrast, almost 90% of dogs from case households were mixed breed which was significantly more than the proportion of this breed in the control population. Over representation of mixed breeds in relinquished, and stray, dogs is in accordance with the findings of others (Council for Science and Society, 1988; Bailey, 1992; Murray and Speare, 1995; Patronek *et al.*, 1995; Patronek *et al.*, 1996a; Salman *et al.*, 1997). While some pure-bred dogs are diverted to breed rescue societies, this is unlikely to account to any significant degree for the difference in breed related disposal rates.

As discussed in Chapter 1, Section 3, these breed data may indicate that some intrinsic characteristics of mixed breed dogs make them unsatisfactory pets. Alternatively, Murray and Speare, (1995) proposed that owner factors and their influence of pet selection have an important bearing on breed related disposal rates. Mixed breed dogs are more readily available as their acquisition often eliminates the requirement for breed selection, breeder location and availability of pups at the appropriate time, as is the case with pure breed dogs. Acquiring a mixed breed dog may require no planning and no, or very little, cost. In addition, upon acquisition of a mixed breed puppy, there is little indication as to the adult size and temperament of the dog, which may be completely undesirable, especially when little thought is given to the acquisition process. Over representation of mixed breeds may also relate to socio-economic status. Significantly more case households had lower household income compare to control households. Godwin (1975) reported that ownership of pedigree dogs was significantly higher in the upper socio-economic groups, with pedigree dog ownership falling by descending income group.

Unlike the findings of others (Patronek *et al.*, 1996a; Patronek *et al.*, 1996b), neutering status was not a significant risk factor for relinquishment, with a propensity to sexual entirety in dogs from case and control households. Investigators of both the relinquished and stray dog population have consistently found that rates of neutering are markedly lower than in the general canine population (Nassar, Mosier and Williams, 1984; Murray and Speare, 1995; Patronek *et al.*, 1996a; Patronek *et al.*, 1996b). This discrepancy in the present investigation may reflect the high proportion of relinquished

dogs obtained from an SSPCA AWC that operate a compulsory neutering system of adoptees. In support of this, was that significantly more case households reported that they were instructed or advised to neuter their dog by the source of the animal. Among owners of sexually intact dogs, more case households cited cost as the reason for not neutering their dog. This may explain why the cheaper procedure, castration, was performed with equal frequency in dogs from case and control households whereas the more expensive operation, speying, was performed with less frequency in dogs from case households, although this latter finding was not statistically significant. Patronek *et al.* (1996a) reported that giving cost as the reason a dog was not neutered was associated with relinquishment. Significantly more case households justified their dogs sexually intact status by reporting that they planned to neuter in the future. While this may reflect the young age of relinquished dogs, it may reflect procrastination and reluctance to invest in neutering, if low priority is given to pet health care.

While similar proportions of case and control households allowed their dog to reproduce, the reasoning behind this significantly differed, with all of the case households reporting that the litter was an unplanned, accident, whereas just over one quarter of the control households gave this reason. This finding suggests inadequate supervision of dogs from case households and failure to attend a veterinary surgeon for misalliance treatment. With regard to the former, this was supported by the finding that an increased proportion of dogs from case households spent most of their time roaming loose outside.

4.4.3.2 Factors associated with dog acquisition and ownership

Although source of dog was associated with relinquishment, the significance of this finding must be questioned. Similar to other reports (Nassar, Mosier and Williams, 1984; Miller *et al.*, 1996; Patronek *et al.*, 1996a), significantly more relinquished dogs were obtained from an AWC and significantly less were obtained from a professional show breeder. However, the preferential adoption system that was in operation during the study period may have artificially raised the number that were obtained from an AWC and consequently, lowered the number from all other sources. In addition, lack of a universally accepted definition of a breeder may have caused inappropriate selection or avoidance of this category. Furthermore, the author believes that confusion may have

arisen from this question, with some households indicating the source of their dog whereas others indicated the method of acquisition. In agreement with others (Arkow and Dow, 1984; Patronek *et al.*, 1996a), dogs from case households cost significantly less than dogs from control households, with a higher proportion of relinquished dogs being obtained at no cost, although this latter finding was not statistically significant. This supports the opinion that a persons psychological investment and commitment to an animal is in part, dictated by financial equity.

An interesting finding regarding the acquisition process was that significantly more case households allowed a child to be responsible for the decision to acquire a dog. Reliance on a child's decision for such an undertaking is likely to be inappropriate. Likewise, Digiacomo, Arluke and Patronek, (1998) reported that 21% of relinquishment cases included acquisition without the consent of adult family members. Most children have no concept of responsibility, frequently become disinterested and may regard dog ownership as a hobby or toy which can readily be abandoned in favour of another. In this study, case households had a significantly higher incidence of spontaneity when deciding to acquire their dog. This may reflect why a child's decision was acted upon. Miller *et al.* (1996) also reported that about one third of owners had not planned to acquire the dog they relinquished. Lack of planning was further emphasised by the finding that significantly more case households acquired the dog because it was homeless or abandoned. Similarly, Arkow and Dow (1994) reported that a quarter of relinquished dogs had been acquired to 'give a puppy a home'. Under these circumstances, reason is replaced by emotion and owners may not appreciate the commitment involved. Surprisingly, Patronek *et al.* (1996a) did not find that the degree of planning associated with the decision to acquire a dog contributed to relinquishment.

The amount of time devoted to playing, walking or training the dog was associated with relinquishment, with more case households spending less than one hour each day interacting with their dog. In as much as researchers have emphasised the importance of interaction and responsiveness in promoting attachment between people, encouraging pet owners to interact with their pets and to become more responsive to them has been suggested as a way of strengthening the owner-pet attachment (Miller *et al.*, 1996). Support for this came from Clark and Boyer (1993) who found an improvement in the human-pet relationship when owners simply spent more time interacting with their pet.

Besides spending less time interacting with their dog, in this present study, significantly less case households participated in obedience training classes after acquiring the dog. Patronek *et al.* (1996a), reported a similar association between failure to attend dog obedience training classes and relinquishment. The protective effect of obedience training may partly reflect improved dog behaviour. However, attendance at formal obedience training programs does not necessarily prevent or resolve specific behavioural problems (Voith, Wright and Danneman, 1992; Overall, 1994). As well as improving behaviour in dogs, obedience training represents positive, appropriate interaction and quality time between an owner and their dog, which may provide security and attachment in the relationship. Expanding on this, Clark and Boyer (1993) reported that participation in obedience training classes improved obedience behaviour in dogs and improved the human-canine relationship, which was further enhanced with behavioural counselling. The present study also found that significantly fewer case households received advice about dog behaviour and training.

Contrary to expectation, the proportion of dogs with behavioural problems did not differ between case and control households, with approximately one third of both research groups believing that their dog behaved in a undesirable way. Previous reports have indicated that between 12 to 70% of dogs are relinquished due to behavioural problems (Arkow and Dow, 1984; Rowan and Williams, 1987; Council for Science and Society, 1988; Bailey, 1992; Houpt, Honig and Reisner, 1996; Miller *et al.*, 1996; Ledger *et al.*, 1995; Ledger, 1997; Ledger and Baxter, 1997a; National Council on Pet Population Study and Policy, 1997). Whilst the number of dogs with behavioural problems in this study is comparable to these figures, the same behaviours, displayed at similar frequencies were reported in an equal proportion of case and control dogs. Similar behaviour may be interpreted differently by individuals, with an owner's tolerance of such behaviour dictating whether it is a problem (Van der Borg *et al.*, 1991; Ledger, 1997; Ledger and Baxter, 1997a; Ledger and Baxter, 1997b). Kidd *et al.* (1992a) found that rejecters and retainers of pets described identical behaviour with rejecters adding 'so we got rid of it' whereas retainers said 'they will probably grow out of it'. Ledger (1995) reported that of dogs returned to an AWC on multiple occasion, only 18% of successive owners cited the same behavioural problem. Although some dogs may exhibit more than one type of behavioural problem, each owner will have their own

personal interpretation of what constitutes a problem behaviour (Van der Borg, Netto and Planta, 1991).

All modern breeds of dogs are derived from subspecies and races of the wolf (Young, 1985; Serpell, 1987). Although dogs have associated with people for several thousand years, they still exhibit most of the behavioural patterns of their wild ancestors (Council for Science and Society, 1988). Despite this, perhaps some owners transfer behaviour that is normal for humans to their dog, resulting in misinterpretation of dog behaviour and behavioural problems (Endenberg and Knol, 1994). As discussed in Chapter 1, this point is emphasised in the finding that many of the behavioural problems cited by owners relinquishing their dog are attributable to normal, expected behaviour (Kidd *et al.*, 1992a; Miller *et al.*, 1996; Ledger, 1997; Melson, Schwarz and Beck, 1997; Salman *et al.*, 1997). For example, Bailey (1992) reported that dogs between 6 to 9 months are commonly relinquished, with the most common reason being destructiveness. However, an explorative, teething, inquisitive juvenile dog is often expected to behave in such a manner by the experienced and educated dog owner. Jagoe and Serpell (1996) found that first-time dog owners reported behavioural problems more frequently, suggesting that novice owners may exaggerate the presence of problems. In contrast, owners with sufficient knowledge about canine behaviour may be less likely to consider these 'unwanted' behaviours a problem (Miller *et al.*, 1996).

While the association between owner attachment levels and companion animal behaviour has received little recognition, Serpell (1996) found that owners with weak attachment were less satisfied with their dog's behaviour. Similarly Voith (1985) reported that many owners keep their pet despite behavioural problems due to high levels of owner attachment to the animal. From the above, it can be seen that there are clearly mechanisms other than the underlying temperament of the dog that are instrumental in these owner-dog incompatibilities. Consequently, possible connections between dog behavioural problems and the characteristics and attitudes of owners warrants future investigation (Endenberg and Knol, 1994).

Lack of veterinary attendance was associated with relinquishment, with significantly more dogs from case households having never attended a veterinary surgery or attended a veterinary surgery when they were first acquired only. This finding must be interpreted

with caution, as it may be partly reflect the short length of ownership for many relinquished dogs. However, Patronek *et al.* (1996a) reported that lack of veterinary care was a strong factor increasing the risk for canine relinquishment, even after adjustment for duration of ownership, household income and dog neutering status. It is unknown whether veterinary care has a direct protective effect or is simply a reflection of the more responsible dog owner who is aware of and practices preventive pet health care. Kidd *et al.* (1992b) found that veterinary clients rejected significantly fewer pets than AWC adopters and speculated that this reflected that practitioners clients get individual attention to ask questions and discuss training or any problems. This educational role of a veterinary surgeon has been suggested by many to be an important aspect of the practitioners' vocation (Arkow, 1987; Arkow, 1991; Avanzino, 1991; Murray, 1992b; MacKay, 1993; Miller *et al.*, 1996; Ledger, 1997). Patronek *et al.* (1996a) found that the strength of attachment to the dog was directly related to frequency of veterinary care, suggesting that veterinary care may increase owner-dog bonding. Alternatively, owners who provide their pet with frequent veterinary care may already be more attached to their pet which is reflected in their desire to devote time and financial investment in the dog. It is likely, that the association of lack of veterinary care and relinquishment involves a complex interaction of all the above factors.

While several standardised measures for assessing pet attachment and bonding have been developed (Stallones, Marx, Garrity and Johnson, 1988; Kidd and Kidd, 1989; Kidd and Kidd, 1990; Endenburg, Hart and Baarda, 1991; Zasloff, 1996), attachment to the dog was not directly measured in this study. Instead, considering a dog to be a family member was adopted as a measure of owner-dog attachment. Using this parameter, this study indicated that attachment to the dog was significantly less for case households, which is consistent with other researchers (Arkow and Dow, 1984; Patronek *et al.*, 1996a). In addition, an indirect indication that case households were less attached to their pet was the finding that more relinquished dogs spent most of their day restricted to some area within the house, confined outside in a kennel or garden or simply loose outside, as opposed to spending most of their time unrestrained within the home, with free access throughout. This may reflect a lower degree of attachment, with separation of the dog from the family and less opportunity for owner-dog interaction. In conjunction with this, lack of attachment has been attributed to unfulfilled or unrealistic

expectations of dog ownership (Arkow, 1991; Kidd *et al.*, 1992a). While no significant difference was found in this study in the role dogs were expected to play, significantly fewer case households reported that their expectations were always met. Kidd *et al.* (1992a) suggested that owners with more limited or unreasonable expectations may develop weaker attachments to their pet, often find that their expectations are not met then usually regret adopting the animal and frequently abandon it.

4.4.3.3 Household demographic characteristics

A number of household demographic characteristics were found to be associated with relinquishment. Living in rented accommodation, living in a flat, absence of a garden, fewer years in the present accommodation, less education and lower household income were all significantly more prevalent in case households. Whilst these findings were supported by Patronek *et al.* (1996a), not all researchers have found a positive association between relinquishment and these household characteristics. Miller *et al.* (1996) found that more married people relinquished their pet as opposed to single people and that the number of home owners and renters were equal. Kidd *et al.* (1992a) reported that men and parents were more likely to relinquish their pet. These two reports disagree with the findings of the present investigation. With regard to household income, Salman *et al.* (1997) reported that 'cost of pet maintenance' was among the top ten reasons for surrendering a dog, which supports the role of lower household income in association with relinquishment. Although people who genuinely can no longer afford the basic care for their dog may have experienced some unexpected poverty, more often they cannot afford to properly maintain the pet from the onset. For example, Kidd *et al.* (1992a), when comparing successful and unsuccessful pet adopters, reported that for retainers, a major consideration was cost of food, vaccinations and veterinary services whereas the discussion never arose with rejecters.

Living in rented accommodation and fewer years in the present home could indicate an unstable family structure that frequently changes abode. This is consistent with reports that one of the most common reason for relinquishment is lifestyle changes. As discussed in Chapter 1, Section 3, owner moving, divorce, landlord prohibiting pets, financial constraints, time constraints, personal problems and new baby or addition of another household member are reported to be common reasons for relinquishment

(Arkow and Dow, 1984; Bailey, 1992; Alexander and Shane, 1994; Hart and Kidd, 1994; Scarlett, Saidla and Pollock, 1994; Houpt, Honig and Reisner, 1996; Miller *et al.*, 1996; National Council on Pet Population Study and Policy, 1997; Salman *et al.*, 1997; Digiacomo, Arluke and Patronek, 1998). Perhaps when some owners experience a change in circumstance the pet becomes expendable, reflecting a lack of owner-pet attachment and the disposable status of companion animals (Arkow, 1991). Alternatively, people may want to keep their pet when moving home but have genuine difficulty (Hart and Kidd, 1994). For example, some local authorities and private landlords ban pets from rented housing, such that prospective pet owning tenants must chose between denying themselves such accommodation of getting rid of their pet (Council for Science and Society, 1988). Educating owners about their responsibilities in rented accommodation and improving landlords' opinions and policies on pets may keep more pets with their families through residence changes (Hart and Kidd, 1994; Miller *et al.*, 1997).

Absence of a garden was a significant risk factor for relinquishment and Salman *et al.* (1997) found that 'yard is too small' was among the top ten reasons for relinquishment. Private gardens are a convenient place to exercise a dog and more specifically, provide an area for defecation and urination. In their absence, an owner has to find a suitable alternative. This may be a public grass-way some distance from the house that necessitates the clearing of all voided faeces. Such a requirement may begin to prove tiresome, especially first thing in the morning or last thing at night. Avoidance may lead to inappropriate elimination which, compounded by an intolerant owner, results in relinquishment of the dog. Lack of a garden may also relate to the finding that significantly more case households described the time and work involved in dog-keeping as more than expected. Patronek *et al.* (1996a) reported that in almost one third of dogs, relinquishment was attributable to the owners belief that the care of the dog was more than expected. With respect to time devoted to care for the dog, Endenburg and Knol (1994) reported that people in paid employment found cleaning the cage or bed of an animal more of a nuisance than people not in paid employment, presumably reflecting less time available to complete this task. In the present study, significantly more case households were unemployed, indicating that limitation of time was not a major contributing factor.

Many owners perhaps underestimate or are simply uneducated about the responsibilities, effort and commitment involved in dog ownership. This lack of knowledge may lead to pets that are mismanaged, untrained, and ultimately, abandoned (Miller *et al.*, 1996). Lack of knowledge is supported by the finding that significantly more case households were first-time owners with no prior experience of pet ownership. Note the use of 'pet' here as opposed to 'dog' as the questionnaire requested information pertaining to prior ownership of any pet. In retrospect, inquiring as to previous dog ownership would have been more appropriate. As discussed in Chapter 1, Section 3, Kidd *et al.* (1992a) also reported that subjects who already had or previously had pets and were therefore educated and experience in pet owning, relinquished significantly less pets than first time adopters. Previous pet owners are more prepared for both the benefits and problems associated with pet keeping.

Only two case households owned another dog which, although only marginally significant, was less than the proportion of control households. Besides the obvious educational benefit, two dogs are easily walked together, interact with each other and offer each other companionship, which may reduce the work requirement for the owner. In contrast, significantly more case households owned another pet in the form of a small mammal. Small mammals can be regarded as easy care pets. They require no walking, less interaction and their lower maintenance requirements mean less food and often less veterinary attention. Due to the confined cages in which they tend to be housed, they are easier to foster out during, for example, owner illness or holidays. Case households may acquire this type of pet then incorrectly assume that dog ownership is analogous. In addition, small mammals such as rabbits, hamsters, gerbils, guinea pigs, mice, rats and chinchillas often serve as animated toys for young children and as with toys, enthusiasm for the pet is often temporary (Council for Science and Society, 1988).

4.4.4 Summary

Research was undertaken to compare the characteristics of households relinquishing dogs to AWCs and the characteristics of dogs surrendered, with a control sample of 'successful' owners and their dogs, to establish risk factors for canine relinquishment. Results revealed that several factors were associated with relinquishment. Whilst certain dog characteristics were identified as important, most of the predisposing characteristics

were owner-related. Uneducated, inexperienced dog owners who impulsively acquired their dog for little cost, were more likely to relinquish the pet after a short duration of ownership because of inappropriate care expectations, lack of planning and the dog failing to meet their expectations. Surprisingly, behaviour problems were no more prevalent in relinquished dogs.

This study has identified several risk factors associated with canine relinquishment, many of which could potentially be modified to decrease the numbers of animals abandoned at animal welfare centres. The results confirm some of the findings of others and also contribute new information about the complex interaction between dogs, owners and animal welfare centres. More importantly, the results provide unique data from the UK that will serve as a background for informed discussion and act as a catalyst for additional scientific inquiry. While exploring the cause of pet relinquishment and abandonment in itself is important, identification of methods to eliminate or control this problem also warrant future consideration.

In this chapter, each variable or factor has been considered independently. In reality, interaction and confounding almost certainly occurred; multivariable analysis is therefore the logical development of this inquiry.

CHAPTER V

RISK FACTORS FOR CANINE RELINQUISHMENT TO ANIMAL WELFARE CENTRES - PART II

CHAPTER V

RISK FACTORS FOR CANINE RELINQUISHMENT TO ANIMAL WELFARE CENTRES - PART II

5.1 INTRODUCTION

5.1.1 Introduction

The results obtained from the case-control study described in Chapter 4, identified a variety of household demographic and dog characteristics associated with relinquishment of a dog to an animal welfare centre. Due to the complexity of the problem, this finding is not surprising and any epidemiological investigation dealing with relinquishment, will undoubtedly have to address a multitude of potential risk factors. With such a data set, the next step entails a comprehensive analysis of these variables, to evaluate the extent to which each is associated with canine relinquishment, and their interaction.

In epidemiological terms, the researcher wishes to describe the relationship between the outcome (response or dependent) variable and several explanatory (predictor or independent) variables. Analysis of such a multivariable problem, typically involves the application of some type of mathematical model to deal with the complex inter-relationship among the variables (Kleinbaum, 1994). Logistic regression is an example of a mathematical modelling approach that is used to examine the simultaneous effects of multiple independent variables. This analytical technique is based on the linear regression model and is used when the dependent (outcome) variable is dichotomous as opposed to continuous, as is the case with linear regression. A dichotomous variable is a discrete variable taking on one of two possible outcomes which, in epidemiological studies, generally represent 'disease present', (1), or 'disease absent', (0). In recent years, the logistic regression model has become, for many researchers, the standard method of analysis in this situation (Hosmer and Lemeshow, 1989) and is appearing with increasing frequency in the medical literature (Dawson-Saunders and Trapp, 1994).

5.1.2 Purpose

The purpose of this study was to apply the logistic regression model to the data set obtained from the investigation described in Chapter 4. The aim was to assess the relative importance of each variable in association with canine relinquishment and develop a model which could be used to assess the risk of relinquishment, using a parsimonious set of these explanatory variables.

5.2 MATERIALS AND METHODS

5.2.1 Research design

A case-control study was conducted between February 1997 and February 1998, to identify the risk factors for 'unsuccessful' dog ownership leading to relinquishment of a dog to an animal welfare centre.

5.2.2 Study region and research sample

The characteristics of the study region, the population from which the research samples were selected and the sampling criteria and procedure have been described previously (Chapter 2 and 4, Sections 2).

5.2.3 Data collection and analysis

5.2.3.1 *Univariable analysis*

Questionnaires were used to secure data from 370 dog owning households, which represented 49 case households and 321 control households (Chapter 4, Section 2). Details were obtained from these households on a total of 41 human demographic and dog factors (Appendix 8). With relinquishment as the dependent variable, case households were assigned 1 (disease present) and control households assigned 0 (diseases absent) for this outcome variable. Based on this, an initial univariable screening of the 41 variables was performed, to identify which dog and household characteristics were associated with relinquishment (Chapter 4, Section 2.5)

Univariable analysis was performed using the two sample t test for continuous variables and the chi-square test for independence for categorical variables, to ascertain which variables demonstrated a significant difference between case and control households.

Upon completion of the univariable analysis, variables were selected for inclusion in the multivariable model. Variables were considered eligible for inclusion if they were found to be significantly associated with relinquishment, with all variables significant at an alpha level of 0.25 considered as candidates for the multivariable analysis.

5.2.3.1 *Multivariable analysis*

The effect of the combination of risk factors identified in Chapter 4, Section 3.2 (univariable analysis) was evaluated using a multiple logistic regression model. Figure 5-1 presents the logistic function which describes the mathematical form on which the logistic regression model is based. Inspection of this figure reveals that the range of the logistic function is bounded between 0 and 1 and the function provides a biologically attractive sigmoid shaped curve. As can be seen, the combined effect of risk factors on the probability of disease is relatively low until some 'threshold' is reach. The risk of disease then greatly increases until it attains a 'plateau' (Kleinbaum, 1994). These features illustrate why the logistic model is commonly used to described the conditional probability (risk) of disease given the combined effect of several risk factors. The specific form of the logistic regression model used in this study was as follows:

$$P(X) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_k x_k)}}$$

where P(X) represents the conditional probability of relinquishment given a combination of independent variables; x_i are the independent explanatory variables and β_0 and the β_i's are constant terms representing unknown parameters which are estimated based on the data set.

While the logistic model is defined primarily for prospective, cohort studies it can also be applied to other study designs, including case-control studies. Results are interpreted in terms of relative risks in cohort studies whereas estimates of odds ratios are obtained in case-control studies (Dawson-Saunders and Trapp, 1994). Odds ratios quantify the effect of exposure to risk factors in an individual with the disease of interest which for rare diseases, provides an estimate of the relative risk. Odds ratios for this study were estimated by fitting a logistic regression model to the data set. Computation of these

ratios used an alternative form of the logistic model, the logit form, which is derived from the logistic model by the logit transformation, g(x), defined as;

$$g(x) = \ln\left[\frac{P(X)}{1 - P(X)}\right]$$

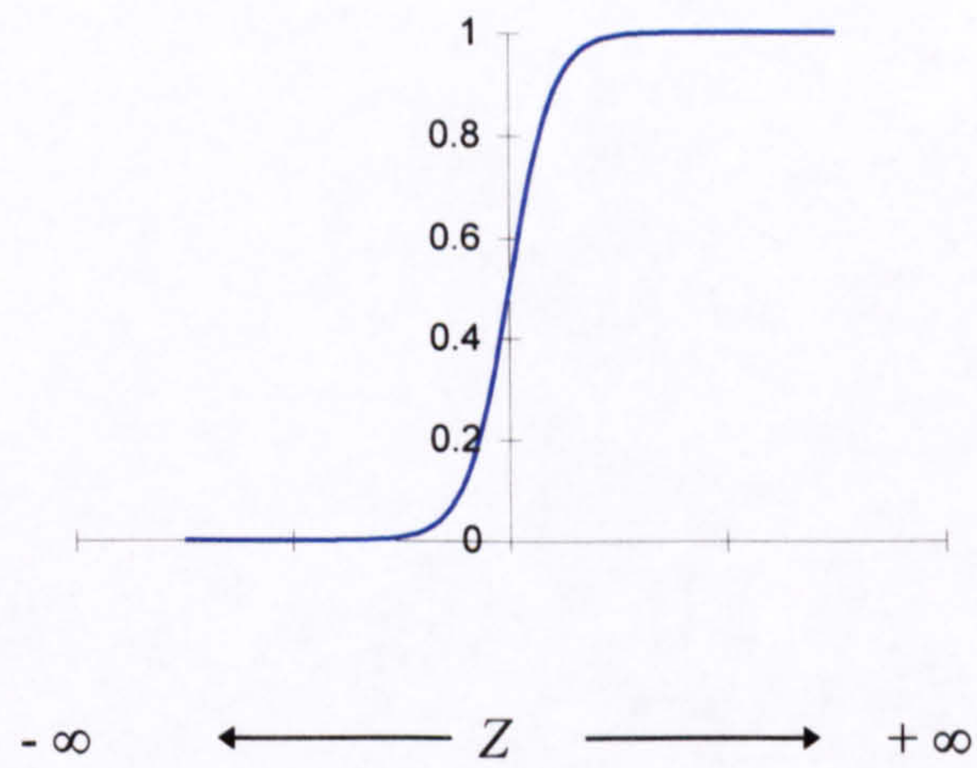
which after substitution of the logistic model form of P(X), simplifies to:

$$g(x) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 \ldots + \beta_k x_k$$

This logit form gives an expression for the log odds of relinquishment for a dog with a specific set of independent explanatory variables. β_i, known as the regression coefficient, represents the change in log odds for one unit change in the variable x_i, when all other variables are fixed. Central to the consideration of the multiple logistic regression model, is estimation of the regression coefficient for each independent variable and testing for the significance of each (Hosmer and Lemeshow, 1989). To fit the logistic regression model to the data set, the estimation method used was maximum likelihood.

Multiple logistic regression was performed using Statistix, Version 4, Analytical Software Package (Stx). Based on the result of the univariable analysis all statistically significant variables were imported into this software package. The observed values for continuous variables were entered directly while dichotomous variables were entered as 0 or 1, representing the presence or absence of the characteristic, respectively. Nominally scaled categorical variables were coded as 'dummy variables', such that a variable with k possible values was coded with k-1 dummy variables (Hosmer and Lemeshow, 1989; PROPHET StatGuide, 1998). Reference coding was the method applied for coding these variables. By this method, the value of the dummy variable was 0 for the reference level of the categorical variable, 1 for the jth dummy variable if the categorical variable was at the jth + 1 level, and 0 otherwise (Table 5-1). The value of the categorical variable taken as the reference level was either the value most frequently selected by control households, or if variable was ordinal scaled, the default choice was the highest level. Transformation of categorical variables into dummy variables was performed in Stx. Prior to this transformation, levels of categorical variables were collapsed if appropriate.

FIGURE 5-1: Logistic function on which the logistic regression model is based.



Where $f(z) = \dfrac{1}{1+e^{-z}}$

Note - the variable Z represents an index that combines the effect of several risk factors and $f(z)$ represents the risk (probability) of disease for a given value of Z.

TABLE 5-1: An example of reference coding of dummy variables for use in the multiple logistic regression model.

	DUMMY VARIABLES			
CATEGORICAL VARIABLE	DV_1	DV_2	DV_3	DV_4
CATEGORY 1*	0	0	0	0
CATEGORY 2	1	0	0	0
CATEGORY 3	0	1	0	0
CATEGORY 4	0	0	1	0
CATEGORY 5	0	0	0	1

* Referent variable

Variables were offered individually to the model and the significance of each assessed by inspection of the Wald Statistic and its associated *P*-value, and the odds ratio. In addition, the likelihood ratio test was performed to estimate the significance of the regression coefficient for each independent variable. Based on the chi-square distribution, the *P*-value corresponding to the change in deviance from the constant only model was assessed. After completion of this second screening stage, any variable that displayed a Wald statistic with an associated *P*-value > 0.25 was eliminated. This was performed in order to confirm the findings of the two sample t test and chi-square analysis.

A stepwise approach was used for variable selection and model building, utilising features of both forward selection and backward elimination. With this method, variables were selected for inclusion or exclusion from the model in a sequential fashion, based on fixed statistical criteria. During the model building process, the statistical significance of each variable was evaluated by inspection of the *P*-value associated with the Wald statistic ($P \leq 0.1$) and the likelihood ratio chi-square test ($P < 0.05$). The first variable included in the model represented the one which had the highest association with relinquishment and consequently, had the lowest *P*-value associated with the likelihood ratio chi-square test. Additional variables were added to the model one at a time and the above evaluation process was repeated to determine the next variable to be included in the model. After each new addition, all previously entered variables were checked to see if they maintained their significance and were retained in the model, only if their subsequent removal caused a significant change in model deviance. This step by step procedure continued until there were no remaining variables that produced a significant change in deviance, by their inclusion or removal from the model. Given the large number of variables, many with multiple levels, and the small number of case households, testing for interaction terms amongst the independent variables was not conducted.

The assumption of linearity in the logit for continuous independent variables was checked. This was achieved by grouping the continuous data into intervals, calculating the mean of the outcome variable (relinquishment) for each interval and creating a scatter plot of this mean versus the mid point of each interval. In addition, the Box-Tidwell transformation was performed, by adding the term xLn(x) to the model and assessing the coefficient associated with this term (Hosmer and Lemeshow, 1989).

To evaluate the effectiveness of the fitted model in predicting the risk of relinquishment, the goodness-of-fit of the final model was evaluated by examination of the Hosmer-Lemeshow statistics (Hosmer and Lemeshow, 1989). Data were grouped according to the percentiles of (decile of risk) and fixed values of (fixed cut points) the estimated probabilities, with subsequent analysis of the observed versus the expected number of cases and controls achieved at these grouping levels. Greater significance was placed on the Hosmer and Lemeshow statistic achieved with data grouped according to the decile of risk (Hosmer and Lemeshow, 1989). A series of logistic regression diagnostics were also inspected to assess the fit of the model over the entire covariate pattern. These included the fitted values (predicted probabilities), the square of the standardised residuals, the leverage and the influence. Influence of individual covariate patterns was calculated by the following method:

$$\Delta\hat{\beta}j = \frac{rj^2 hj}{1-hj}$$

(Hosmer and Lemeshow, 1989)

where $\Delta\hat{\beta}$ represents the influence diagnostic, j represents individual covariate patterns, r^2 represents the square of the standardised residuals and h represents the leverage.

Inspection of these regression diagnostics allowed identification of any covariate patterns that were poorly fit to the logistic regression model and those that had a large influence of the estimated probability of relinquishment. Households with influential covariate patterns were individually dropped from the data set and the significance of variables retained in the model re-evaluated. The per cent change in the estimated coefficients from the full data set was calculated to assess the effect of covariate exclusion, with changes greater than 20% considered significant. The fitting, assessment and diagnostics were repeated until a final main effects model was attained in which all variables were considered to be of biological and statistical significance. Adjusted odds ratios and 95% confidence intervals for each risk factor retained in the final multivariable model were obtained by exponentiation of the regression coefficients.

After completion of the above process a second multivariable logistic regression analysis was performed. One hundred and ninety-six representative households were randomly selected from the control household sample of 321. This was accomplished by using a list of randomly generated numbers, created by computer software (Microsoft Excel, Microsoft Corporation), which identified households with the corresponding identification number. Only these households, in combination with the 49 case households, were eligible for the second analysis, with all other control households excluded from the data set. Execution of this second multivariable logistic regression analysis proceeded in an identical manner to that described above for the first analysis.

5.3 RESULTS

5.3.1 Initial univariable screening

Based on the results of the univariable analysis (Chapter 4, Section 3), a total of 28 factors were identified as important variables, showing a significant difference between case and control households at $P \leq 0.25$. Table 5-2 presents details of each of these variables and their associated P-value from the initial univariable screening. Although the P-value associated with the neutering status of a dog was higher than the critical level set, the author believed a *priori* that this variable should be included. Details pertaining to other pets owned in the household were subdivided into three separate variables. These steps resulted in a total of 31 eligible factors for inclusion in the multivariable model. Table 5-3 presents details of the 16 categorical variables, with respect to their dummy variable coding.

5.3.2 Univariable logistic regression

Table 5-4 presents details of the statistics obtained after each variable was added individually to the constant only model. As it can be seen, no entries are given for 'the reason given by households for allowing their dog to have a litter of pups' (RLP). For this dichotomous variable, four case and five control households reported that the litter of pups was accidental with an unknown mate, and 13 control households reported that they had carefully planned the breeding of their female dog whereas no case households selected this option. Non-representation of case households for this category in a two by two contingency table, precluded assessment of this variable in the logistic regression model. All other variables proceeded to the next stage of the model building process.

TABLE 5-2: Variables that showed a significant difference between 49 case households and 321 control households in Strathclyde Region, Scotland, at the univariable screening stage of analysis.

CHARACTERISTIC ASSESSED		VARIABLE TYPE	*P*-VALUE	CODE
Other pets owned	any other pet	Dichotomous*	0.07	OP
	dog	Dichotomous*	0.08	ODP
	small mammal	Dichotomous*	<0.01	SMP
Previous pet ownership		Dichotomous*	<0.01	PP
Age of dog		Continuous	<0.01	AGE
Breed of dog		Dichotomous**	<0.01	B
Reasons for not neutering dog		Categorical	<0.01	RNN
Age when dog was neutered		Continuous	<0.01	AWN
Reasons for neutering dog		Categorical	<0.01	RN
Was litter of pups an accident/unplanned		Dichotomous*	0.02	RLP
Source of dog		Categorical	<0.01	S
Cost of dog		Continuous	<0.01	C
Member of household responsible for decision to acquire dog		Categorical	<0.01	RD
Degree of planning before acquisition		Categorical	<0.01	DP
Factor important in decision to acquire dog		Categorical	<0.01	DF
Does dog fulfil respondents expectations		Categorical	<0.01	FF
Behavioural advice		Dichotomous*	0.01	BA
Timing of behavioural advice		Dichotomous*	0.09	ABA
Where dog spends most of its time		Categorical	<0.01	DST
Time spent interacting with dog		Categorical	0.06	DI
Attendance at obedience training		Dichotomous*	0.05	OT
Hyperactivity of dog		Dichotomous*	0.22	HPB
Veterinary attendance		Categorical	<0.01	V
Expectations		Categorical	<0.01	E
Are dogs considered family members		Categorical	<0.01	FM
Accommodation		Categorical	<0.01	H
Presence of a garden		Dichotomous*	<0.01	G
Length of time in present home		Categorical	<0.01	LTH
Qualifications		Categorical	<0.01	Q
Income		Categorical	<0.01	I

* Coded as 1= yes/characteristic present, 0 = no/characteristic absent

** Coded as 1 = pure breed, 0 = mixed breed

TABLE 5-3: Dummy variable coding of 16 categorical variables, selected for inclusion in a multivariable logistic regression model, using data available from 49 case households and 321 control households in Strathclyde Region, Scotland.

QUESTION	VARIABLE CATEGORIES	DV CODE
Q8	Personal preference not to neuter dog	Referent
	Disagree with neutering of <u>any</u> dog	RNN1
	Advised by vet/non-vet not to neuter dog	RNN2
	The cost of the surgery is too expensive	RNN3
	Plan to neuter dog in the future	RNN4
	Other	RNN5
Q10	Prevent unwanted pregnancies	Referent
	Dog already neutered when acquired	RN1
	Instructed/advised by the source of dog	RN2
	Advised to neuter by a vet	RN3
	Male behavioural problems	RN4
	Inconvenience of season/heat	RN5
Q15	Source of dog- breeder	Referent
	Source of dog - private owner	S1
	Source of dog -animal welfare centre	S2
	Found as a stray	S3
	Received as a gift	S4
	Born in the respondent's home	S5
Q17	Everyone was responsible for decision	Referent
	Respondent alone was responsible for decision	RD1
	Another adult member was responsible for decision	RD2
	A child member was responsible for decision	RD3
	Most members were responsible for decision	RD4
Q18	Decision was carefully thought out and planned	Referent
	Decision was vaguely discussed	DP1
	Decision was not planned	DP2
Q19	Physical characteristics of the dog	Referent
	Behavioural characteristics of the dog	DF1
	The reputation of a particular breed	DF2
	The timing of this dog becoming available	DF3
	The dog was homeless/abandoned	DF4
	Other	DF5
Q21	Always fulfilled expectations	Referent
	Fulfilled expectations most of the time	FF1
	Occasionally/rarely fulfilled expectations	FF2
Q25	Dog spends time unconfined inside the home	Referent
	Dog spends time confined inside home	DST1
	Dog spends time in a garage/shed/dog kennel	DST2
	Dog spends time in garden or loose outside	DST3

TABLE 5-3: Continued.

QUESTION	VARIABLE CATEGORIES	DV CODE
Q27	Interact with dog for greater than 3 hours	Referent
	Interact with dog for 2 to 3 hours	DI1
	Interact with dog for 1 to less than 2 hours	DI2
	Interact with dog for less than 1 hour	DI3
Q32	Attends a vet more than twice a year	Referent
	Attends a vet twice a year	V1
	Attends a vet once a year	V2
	Attends a vet less than once a year	V3
	Never attended a vet	V4
Q33	Work involved in keeping dog was same as expected	Referent
	Work involved in keeping dog was less than expected	E1
	Work involved in keeping dog was more than expected	E2
	Work involved in keeping dog was much more than expected	E3
Q34	Strongly believe that dogs are family members	Referent
	Believe that dogs are family members	FM1
	Not sure/do not believe that dogs are family members	FM2
Q37	Owned house	Referent
	Owned flat	H1
	Rented house	H2
	Rented flat	H3
	Farm	H4
Q38	Lived in present home for 10 years or more	Referent
	Lived in present home for 5 years to less than 10 years	LTH1
	Lived in present home for 2 years to less than 5 years	LTH2
	Lived in present home for 1 year to less than 2 years	LTH3
	Lived in present home for less than 1 year	LTH4
Q40	Attend further education and obtained a formal qualification	Referent
	Attended further education but gained no qualifications	Q1
	Completed secondary school and gained 'H' grades	Q2
	Completed secondary school and gained 'O' grades	Q3
	Completed secondary school but gained no qualifications	Q4
Q41	Taxable income greater than £30,000	Referent
	Taxable income between £21,000 and £30,000	I1
	Taxable income between £11,000 and £20,000	I2
	Taxable income less than or equal to £10,000	I3
	Unemployed with no taxable income	I4
	Other	I5

TABLE 5-4: Statistics obtained from the univariable logistic regression model, using data available from 49 case households and 321 control households in Strathclyde Region, Scotland.

VARIABLE	COEFFICIENT	SE	WALDS	*P*-VALUE	OR	95% CI
Constant	-1.88	0.15	-12.27	<0.01	-	-
OP	0.61	0.31	1.96	0.05	1.85	1.00, 3.40
ODP	-1.37	0.73	-1.88	0.06	0.25	0.06, 1.06
SMP	1.79	0.37	4.83	<0.01	6.00	2.90, 12.42
PP	-1.52	0.32	-4.75	<0.01	0.22	0.12, 0.41
AGE	-0.05	0.01	-6.52	<0.01	0.95	0.94, 0.97
B	-2.94	0.48	-6.06	<0.01	0.05	0.02, 0.14
N	-0.35	0.32	-1.10	0.27	0.71	0.38, 1.31
AWN	-0.06	0.03	-2.13	0.03	0.994	0.89, 1.00
RLP	-	-	-	-	-	-
C	-0.01	0.003	-3.33	0.01	0.99	0.98, 1.00
BA	-0.88	0.36	-2.64	0.01	0.41	0.21, 0.80
ABA	-1.30	0.65	-2.00	0.04	0.27	0.08, 0.97
OT	-1.10	0.54	-2.05	0.04	0.33	0.12, 0.95
HPB	0.94	0.60	1.56	0.12	2.55	0.78, 8.33
G	-1.82	0.42	-4.34	<0.01	0.16	0.07, 0.37
RNN1	1.11	0.83	1.33	0.18	3.03	0.59, 15.55
RNN2	1.40	1.21	1.15	0.25	4.04	0.38, 43.51
RNN3	3.16	0.83	3.79	<0.01	23.58	4.61, 120.64
RNN4	3.03	0.70	4.36	<0.01	20.75	5.30, 81.21
RNN5	1.89	0.71	2.66	0.01	6.60	1.64, 26.52
RN1	0.96	0.87	1.11	0.27	2.62	0.47, 14.52
RN2	2.35	0.73	3.21	<0.01	10.50	2.50, 44.14
RN3	-0.83	1.07	-0.77	0.44	0.44	0.05, 3.57
RN4	-0.29	1.10	-0.26	0.79	0.75	0.09, 6.45
RN5	0.27	1.12	0.24	0.81	1.31	0.15, 11.86

TABLE 5-4: Continued.

VARIABLE	COEFFICIENT	SE	WALDS	*P*-VALUE	OR	95% CI
S1	2.25	0.61	3.69	<0.01	9.49	2.87, 31.39
S2	3.15	0.56	5.59	<0.01	23.25	7.71, 70.12
S3	3.14	0.79	3.97	<0.01	23.25	4.92, 109.76
S4	2.74	0.66	4.12	<0.01	15.50	4.21, 57.09
S5	1.44	1.16	1.24	0.21	4.23	0.44, 40.97
RD1	0.45	0.43	1.04	0.30	1.57	0.67, 3.67
RD2	0.93	0.51	1.83	0.07	2.54	0.94, 6.87
RD3	3.18	1.17	2.72	0.01	24.10	2.43, 239.42
RD4	-0.48	0.76	-0.63	0.53	0.62	0.14, 2.74
DP1	0.80	0.37	2.14	0.03	2.23	1.07, 4.64
DP2	1.53	0.38	3.97	<0.01	4.63	2.17, 9.85
DF1	-0.21	0.51	-0.41	0.68	0.81	0.30, 2.20
DF2	-2.51	1.02	-2.47	0.01	0.08	0.01, 0.59
DF3	-0.13	0.51	-0.26	0.79	0.87	0.32, 2.38
DF4	0.79	0.41	1.93	0.05	2.20	0.99, 4.91
DF5	0.15	0.68	0.22	0.82	1.16	0.30, 4.46
FF1	1.57	0.35	4.49	<0.01	4.80	2.42, 9.51
FF2	4.66	1.08	4.29	<0.01	105.60	12.58, 886.68
DST1	0.56	0.39	1.41	0.16	1.75	0.80, 3.79
DST2	0.70	1.13	0.62	0.54	2.01	0.22, 18.50
DST3	1.21	0.56	2.14	0.03	3.35	1.11, 10.10
DI1	-0.26	0.41	-0.63	0.53	0.77	0.35, 1.72
DI2	0.50	0.41	1.21	0.23	1.64	0.74, 3.67
DI3	0.96	0.48	1.99	0.05	2.62	1.01, 6.77
V1	0.61	0.73	0.85	0.40	1.85	0.45, 7.65
V2	0.31	0.70	0.44	0.66	1.36	0.34, 5.40
V3	1.24	0.65	1.91	0.06	3.45	0.96, 12.32
V4	4.28	0.77	5.52	<0.01	71.99	15.78, 328.34

TABLE 5-4: Continued.

VARIABLE	COEFFICIENT	SE	WALDS	*P*-VALUE	OR	95% CI
E1	-0.51	1.03	-0.50	0.62	0.60	0.08, 4.53
E2	2.48	0.39	6.39	<0.01	11.94	5.58, 25.37
E3	2.33	0.48	4.84	<0.01	10.24	3.99, 26.24
FM1	0.89	0.34	2.62	0.01	2.44	1.25, 4.76
FM2	2.47	0.56	4.39	<0.01	11.78	3.92, 35.41
H1	1.65	0.54	3.08	<0.01	5.22	1.82, 14.93
H2	2.04	0.44	4.67	<0.01	7.70	3.27, 18.14
H3	2.76	0.49	5.61	<0.01	15.81	6.02, 41.47
H4	2.45	0.78	3.13	<0.01	11.55	2.49, 52.56
LTH1	1.22	0.43	2.81	0.01	3.38	1.44, 7.91
LTH2	0.67	0.53	1.26	0.21	1.96	0.69, 5.54
LTH3	2.81	0.53	5.34	<0.01	16.64	5.93, 46.71
LTH4	2.59	0.57	4.57	<0.01	13.31	4.39, 40.37
Q1	2.33	0.57	4.06	<0.01	10.30	3.34, 31.73
Q2	0.93	0.57	1.62	0.10	2.53	0.82, 7.76
Q3	1.48	0.44	3.36	<0.01	4.38	1.85, 10.38
Q4	1.62	0.46	3.51	<0.01	5.09	2.05, 12.63
I1	2.12	1.07	1.98	0.05	8.34	1.02, 67.91
I2	2.77	1.02	2.70	0.01	15.91	2.14, 118.41
I3	3.43	1.07	3.20	<0.01	30.98	3.79, 253.31
I4	3.12	1.05	2.97	<0.01	22.72	2.89, 178.63
I5	0.16	1.41	0.11	0.92	1.17	0.07, 18.45

Note

Odds ratios and 95% confidence intervals are obtained by exponentiation of the regression coefficients.

For an explanation of variable coding see Table 5-2.

5.3.3 Multivariable logistic regression

Multivariable logistic regression analysis was run with the variables listed in Table 5-2, excluding RLP. With the univariable logistic regression stage referred to as step 0, during the model building procedure, a total of eight forward selection followed by backward elimination steps were performed, until the fitted model was reached. Table 5-5 displays the Stx output for this model, detailing the estimated coefficient and associated *P*-value, odds ratio and 95% confidence interval for each variable. Seven factors were retained in this multivariable model; a small mammal pet, age of the dog, breed of the dog, veterinary attendance, how households described the time and work involved in dog ownership, the length of time in the present home and presence of a garden. On reaching this stage, addition or removal of any of the remaining variables did not significantly improve the relative fit of this model. Using the data from the Stx output, this first model was as follows:

$$g(R) = -0.98 + 2.33(SMP) - 0.06(AGE) - 3.56(B) + \begin{Bmatrix} 2.78(V1) \\ 3.16(V2) \\ 3.91(V3) \\ 6.84(V4) \end{Bmatrix} + \begin{Bmatrix} 0.82(E1) \\ 2.83(E2) \\ 1.97(E3) \end{Bmatrix} + \begin{Bmatrix} 0.78(LTH1) \\ -2.34(LTH2) \\ 3.23(LTH3) \\ 2.36(LTH4) \end{Bmatrix} -3.14(G)$$

where g(R) represents the logit for the probability of relinquishment, SMP represents small mammal pet, B represents breed of dog, V represents veterinary attendance, E represents how households described the time and work involved in dog keeping, LTH represents the length of time in the present home and G represents presence of a garden.

The Hosmer-Lemeshow goodness-of-fit statistics for this model are presented in Table 5-6. Inspection of this table indicated that the model fitted the observed data well (Hosmer-Lemeshow statistic (C) 0.78, P=1.00 and (H) 4.98, P=0.76). In addition, this table highlighted that the model was fit to all 49 case households but only 318 of the control households. This reflected that some of the information pertaining to the seven risk factors was unavailable for three control households.

TABLE 5-5: Results of fitting a multivariable logistic regression model to data available from 49 case households and 318 control households in Strathclyde Region Scotland, detailing the parameters that best describe the risk factors for canine relinquishment.

VARIABLE	COEFFICIENT	SE	WALD	*P*-VALUE	OR	95% CI
Constant	-0.98	1.82	-0.54	0.59	-	-
SMP	2.33	0.88	2.66	0.01	10.30	1.85, 57.49
AGE	-0.06	0.01	-3.81	<0.01	0.95	0.92, 0.97
B	-3.56	0.91	-3.92	<0.01	0.03	0.00, 0.17
V1	2.78	1.81	1.54	0.12	16.21	0.46, 566.47
V2	3.16	1.87	1.69	0.09	23.66	0.60, 926.03
V3	3.91	1.88	2.07	0.04	49.90	1.24, 2004.93
V4	6.84	2.11	3.25	<0.01	939.92	15.16, 58270.74
E1	0.82	1.40	0.58	0.56	2.26	0.14, 35.26
E2	2.83	0.87	3.24	<0.01	16.94	3.06, 93.70
E3	1.97	1.16	1.70	0.09	7.19	0.74, 78.08
LTH1	0.78	0.79	0.99	0.32	2.18	0.46, 10.23
LTH2	-2.34	1.29	-1.81	0.07	0.10	0.01, 1.21
LTH3	3.23	1.33	2.42	0.02	25.28	1.85, 345.07
LTH4	2.36	1.11	2.13	0.03	10.57	1.21, 92.69
G	-3.14	1.05	-2.99	<0.01	0.04	0.01, 0.34
Deviance	75.29					
P-value	1.00					
DF	351					

TABLE 5-6: Hosmer-Lemeshow goodness-of-fit statistics for the first multivariable logistic regression model, fitted to data available from 49 case households and 318 control households in Strathclyde Region, Scotland.

		DECILE OF RISK										
		1	2	3	4	5	6	7	8	9	10	
Status		0.00	0.00	0.00	0.00	0.0	0.0	0.02	0.11	0.68	1.00	Total
1	Obs	0	0	0	0	0	0	0	1	13	35	49
	Exp	0.0	0.0	0.0	0.0	0.0	0.1	0.2	1.6	13.1	34.1	49
2	Obs	37	36	38	36	37	36	37	36	23	2	318
	Exp	37.0	36.0	38.0	36.0	37.0	35.9	36.8	35.4	22.9	2.9	318
	Total	37	36	38	36	37	36	37	37	36	37	367

Hosmer-Lemeshow Statistic (C)	0.78
P-value	1.00
Degrees of freedom	8

		FIXED CUT POINTS										
Status		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	Total
1	Obs	2	1	0	5	3	2	4	3	3	26	49
	Exp	1.9	0.9	0.8	4.5	2.3	2.6	3.9	2.3	2.6	27.2	49
2	Obs	293	5	3	8	2	3	2	0	0	2	318
	Exp	293.1	5.1	2.2	8.5	2.7	2.4	2.1	0.7	0.4	0.8	318
	Total	295	6	3	13	5	5	6	3	3	28	367

Hosmer-Lemeshow Statistic (H)	4.98
P-value	0.76
Degrees of freedom	8

Key

Status 1=case, 2=control
Obs observed cell frequency
Exp expected cell frequency

The aim of this study was to identify risk factors that could assess future relinquishment of a pet dog to an animal welfare centre. In view of this, a second model building procedure was run after elimination of the 'expectations' variable. This variable asked households to describe how the time and work involved in keeping their dog compared with what they had expected. Such a variable could not be measured at the onset of dog ownership and therefore, could not be used to assess future relinquishment.

During this second model building procedure, a total of seven forward selection followed by backward elimination steps were performed until the final model was reached. Table 5-7 displays the Stx output for this second model. Again it was found that a total of seven variables were retained in the second model; a small mammal pet, previous pet ownership, age of the dog, breed of the dog, veterinary attendance, the length of time in the present home and presence of a garden. Although the likelihood ratio test for addition of the variable 'source' at step eight (P=0.04) marginally conformed to the statistical criteria for variable addition, this variable made the model extremely unstable and consequently, was not included. Addition or removal of any of the remaining variables did not influence the relative fit of this final model. Using the data from the Stx output, model two was as follows:

$$g(R) = 2.78 + 2.10(SMP) - 1.86(PP) - 0.05(AGE) - 3.11(B) + \begin{Bmatrix} 0.92(V1) \\ 0.72(V2) \\ 1.48(V3) \\ 5.80(V4) \end{Bmatrix} + \begin{Bmatrix} 1.26(LTH1) \\ -1.87(LTH2) \\ 2.29(LTH3) \\ 2.38(LTH4) \end{Bmatrix} - 3.26\,(G)$$

where g (R) represents the logit for the probability of relinquishment, SMP represents small mammal pet, PP represents previous pet ownership, B represents breed of dog, V represents veterinary attendance, LTH represents the length of time in the present home and G represents presence of a garden. There was evidence that age was linear in the logit.

Table 5-8 presents the Hosmer-Lemeshow goodness-of-fit statistics for this model. Chi-square analysis of the observed versus the expected number of cases and controls

TABLE 5-7: Second multivariable logistic regression model, fitted to data available from 49 case households and 315 control households in Strathclyde Region Scotland, detailing the parameters that best describe the risk factors for canine relinquishment.

VARIABLE	COEFFICIENT	SE	WALD	*P*-VALUE	OR	95% CI
Constant	2.78	1.66	1.67	0.09	-	-
SMP	2.10	0.81	2.58	0.01	8.15	1.65, 40.17
PP	-1.86	0.66	-2.81	<0.01	0.16	0.04, 0.57
AGE	-0.05	0.01	-4.01	<0.01	0.95	0.93, 0.98
B	-3.11	0.81	-3.87	<0.01	0.04	0.01, 0.22
V1	0.92	1.44	0.64	0.52	2.51	0.15, 42.13
V2	0.72	1.36	0.53	0.60	2.05	0.14, 29.23
V3	1.48	1.38	1.08	0.28	4.41	0.30, 65.47
V4	5.80	1.64	3.54	<0.01	329.80	13.32, 8163.03
LTH1	1.26	0.74	1.71	0.09	3.54	0.83, 15.19
LTH2	-1.87	1.24	-1.51	0.13	0.15	0.01, 1.76
LTH3	2.29	1.14	2.01	0.04	9.84	1.05, 91.91
LTH4	2.38	1.14	2.09	0.04	10.76	1.16, 99.92
G	-3.26	1.05	-3.10	<0.01	0.04	0.00, 0.30
Deviance	80.84					
P-value	1.00					
DF	350					

TABLE 5-8: Hosmer-Lemeshow goodness-of-fit statistics for the second multivariable logistic regression model, fitted to data available from 49 case households and 315 control households in Strathclyde Region, Scotland.

		DECILE OF RISK										
		1	2	3	4	5	6	7	8	9	10	
Status		0.00	0.00	0.00	0.00	0.0	0.0	0.02	0.11	0.68	1.00	Total
1	Obs	0	0	0	0	0	0	0	2	15	32	49
	Exp	0.0	0.0	0.0	0.0	0.0	0.1	0.3	1.9	13.5	33.1	49
2	Obs	36	37	36	37	36	36	37	34	22	4	315
	Exp	36.0	37.0	36.0	37.0	36.0	35.9	36.7	34.1	23.5	2.9	315
	Total	36	37	36	37	36	36	37	36	37	36	364

Hosmer-Lemeshow Statistic (C)	1.17
P-value	1.00
Degrees of freedom	8

		FIXED CUT POINTS										
Status		0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0	Total
1	Obs	1	3	3	2	2	2	4	5	2	25	49
	Exp	1.9	1.8	2.3	1.7	2.2	2.1	3.9	5.3	2.6	25.2	49
2	Obs	285	10	6	3	3	2	2	2	1	1	315
	Exp	284.1	11.2	6.7	3.3	2.8	1.9	2.1	1.7	0.4	0.8	315
	Total	286	13	9	5	5	4	6	7	3	26	364

Hosmer-Lemeshow Statistic (H)	2.68
P-value	0.95
Degrees of freedom	8

Key

Status 1=case, 2=control
Obs observed cell frequency
Exp expected cell frequency

achieved at different grouping levels indicated that the model fitted the observed data very well (Hosmer-Lemeshow statistic (C) 1.17, P=1.0, Hosmer-Lemeshow statistic (H) 2.68, P=0.95). This table also highlighted that the model was fit to all 49 case households but only 315 of the control households, as six of this latter group had missing information pertaining to the seven risk factors. Examination of scatter plots of specific regression diagnostics to further assess the fit of the model, highlighted several households with ill-fitting or influential covariate patterns (Figures 5-2, 5-3 and 5-4). With covariates ordered according to the magnitude of the influence diagnostic, ten covariate patterns with the highest values were selected. Individual removal of data for each of these covariate patterns resulted in a wide range of changes in the individual coefficients from the full data set, some of which were greater than 20% (Table 5-9). In particular, the categorical variable 'veterinary care' which encompassed four levels, showed the greatest per cent change in variable coefficient. The odds ratio and 95% confidence intervals associated with levels of this categorical variable were also noticeably high, suggesting a degree of instability in the model. Consequently, this variable was collapsed into a dichotomous variable: receives veterinary care less than once a year or receives veterinary care once a year or more. Routine prophylactic veterinary care usually entails annual physical examination and vaccination. Transformation of the variable 'veterinary care' as outline above was, therefore, considered to appropriately represent the biological significance of this variable and was the prime interest of the author.

Table 5-10 displays the Stx output for the final model with veterinary care collapsed into a dichotomous variable. The final model two was as follows:

$$g(R) = 2.03 + 1.75(SMP) - 1.19(PP) - 0.04(AGE) - 2.70(B) + 1.84(VC) + \begin{Bmatrix} 1.28\,(LTH1) \\ -0.69\,(LTH2) \\ 2.04\,(LTH3) \\ 2.39\,(LTH4) \end{Bmatrix} - 2.20(G)$$

where g (R) is the logit for the probability of relinquishment, SMP represents small mammal pet, PP represents previous pet ownership, B represents breed of dog, VC represents veterinary care, LTH represents the length of time in the home and G is presence of a garden. There was evidence that age was linear in this logit.

FIGURE 5-2: Scatter plot of the regression diagnostic for the second multivariable logistic regression model, fitted to data available from 49 case households and 315 control households in Strathclyde Region, Scotland-1.

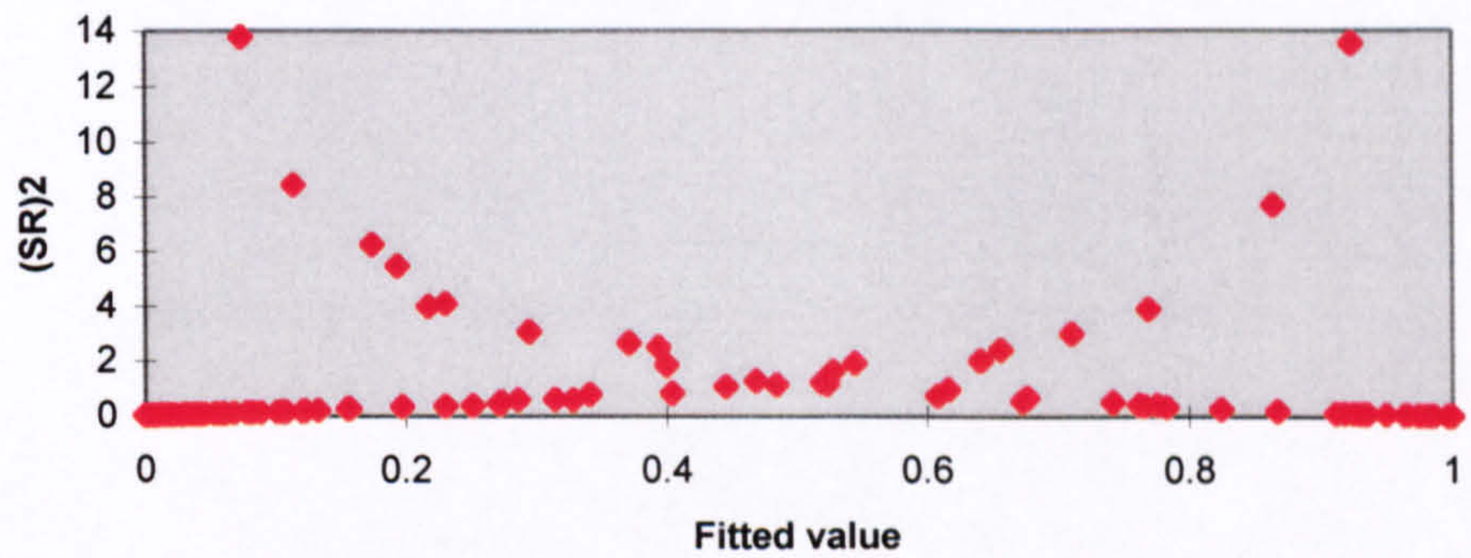


FIGURE 5-3: Scatter plot of the regression diagnostic for the second multivariable logistic regression model, fitted to data available from 49 case households and 315 control households in Strathclyde Region, Scotland-2.

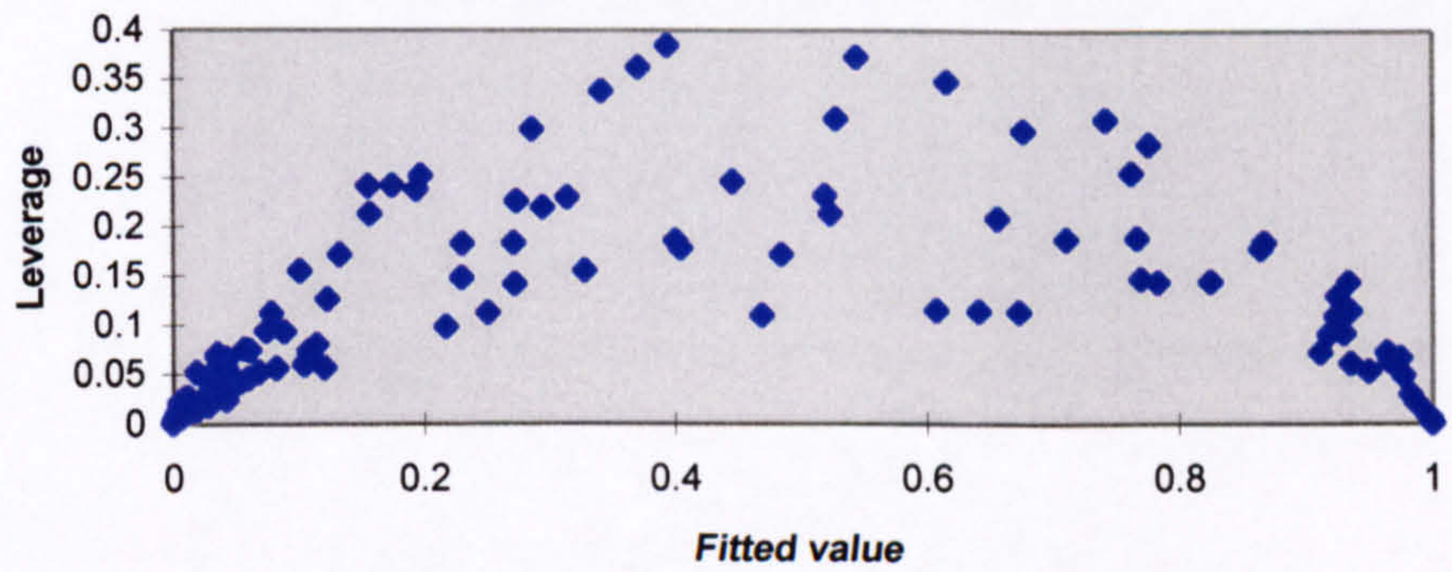
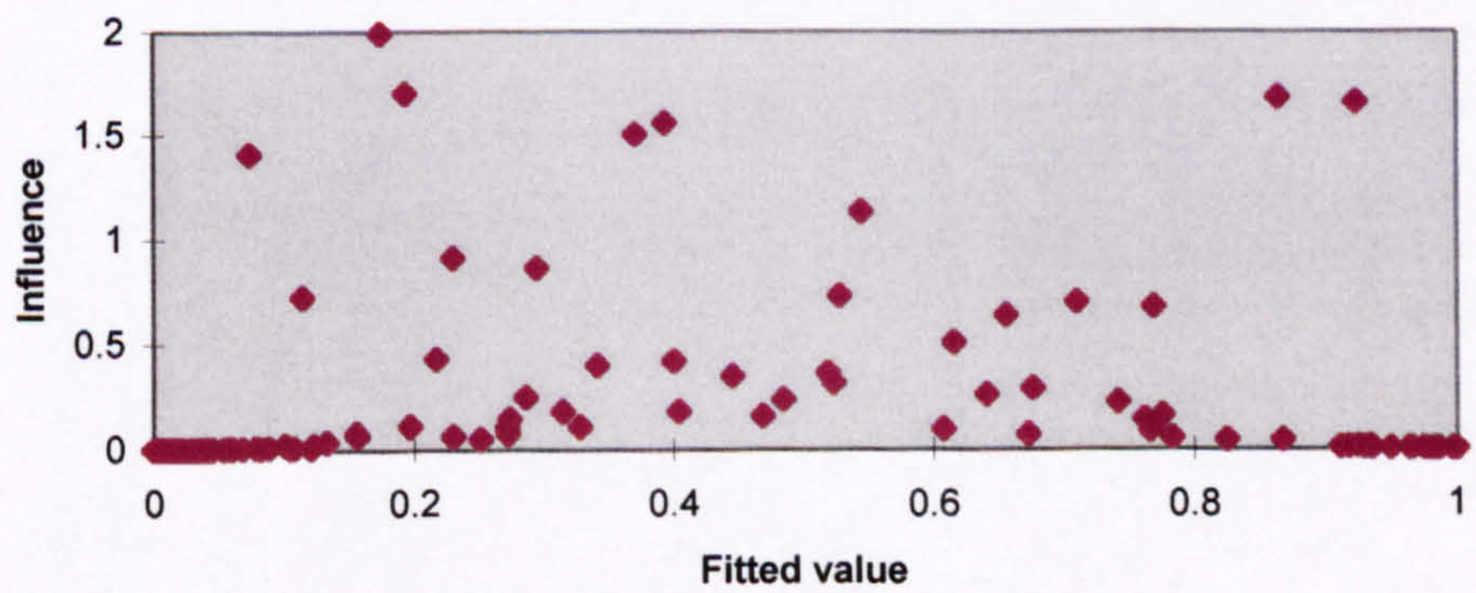


FIGURE 5-4: Scatter plot of the regression diagnostic for the second multivariable logistic regression model, fitted to data available from 49 case households and 315 control households in Strathclyde Region, Scotland-3.



Key

Fitted value	predicted probability
(SR)2	square of the standardised residuals

TABLE 5-9: Percentage change in estimated coefficients, obtained after deleting selected covariate patterns from the second multivariable logistic regression model, fitted to data available from 49 case households and 315 control households in Strathclyde Region, Scotland.

	% CHANGE IN COEFFICIENT									
VARIABLE	**DROP 521**	**DROP 509**	**DROP 74**	**DROP 240**	**DROP 807**	**DROP 809**	**DROP 811**	**DROP 258**	**DROP 805**	**DROP 710**
Constant	10.90	4.45	9.25	27.37	36.69	13.56	29.25	11.04	10.46	19.10
SMP	6.14	10.67	18.21	2.21	6.13	12.75	1.28	13.21	5.43	18.77
PP	9.38	11.32	6.57	23.16	10.44	8.76	13.47	9.20	2.73	9.24
AGE	7.05	6.67	3.94	9.80	1.66	8.09	7.75	0.36	7.80	6.67
B	20.68	15.50	4.88	12.05	4.47	4.12	8.74	6.04	9.93	1.40
G	22.18	5.44	2.74	9.08	8.50	3.41	21.45	1.52	3.29	4.48
V1	116.06	18.36	16.48	20.77	126.93	7.06	8.73	33.16	5.05	60.88
V2	61.98	22.18	16.88	27.87	164.26	38.88	27.86	58.43	7.71	3.88
V3	32.11	9.35	4.61	14.32	80.86	3.44	3.17	23.11	3.17	10.06
V4	5.33	5.96	14.23	3.06	22.48	0.10	10.18	4.91	5.89	0.98
LTH1	32.15	0.11	0.66	9.88	15.24	6.98	17.04	3.62	17.64	5.86
LTH2	25.45	22.49	44.94	0.65	10.28	10.26	58.95	1.22	5.00	3.07
LTH3	10.69	5.56	5.44	1.12	30.57	3.26	5.94	20.20	0.58	0.53
LTH4	23.23	40.97	1.78	50.27	8.39	34.50	12.97	1.39	3.08	8.87
Average	27.38	12.79	10.76	15.11	37.64	11.08	16.20	13.39	6.27	10.98
Median	21.43	10.01	6.00	10.96	12.84	7.58	11.58	7.62	5.24	6.26
Sd	29.64	10.58	11.50	13.77	50.56	11.52	14.93	16.19	4.32	15.51

TABLE 5-10: Final multivariable logistic regression model, fitted to data available from 49 case households and 315 control households in Strathclyde Region Scotland, detailing the parameters that best describe the risk factors for canine relinquishment.

VARIABLE	COEFFICIENT	SE	WALD	*P*-VALUE	OR	95% CI
Constant	2.03	1.05	1.94	0.05	-	-
SMP	1.75	0.65	2.71	0.01	5.73	1.62, 20.30
PP	-1.19	0.54	-2.19	0.03	0.30	0.10, 0.88
AGE	-0.04	0.01	-4.80	0.00	0.96	0.94, 0.97
B	-2.70	0.65	-4.12	0.00	0.07	0.02, 0.24
G	-2.20	0.84	-2.62	0.01	0.11	0.02, 0.57
VC	1.84	0.57	3.25	0.00	6.32	2.08, 19.23
LTH1	1.28	0.65	1.96	0.05	3.60	1.00, 12.94
LTH2	-0.69	0.85	-0.82	0.41	0.50	0.10, 2.63
LTH3	2.04	0.97	2.10	0.04	7.69	1.14, 51.81
LTH4	2.39	0.92	2.59	0.01	10.89	1.79, 66.29
Deviance	103.41					
P-value	1.0					
DF	353					

Table 5-11 presents the Hosmer-Lemeshow goodness-of-fit statistics for this final model which indicated that the model fitted the observed data well (Hosmer-Lemeshow statistic (C) 0.54, P=1.0, Hosmer-Lemeshow statistic (H) 9.76, P=0.28). Examination of scatter plots of specific regression diagnostics highlighted several households with ill-fitting or influential covariate patterns (Figures 5-5, 5-6 and 5-7). Individual removal of data for the ten covariate patterns identified as influential, resulted in per cent changes in the estimated coefficients as outlined in Table 5-12. As can be seen, the majority of coefficient changes of the retained variables were less than 20%, confirming a good fit.

A third multivariable logistic regression analysis was run with 196 randomly selected control households and 49 case households. During this model building procedure, a total of seven forward selection followed by backward elimination steps were performed until the fitted model was attained. Table 5-13 displays the Stx output for this model, detailing the estimated coefficient and associated P-value, odds ratio and 95% confidence interval for each variable. Seven factors were retained in this multivariable model, identical to those retained in the previous two models. Addition or removal of any of the remaining variables did not significantly improve the relative fit of this model. Using the data from the Stx output the third model was as follows:

$$g(R) = 3.33 + 2.28(SMP) - 1.88(PP) - 0.05(AGE) - 2.97(B) + \begin{Bmatrix} 0.79(V1) \\ 0.21(V2) \\ 1.04(V3) \\ 5.54(V4) \end{Bmatrix} + \begin{Bmatrix} 1.08(LTH1) \\ -2.24(LTH2) \\ 2.22(LTH3) \\ 2.70(LTH4) \end{Bmatrix} - 2.85(G)$$

where g(R) represents the logit for the probability of relinquishment, SMP represents small mammal pet, PP represents previous pet ownership, B represents breed of dog, V represents veterinary attendance, LTH represents the length of time in the present home and G represents presence of a garden. There was evidence that age was linear in this logit.

The Hosmer-Lemeshow goodness-of-fit statistics for this model are presented in Table 5-14. Inspection of this table indicated that the model fitted the observed data well

TABLE 5-11: Hosmer-Lemeshow goodness-of-fit-statistics for the final multivariable logistic regression model, fitted to data available from 49 case households and 315 control households in Strathclyde Region Scotland.

		DECILE OF RISK										
		1	2	3	4	5	6	7	8	9	10	
Status		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.04**	**0.16**	**0.58**	**1.00**	**Total**
1	Obs	0	0	0	0	0	0	1	3	14	31	49.0
	Exp	0.0	0.0	0.0	0.1	0.1	0.3	0.8	3.1	13.4	31.2	49.0
2	Obs	36	38	34	39	35	36	36	34	22	5	315
	Exp	36.0	38.0	34.0	38.9	34.9	35.7	36.2	33.9	22.6	4.8	315.0
	Total	36	38	34	39	35	36	37	37	36	36	364

Hosmer-Lemeshow Statistic (C)	0.54
P-value	1.0
Degrees of freedom	8

		FIXED CUT POINTS										
Status		**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**	**1.0**	**Total**
1	Obs	2	2	4	4	3	3	4	5	3	19	49
	Exp	3.1	1.9	1.9	3.1	4.0	3.8	2.7	6.8	3.4	18.3	49.0
2	Obs	280	11	4	5	6	4	0	4	1	0	315
	Exp	278.9	11.1	6.1	5.9	5	3.2	1.3	2.2	0.6	0.7	315
	Total	282	13	8	9	9	7	4	9	4	19	364

Hosmer-Lemeshow Statistic (H)	9.76
P-value	0.28
Degrees of freedom	8

Key

Status 1=case, 2=control
Obs observed cell frequency
Exp expected cell frequency

FIGURE 5-5: Scatter plot of the regression diagnostic for the final multivariable logistic regression model, fitted to data available from 49 case households and 315 control households in Strathclyde Region, Scotland-1.

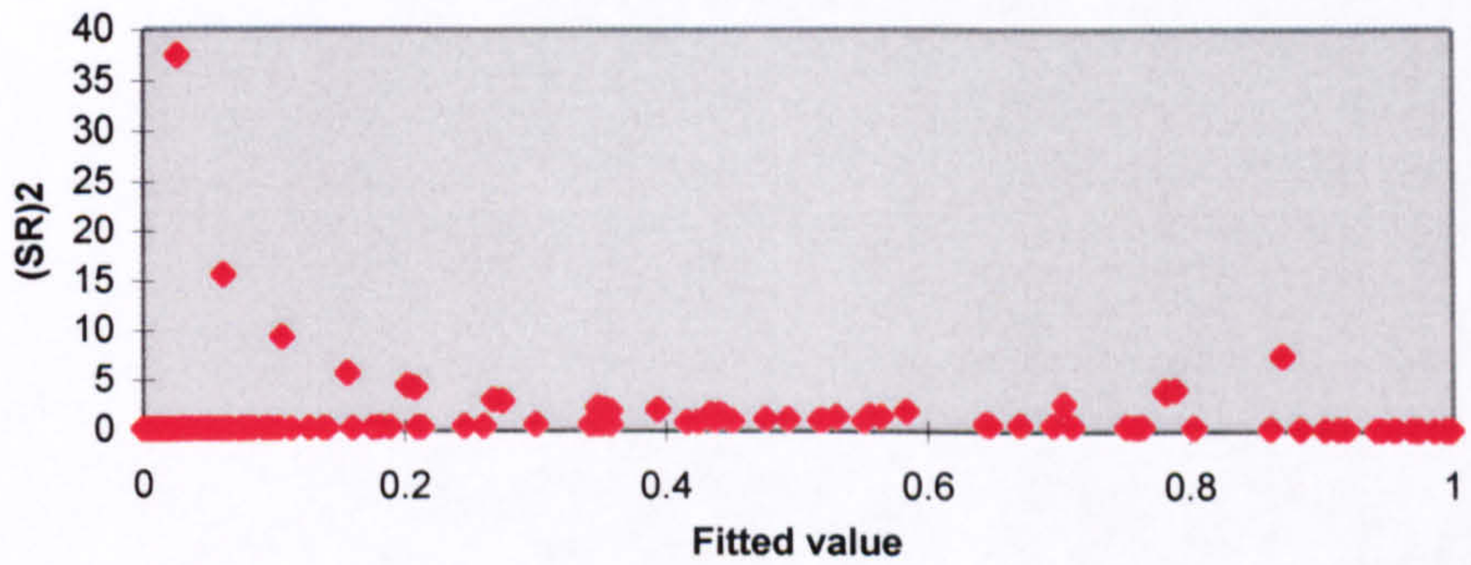


FIGURE 5-6: Scatter plot of the regression diagnostic for the final multivariable logistic regression model, fitted to data available from 49 case households and 315 control households in Strathclyde Region, Scotland-2.

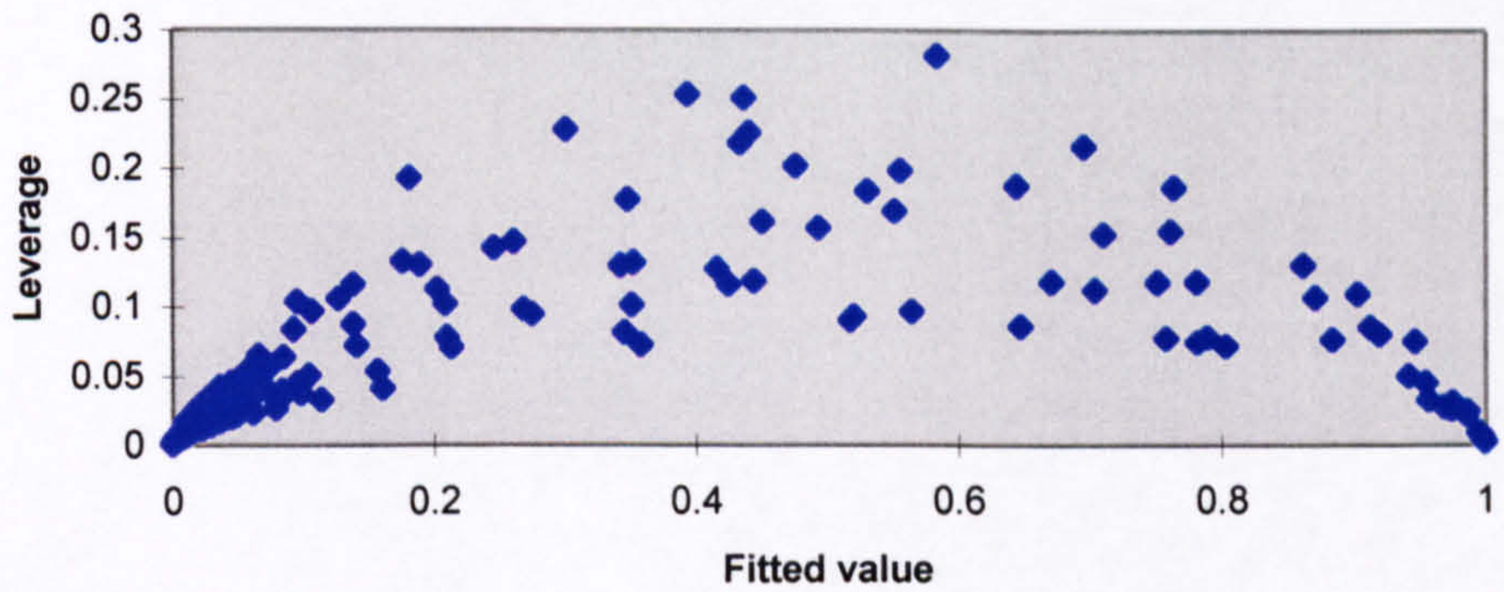
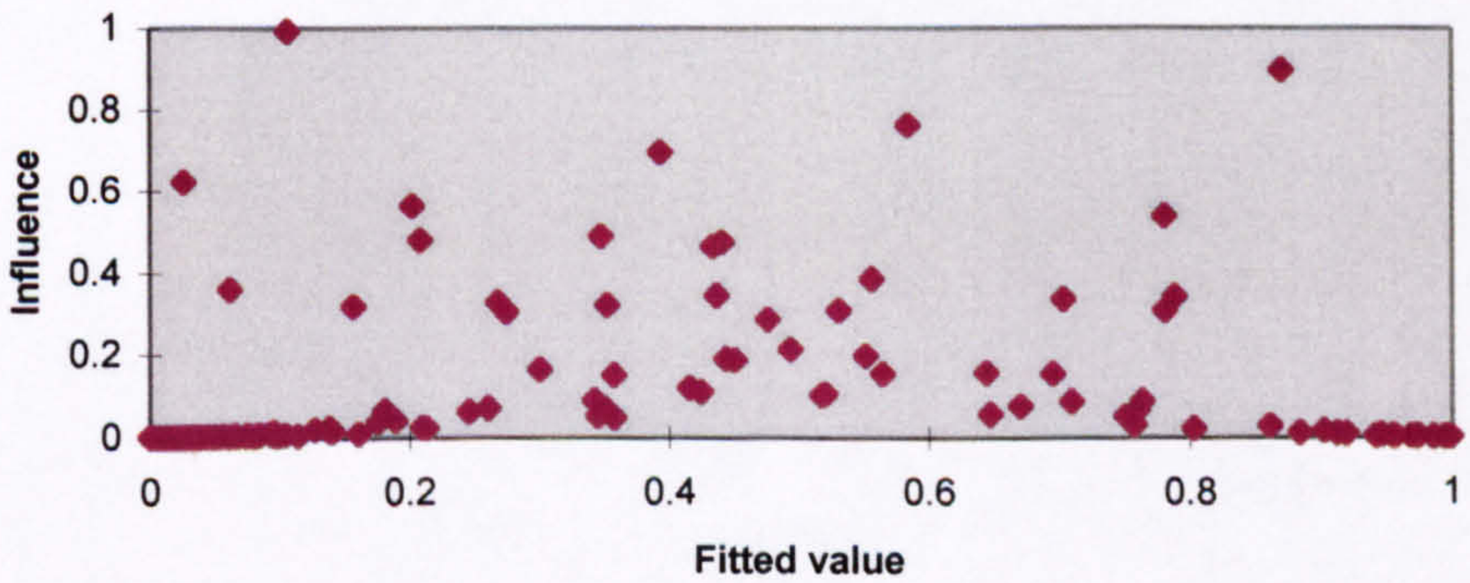


FIGURE 5-7: Scatter plot of the regression diagnostic for the final multivariable logistic regression model, fitted to data available from 49 case households and 315 control households in Strathclyde Region, Scotland-3.



Key:

Fitted value	predicted probability
(SR)2	square of the standardised residuals

TABLE 5-12: Percentage change in estimated coefficients, obtained after deleting selected covariate patterns from the final multivariable logistic regression model, fitted to data available from 49 case households and 315 control households in Strathclyde Region, Scotland.

	% CHANGE IN COEFFICIENT									
VARIABLE	**DROP 521**	**DROP 240**	**DROP 258**	**DROP 809**	**DROP 805**	**DROP 811**	**DROP 310**	**DROP 520**	**DROP 522**	**DROP 509**
Constant	34.16	18.83	0.70	7.95	19.93	6.90	5.02	6.74	6.95	0.67
SMP	4.13	5.39	14.65	11.18	6.82	6.34	13.97	1.77	3.33	2.26
PP	7.50	18.38	9.76	7.16	9.94	7.27	4.94	5.95	8.17	12.39
AGE	4.54	4.58	1.77	6.02	6.29	1.64	4.38	0.85	3.75	1.71
B	12.79	9.60	6.31	4.22	14.54	0.51	2.02	6.37	10.24	6.11
G	22.11	2.91	0.67	2.95	7.82	8.44	1.00	1.14	2.28	0.06
VC	7.34	6.33	1.07	4.64	4.20	9.65	7.93	5.86	6.41	5.20
LTH1	17.19	3.71	3.70	4.06	13.90	5.50	0.06	0.07	14.24	0.73
LTH2	32.45	3.55	8.14	5.93	13.31	54.69	37.68	0.21	0.48	7.61
LTH3	15.94	1.20	23.38	1.07	1.10	3.49	2.56	0.28	1.34	0.51
LTH4	13.71	28.37	2.90	19.63	5.82	2.91	0.16	17.05	4.68	16.55
Average	15.62	9.35	6.64	6.80	9.42	9.76	7.25	4.21	5.62	4.89
Median	13.71	5.39	3.70	5.93	7.82	6.34	4.38	1.77	4.68	2.26
Sd	10.36	8.68	7.10	5.03	5.48	15.17	10.87	5.07	4.13	5.44

TABLE 5-13: First multivariable logistic regression model, fitted to data available from 49 case households and 193 control households in Strathclyde Region Scotland, detailing the parameters that best describe the risk factors for canine relinquishment.

VARIABLE	COEFFICIENT	SE	WALD	*P*-VALUE	OR	95% CI
Constant	3.33	1.77	1.88	0.06	-	-
SMP	2.28	0.96	2.38	0.02	9.74	1.49, 63.76
PP	-1.88	0.76	-2.48	0.01	0.15	0.03, 0.67
AGE	-0.05	0.01	-3.73	0.00	0.95	0.93, 0.98
B	-2.97	0.91	-3.27	0.00	0.05	0.01, 0.30
G	-2.85	1.09	-2.62	0.01	0.06	0.01, 0.49
V1	0.79	1.51	0.53	0.60	2.21	0.11, 42.68
V2	0.21	1.46	0.14	0.89	1.23	0.07, 21.61
V3	1.04	1.49	0.70	0.48	2.83	0.15, 52.26
V4	5.54	1.80	3.08	0.00	254.62	7.54, 8603.43
LTH1	1.08	0.80	1.35	0.18	2.95	0.62, 14.11
LTH2	-2.24	1.37	-1.64	0.10	0.11	0.01, 1.56
LTH3	2.22	1.25	1.78	0.08	9.22	0.80, 106.31
LTH4	2.70	1.38	1.96	0.05	14.85	1.00, 220.23
Deviance	65.64					
P-value	1.0					
DF	228					

TABLE 5-14: Hosmer-Lemeshow goodness-of-fit statistics for the first multivariable logistic regression model, fitted to data available from 49 case households and 193 control households in Strathclyde Region Scotland.

		DECILE OF RISK										
		1	2	3	4	5	6	7	8	9	10	
Status		**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.02**	**0.08**	**0.56**	**0.95**	**1.00**	**Total**
1	Obs	0	0	0	0	0	0	0	7	19	23	49
	Exp	0.0	0.0	0.0	0.0	0.1	0.2	1.0	6.0	18.1	23.6	49.0
2	Obs	24	24	25	24	24	24	24	18	5	1	193
	Exp	24.0	24.0	25.0	24.0	23.9	23.8	23.0	19.0	5.9	0.4	193.0
	Total	24	24	25	24	24	24	24	25	24	24	242

Hosmer-Lemeshow Statistic (C)	2.86
P-value	0.94
Degrees of freedom	8

		FIXED CUT POINTS										
Status		**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**	**1.0**	**Total**
1	Obs	1	1	1	3	1	4	3	3	6	26	49
	Exp	1.7	1.2	1	2.4	0.4	3.4	2.6	3.8	5.1	27.3	49
2	Obs	172	7	3	4	0	2	1	2	0	2	193
	Exp	171.3	6.8	3	4.6	0.6	2.6	1.4	1.2	0.9	0.7	193
	Total	173	8	4	7	1	6	4	5	6	28	242

Hosmer-Lemeshow Statistic (H)	6.60
P-value	0.58
Degrees of freedom	8

Key

Status 1=case, 2=control
Obs observed cell frequency
Exp expected cell frequency

(Hosmer-Lemeshow statistic (C) 2.86, P=0.94 and (H) 6.60, P=0.58). This table also highlighted that the model was fit to all 49 case households but only 193 of the control households. This was because some of the information pertaining to the seven risk factors was unavailable for three control households. Examination of scatter plots of specific regression diagnostics revealed several households with ill-fitting or influential covariate patterns (Figures 5-8, 5-9 and 5-10). Individual removal of data for the ten covariate patterns with the highest value for the influence diagnostic resulted in significant changes in the estimated coefficients from the full data set, many of which were greater than 20% (Table 5-15). Again, these large per cent changes were predominantly associated with the categorical variable 'veterinary care'. Therefore, this variable was again collapsed into a dichotomous variable as outlined above. Table 5-16 displays the Stx output for the model with 'veterinary care' collapsed into a dichotomous variable. Using the data from the Stx output, the final third model was as follows:

$$g(R) = 2.37 + 1.90(SMP) - 1.18(PP) - 0.05(AGE) - 2.45(B) + 1.83(VC) + \begin{Bmatrix} 1.12(LTH1) \\ -1.03(LTH2) \\ 1.99(LTH3) \\ 2.56(LTH4) \end{Bmatrix} - 1.86(G)$$

where g (R) represents the logit for the probability of relinquishment, SMP represents small mammal pet, PP represents previous pet ownership, B represents breed of dog, VC represents veterinary care, LTH represents the length of time in the present home and G represents presence of a garden. There was evidence that age was linear in this logit.

Table 5-17 presents the Hosmer-Lemeshow goodness-of-fit statistics for this model. Chi-square analysis of the observed versus the expected number of cases and controls achieved at different grouping levels indicated that the model fitted the observed data well (Hosmer-Lemeshow statistic (C) 3.13, P=0.93, Hosmer-Lemeshow statistic (H) 6.98, P=0.54). Examination of scatter plots of specific regression diagnostics to further assess the fit of this model exhibited several households with ill-fitting or influential covariate patterns (Figures 5-11, 5-12 and 5-13). Individual removal of data for the ten covariate patterns identified as influential, resulted in per cent changes in the estimated coefficients as outlined in Table 5-18. The majority of individual coefficient changes of the retained variables were less than 20%, confirming a good fit.

FIGURE 5-8: Scatter plot of the regression diagnostic for the first multivariable logistic regression model, fitted to data available from 49 case households and 193 control households in Strathclyde Region, Scotland-1.

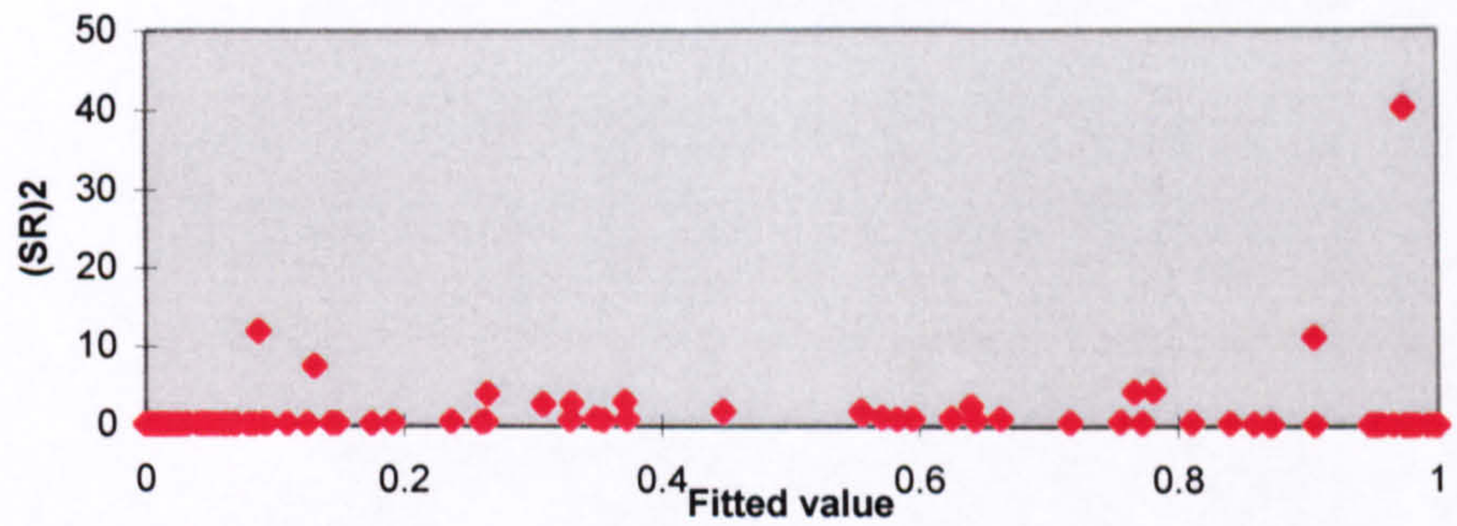


FIGURE 5-9: Scatter plot of the regression diagnostic for the first multivariable logistic regression model, fitted to data available from 49 case households and 193 control households in Strathclyde Region, Scotland-2.

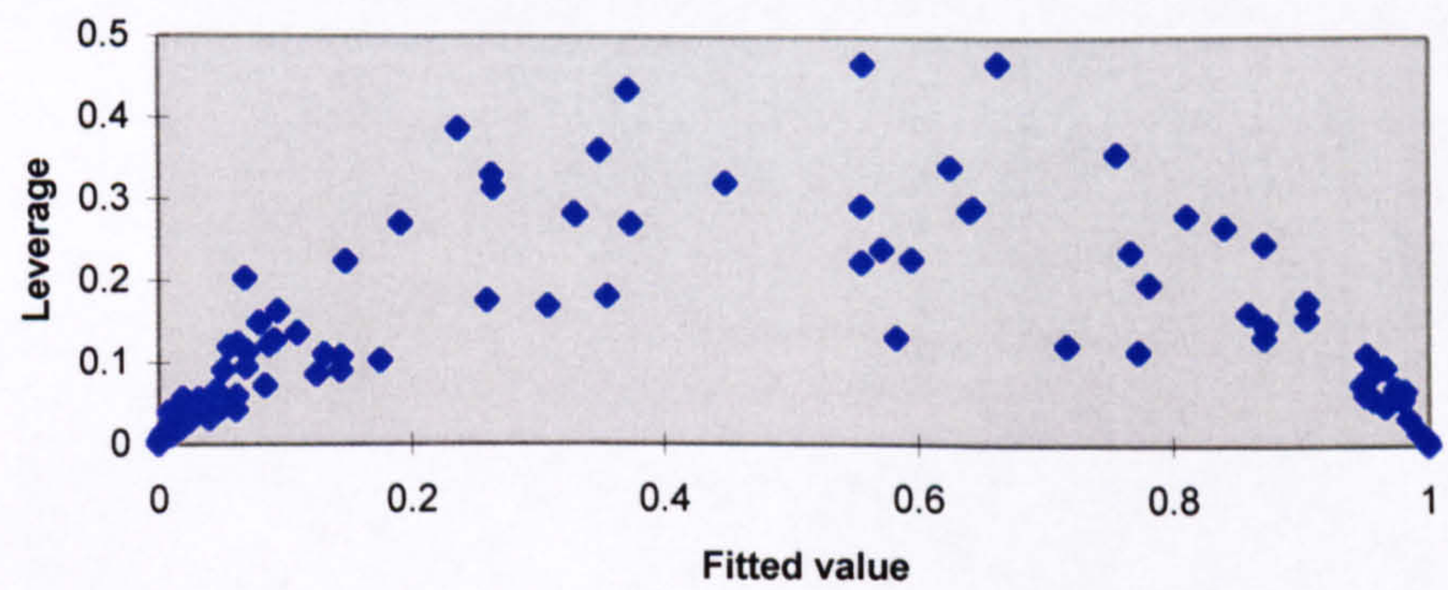
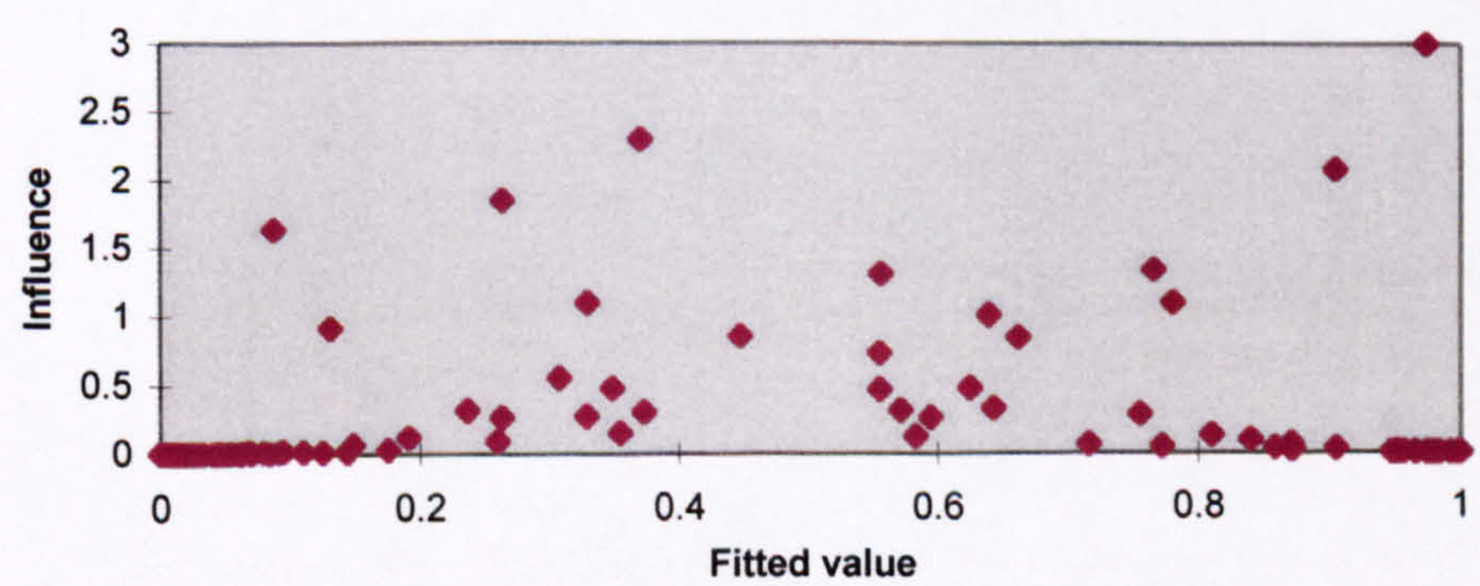


FIGURE 5-10: Scatter plot of the regression diagnostic for the first multivariable logistic regression model, fitted to data available from 49 case households and 193 control households in Strathclyde Region, Scotland-3.



Key:

Fitted value	predicted probability
(SR)2	square of the standardised residuals

TABLE 5-15: Percentage change in estimated coefficients, obtained after deleting selected covariate patterns from the first multivariable logistic regression model, fitted to data available from 49 case households and 193 control households in Strathclyde Region, Scotland.

	% CHANGE IN COEFFICIENT									
VARIABLE	**DROP 240**	**DROP 509**	**DROP 74**	**DROP 521**	**DROP 811**	**DROP 262**	**DROP 809**	**DROP 805**	**DROP 177**	**DROP 29**
Constant	31.26	3.46	2.16	6.85	28.21	7.89	9.57	10.04	0.58	2.00
SMP	7.64	7.08	19.54	6.38	1.48	35.48	11.49	1.50	25.44	7.74
PP	25.41	13.62	12.15	8.99	12.83	21.53	7.98	0.89	5.92	2.89
AGE	20.80	3.53	3.51	7.19	10.87	3.61	4.87	8.81	12.63	7.60
B	31.07	15.67	5.89	19.10	14.23	0.32	4.63	12.27	6.06	8.28
G	15.83	3.46	2.33	23.44	28.85	5.74	2.00	3.32	6.05	1.41
V1	88.24	0.99	6.87	132.02	3.80	21.55	9.97	6.88	12.03	27.40
V2	132.57	51.84	128.35	218.04	93.29	267.11	127.23	0.47	251.78	143.43
V3	12.93	24.00	6.19	48.68	13.98	21.38	6.95	4.83	22.24	27.25
V4	11.29	3.95	20.47	5.54	15.01	10.37	1.60	8.42	7.68	19.70
LTH1	22.39	0.08	3.24	30.72	17.71	28.59	6.88	23.61	26.41	24.27
LTH2	1.56	18.30	43.15	21.27	59.60	32.43	10.06	3.59	29.18	22.01
LTH3	9.06	1.04	10.09	11.37	8.23	0.80	3.00	0.57	7.21	2.81
LTH4	84.26	49.80	3.95	13.09	19.27	16.66	36.87	6.56	2.77	9.69
Average	35.31	14.06	19.14	39.48	23.38	33.82	17.36	6.55	29.71	21.89
Median	21.59	5.51	6.53	16.09	14.62	19.02	7.47	5.70	9.86	8.99
Sd	38.45	17.20	33.32	61.01	24.66	68.13	32.78	6.18	64.60	36.29

TABLE 5-16: Final multivariable logistic regression model, fitted to data available from 49 case households and 193 control households in Strathclyde Region Scotland, detailing the parameters that best describe the risk factors for canine relinquishment.

VARIABLE	COEFFICIENT	SE	WALD	*P*-VALUE	OR	95% CI
Constant	2.37	1.09	2.17	0.03	-	-
SMP	1.90	0.78	2.45	0.01	6.71	1.47, 30.68
PP	-1.18	0.62	-1.91	0.06	0.31	0.09, 1.03
AGE	-0.05	0.01	-4.57	0.00	0.95	0.93, 0.97
B	-2.45	0.72	-3.39	0.00	0.09	0.02, 0.36
G	-1.86	0.87	-2.14	0.03	0.16	0.03, 0.85
VC	1.83	0.62	2.94	0.00	6.26	1.85, 21.22
LTH1	1.12	0.70	1.61	0.11	3.07	0.78, 12.06
LTH2	-1.03	0.94	-1.10	0.27	0.36	0.06, 2.24
LTH3	1.99	1.05	1.90	0.06	7.35	0.94, 57.35
LTH4	2.56	1.07	2.40	0.02	12.95	1.59, 105.09
Deviance	85.16					
P-value	1.0					
DF	231					

TABLE 5-17: Hosmer-Lemeshow goodness-of-fit statistics for the final multivariable logistic regression model, fitted to data available from 49 case households and 193 control households in Strathclyde Region Scotland.

		DECILE OF RISK										
		1	2	3	4	5	6	7	8	9	10	
Status		**0.00**	**0.00**	**0.00**	**0.00**	**0.01**	**0.04**	**0.13**	**0.49**	**0.85**	**1.00**	**Total**
1	Obs	0	0	0	0	0	1	1	8	17	22	49
	Exp	0.0	0.0	0.0	0.1	0.2	0.5	2.0	7.2	15.8	23.1	49.0
2	Obs	24	25	25	23	24	23	23	18	6	2	193
	Exp	24.0	25.0	25.0	22.9	23.8	23.5	22.0	18.8	7.2	0.9	193.0
	Total	24	25	25	23	24	24	24	26	23	24	242

Hosmer-Lemeshow Statistic (C)	3.13
P-value	0.93
Degrees of freedom	8

		FIXED CUT POINTS										
Status		**0.1**	**0.2**	**0.3**	**0.4**	**0.5**	**0.6**	**0.7**	**0.8**	**0.9**	**1.0**	**Total**
1	Obs	2	1	2	2	3	5	3	6	4	21	49
	Exp	1.8	2.3	1.8	1.4	2.7	3.8	2.7	5.2	5.9	21.4	49
2	Obs	159	15	6	2	3	2	1	1	3	1	193
	Exp	159.2	13.7	6.2	2.6	3.3	3.2	1.3	1.8	1.1	0.6	193
	Total	161	16	8	4	6	7	4	7	7	22	242

Hosmer-Lemeshow Statistic (H)	6.98
P-value	0.54
Degrees of freedom	8

Key

Status 1=case, 2=control
Obs observed cell frequency
Exp expected cell frequency

FIGURE 5-11: Scatter plot of the regression diagnostic for the final multivariable logistic regression model, fitted to data available from 49 case households and 193 control households in Strathclyde Region, Scotland-1.

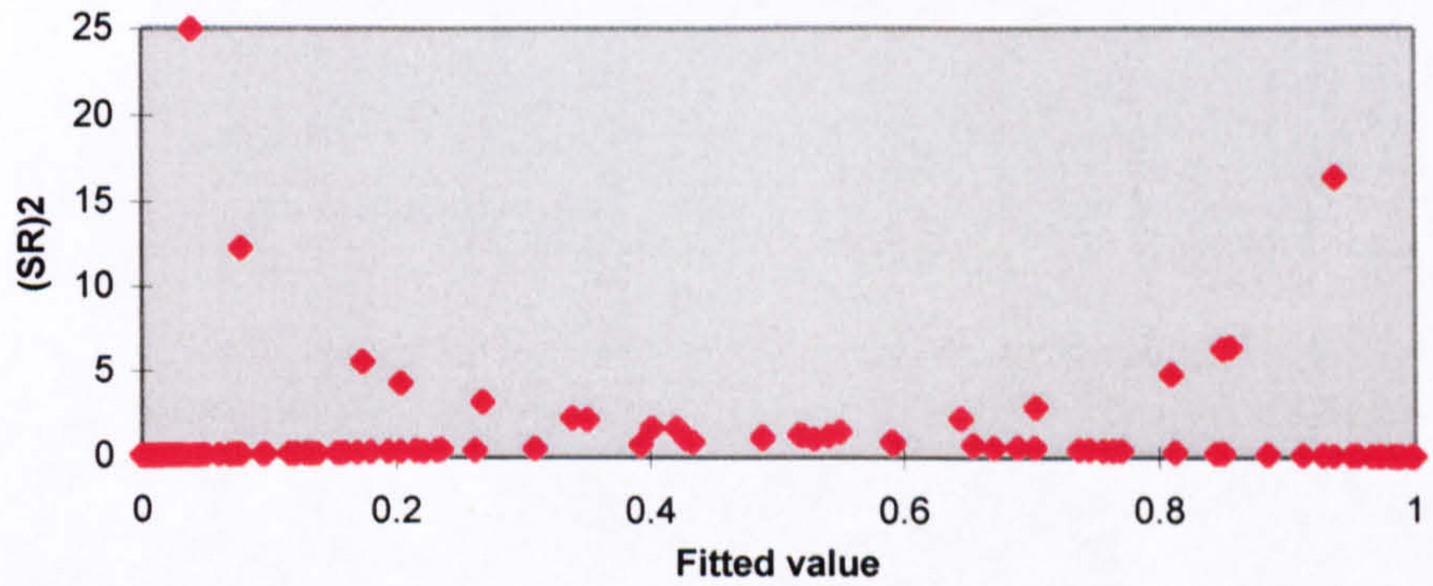


FIGURE 5-12: Scatter plot of the regression diagnostic for the final multivariable logistic regression model, fitted to data available from 49 case households and 193 control households in Strathclyde Region, Scotland-2.

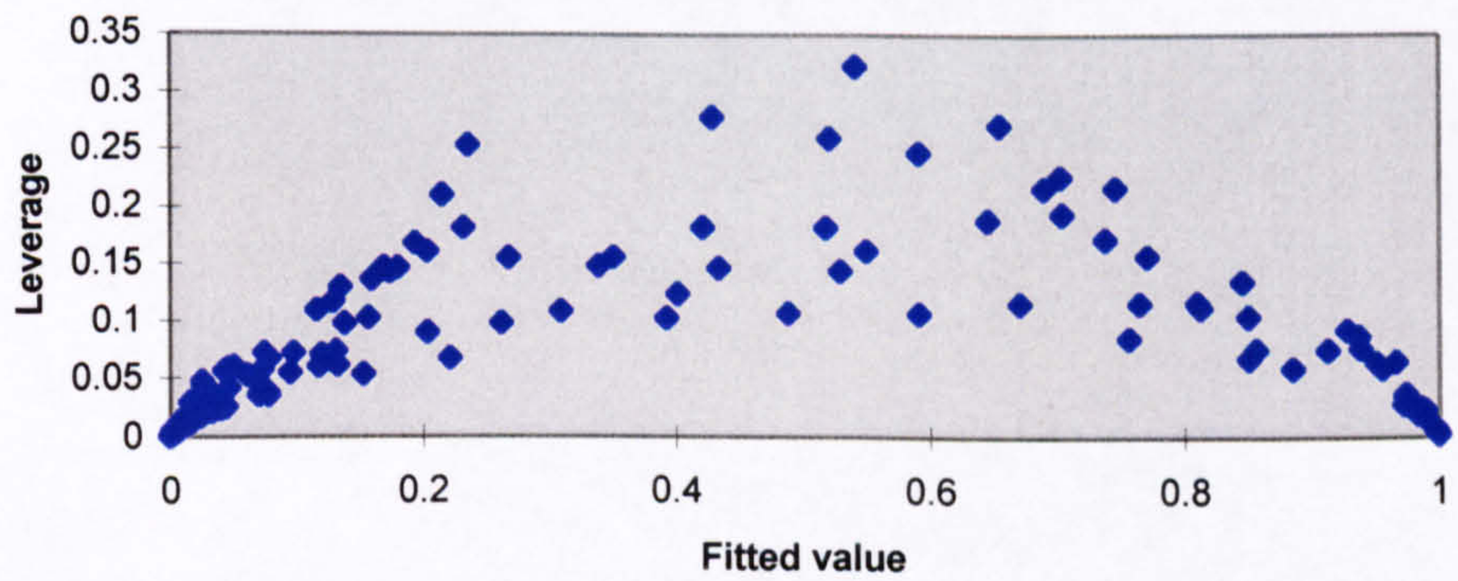
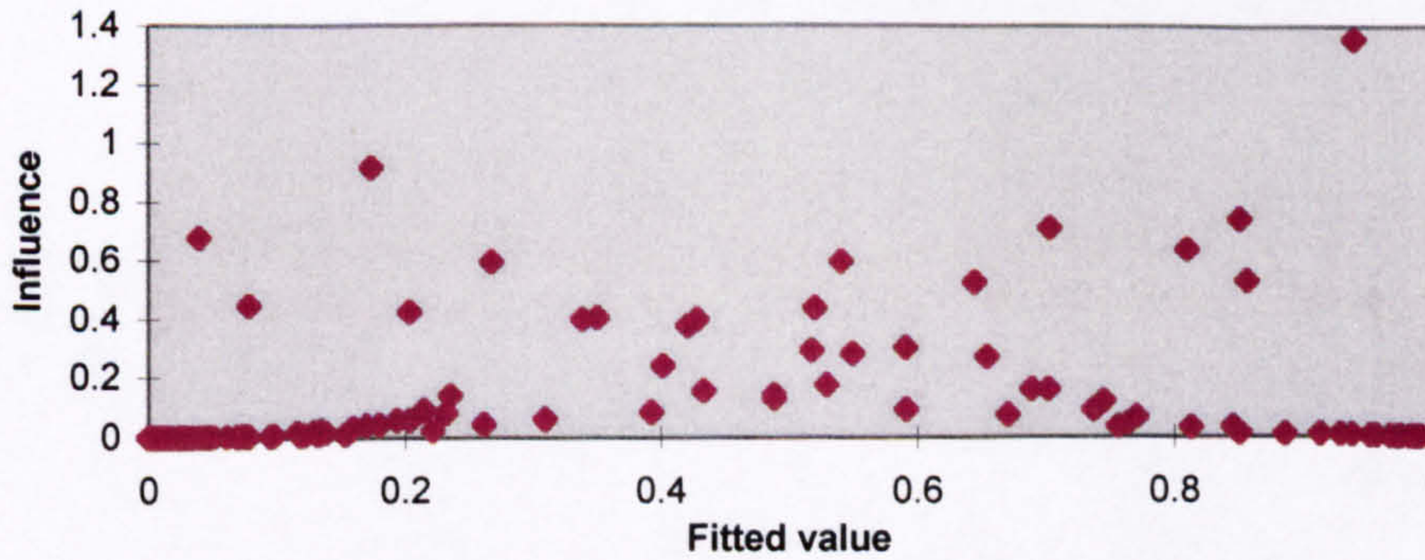


FIGURE 5-13: Scatter plot of the regression diagnostic for the final multivariable logistic regression model, fitted to data available from 49 case households and 193 control households in Strathclyde Region, Scotland-3.



Key:

Fitted value	predicted probability
(SR)2	square of the standardised residuals

TABLE 5-18: Percentage change in estimated coefficients, obtained after deleting selected covariate patterns from the final multivariable logistic regression model, fitted to data available from 49 case households and 193 control households in Strathclyde Region, Scotland.

	% CHANGE IN COEFFICIENT									
VARIABLE	**DROP 240**	**DROP 521**	**DROP 310**	**DROP 345**	**DROP 805**	**DROP 177**	**DROP 809**	**DROP 811**	**DROP 26**	**DROP 262**
Constant	23.07	29.42	2.93	7.10	20.05	3.88	5.21	7.53	3.20	12.84
SMP	8.18	1.24	18.44	5.09	4.65	20.24	8.53	6.67	2.63	20.30
PP	20.25	4.79	4.48	23.17	7.88	9.04	7.81	7.72	12.19	16.87
AGE	8.45	4.56	7.22	6.98	8.13	7.87	4.38	1.90	9.88	1.59
B	17.53	13.05	1.83	11.55	18.49	4.94	4.92	1.36	9.81	0.34
G	6.47	27.57	0.74	4.18	10.21	0.10	3.00	11.77	2.52	0.94
VC	4.28	4.88	11.82	11.12	3.21	3.40	5.35	11.29	10.76	4.22
LTH1	7.18	17.79	0.72	23.17	20.10	19.31	3.41	4.06	25.44	17.79
LTH2	1.13	26.58	26.94	0.78	14.02	22.85	5.30	40.27	11.73	28.38
LTH3	0.65	15.82	5.98	1.94	2.44	0.72	0.54	3.67	4.43	7.72
LTH4	42.65	12.90	0.16	2.24	8.41	0.93	20.72	4.08	4.99	8.55
Average	12.71	14.42	7.39	8.85	10.69	8.48	6.29	9.12	8.87	10.87
Median	8.18	13.05	4.48	6.98	8.41	4.94	5.21	6.67	9.81	8.55
Sd	12.42	10.09	8.52	7.89	6.55	8.42	5.26	10.89	6.67	9.16

5.4 DISCUSSION

5.4.1 Multivariable logistic regression

The objective of this study was to identify the most parsimonious, yet biologically reasonable, combination of factors which best describe the risk of relinquishment of a dog to an animal welfare centre. This was based on data obtained during the study described in Chapter 4, which identified several variables that were associated with canine relinquishment. The method employed in this present study was multivariable logistic regression. Any multivariable regression analysis examines the simultaneous effects of several independent, or explanatory, variables on the dependent, or outcome, variable. By applying a stepwise procedure, these methods develop a model which uses a parsimonious set of the explanatory variables to classify the dependent variable. The most common form of multiple regression is multivariable linear regression. Multivariable logistic regression analysis was deemed appropriate in this study because there were only two possible outcomes of the dependent variable (case or control).

In recent years, there has been a general increase in the use of multivariable methods in the medical literature (Dawson-Saunders and Trapp, 1994). The reasons for this include an increased statistical awareness by investigators, increased collaboration with statisticians when undertaking epidemiological investigations and the widespread availability of statistical packages for computers. However, most importantly is that with advanced knowledge, many 'diseases' have been investigated as complex interactions of a variety of potential risk factors. Multivariable methods aim to reduce this array of risk factors to a parsimonious set of variables that best explain the disease states. With respect to relinquishment, Patronek *et al.* (1996a, 1996b) applied multivariable logistic regression to their data set to investigate the risk factors for canine and feline relinquishment.

The fitted logistic regression model gives an estimated probability that the outcome (relinquishment) occurs, as an exponential function of the value of the independent variables retained in the final model. The estimation method is maximum likelihood and logistic regression uses an iterative procedure (iterative reweighted least squares) to obtain the maximum likelihood results (Siegel, 1992). The model building strategy used in this study involved a stepwise inclusion/exclusion approach which although is based

on statistical criteria, to an extent, is a subjective process. Such investigator subjectivity aims to prevent the computer yielding a biologically implausible model, which has been cited as an inherent problem with this method of analysis (Hosmer and Lemeshow, 1989).

As discussed in Chapter 5, Section 2, initial univariable screening was performed using the two sample t test and the Pearson chi-square test. According to Hosmer and Lemeshow (1989), the two sample t test is equivalent to the Wald statistic at the univariable level. Similarly, the Pearson chi-square test is equivalent to assessing the significance of the coefficient, in a univariable logistic regression model, using the likelihood ratio test. In the present study, a second univariable screening was performed, which utilised these univariable logistic regression model parameters. As anticipated, all variables identified as significant at the initial screening stage were retained in the model after the second screening stage, excluding one; 'reason for allowing a dog to have a litter of pups'. An explanation for exclusion of this variable from the multivariable logistic regression model has been given in Section 5.3.2. The importance of variable pre-screening was that the factors of likely importance were identified at an early stage in the analysis, which reduced the number of potential explanatory variables introduced to the model. A moderate degree of significance ($P \leq 0.25$) was chosen for entry into the model as use of a more stringent cut off level e.g. $P<0.05$ has been shown to reject variables of importance (Hosmer and Lemeshow, 1989).

5.4.2 Risk factors for relinquishment

This study led to the development of three models which may be used in the assessment of the likelihood of a pet dog being relinquished to an animal welfare centre. Inspection of these fitted models demonstrated little difference between them, with all three models identifying the same important risk factors. Theoretically, due to the subjective nature of the model building process, other investigators may have fitted a different model to the data used here. However, this seems unlikely given that three model building procedures fitted models which contained six (out of seven) of the same variables.

Following multivariable logistic regression involving only clinically significant variables, model one identified seven epidemiological factors associated with canine relinquishment. However as discussed in Chapter 5, Section 2, retention of the

'expectations' variable in a model that would be used to assess future relinquishment was considered inappropriate, due to the retrospective nature of this question. In contrast, Patronek *et al.* (1996a) retained this variable in their final logistic regression model and on the basis of a calculated population attributable risk, reported that in almost one third of dogs, relinquishment was attributable to the owners belief that the care of the dog was more than expected. In the present study, households who believed that the time and work involved in keeping their dog was more than expected were 16.9 times more likely to relinquish their dog. Close inspection of the Stx output for this model (Table 5-5) revealed that the odds ratios and 95% confidence intervals associated with 'veterinary attendance' were extremely large. This suggested considerable instability in the model and contributed to the decision to reject the first model.

Following a second multivariable logistic regression analysis, model two was fitted to the data set. Assessment of the goodness-of-fit of this second model by examination of the Hosmer-Lemeshow statistics suggested a very good fit. Despite this, inspection of a series of logistic regression diagnostics revealed that several households had ill fitting or influential covariate patterns. Such a disparity in the goodness-of-fit of a fitted logistic regression model is not unusual and emphasises the importance of selecting multiple methods for assessing the fit of a model. Hosmer and Lemeshow (1989) recommended that a complete model assessment should encompass both the calculation of overall, non-specific measures of fit and a thorough examination of individual components of these summary statistics, to highlight any deviation from fit for a few subjects. As anticipated, careful examination of covariate patterns exerting a significant influence on the model, revealed households with attributes which conflicted with the predictions of the multivariable logistic regression model, with respect to the retained variables (Appendix XIV). Inspection of the Stx output for this second model (Table 5-7) also suggested a degree of model instability. However, the variables retained were considered to be of biological significance. Consequently, collapsing the variable 'veterinary attendance' into a dichotomous variable improved model stability and fit, while retaining the same statistically significant variables identified in the second model building procedure. This collapsed model was considered to be more appropriate and therefore, the final fitted model for this study.

The number of case households for which data were available for inclusion in the multivariable logistic regression model was considerably lower than the number of control households. Consequently, a third multivariable logistic regression analysis was performed using data from a random selection of households from the control sample, to achieve a case to control ratio of 1:4. Anecdotal evidence suggests that a case:control ratio of 1:4 is ideal when comparing two independent groups. This third multivariable analysis retained the same variables as the analysis using the full data set. In addition, this third fitted model required the same adjustments to improve model stability and fit, as the fitted model attained using data from all 321 control households.

The final fitted models each identified seven epidemiological risk factors associated with canine relinquishment to an animal welfare centre, similar to those described by others (Arkow and Dow, 1984; Nassar, Mosier and Williams, 1984; Rowan and Williams, 1987; Kidd *et al.*, 1992a; Kidd *et al.*, 1992b; Patronek and Glickman, 1994; Murray and Speare, 1995; Patronek *et al.*, 1995; Miller *et al.*, 1996; Patronek *et al.*, 1996a; Salman *et al.*, 1997). Ownership of a small mammal pet, previous pet ownership, age of the dog, breed of the dog, veterinary care, length of time in the present home, inappropriate care expectations and presence of a garden. Six of the variables retained in the first model, remained in the second and third models, emphasising the importance of these factors. The discrepancies between the models was the variables expectations (retained in model one) and previous pet ownership (retained in model two and three).

At the univariable screening stage, significantly fewer case households were found to have a history of previous pet ownership, compared to control households. This finding is in agreement with the negative coefficient associated with this variable in the final multivariable models and indicated that if a history of previous pet ownership is absent, a household will be more likely to relinquish their dog. This observation adds additional evidence to the similarity of the two models. As discussed in Chapter 4, Section 4, previous pet owners have prior knowledge of the responsibilities, effort and commitment involved in pet ownership, whereas ignorance often stems from inexperience. Unrealistic care expectations i.e. considering the time and work involved in dog ownership to be more than expected, could therefore, be considered comparable to absence of a history of previous pet ownership.

Interpretation of the final models involves inspection of the variables retained and their associated coefficients. The positive or negative sign proceeding the coefficient denotes the association of that variable with relinquishment, where a positive sign indicates that the presence of the factor in question will increase the probability that a household will relinquish their dog and vice versa. With respect to the strength of association between the variables retained in the model and relinquishment, exponentiation of each regression coefficient gives the odds ratio associated with individual variables. The higher the odds ratio, the greater the strength of association. For example, households that own a small mammal as a pet are between 5.73 and 6.71 times more likely to relinquish their dog, whereas households with a history of previous pet ownership and households with a garden are between 3.25 and 3.29 and 6.45 and 9.02 times less likely to relinquish their dog, respectively. With breed data coded in the model as purebreed (1) or mixed breed (0), the negative coefficient associated with this variable indicates that the probability of relinquishment is lower for pure breeds dogs compared with mixed breed dogs, which are between 11.58 and 14.85 times more likely to be relinquished. With respect to age, a continuous variable, the negative coefficient indicates that with increasing age, a corresponding decreasing likelihood of relinquishment occurs i.e. younger dogs will have a higher probability that they will be relinquished.

Interpretation of the dummy variables retained in the models is facilitated by analysis of Table 5-3 (dummy variable coding). As can be seen, compared to households that have lived in their present home for ten years or more, households that have lived in their present residence for five to less than ten years, one to less than two years or less than one year were more likely to relinquish their dogs. Households that have lived in their present home for two to less than five years were less likely to relinquish their dog. At present, there is no apparent explanation for this finding, Similarly, compared to dogs that received veterinary care greater than twice a year, dogs that attended a veterinary surgery twice a year, once a year, less than once a year or never were at an increased risk of relinquishment, with the risk increasing as the frequency of veterinary care decreased. However, as discussed above, the stability of this categorical variable was questionable. Consequently, it can only be summarised from the second and third final logistic regression models that households who provided their dog with veterinary care less than once a year were approximately six times more likely to surrender ownership of the dog.

Discussion of the above variables and their association with relinquishment can be found in Chapter 4, Section 4. As mentioned above, Patronek *et al.* (1996a) applied a logistic regression model to estimate the risk for canine relinquishment. Similar to this study, the final model fitted to their data set retained the variables 'lack of veterinary care' and 'inappropriate care expectations' as risk factors for relinquishment. Three other variables were also included in their final model; failure to participate in obedience training classes, inappropriate elimination and sexually intact dogs. With the exception of inappropriate elimination, these variables were found to be significant at the univariable screening stage in the present study. While Patronek and colleagues based their model on modifiable risk factors i.e. those amenable to intervention, the present study did not specify such a criteria. This may explain some of the discrepancies between the two studies. For example age and breed are intrinsic characteristics of a dog that cannot be adjusted. Therefore, while the present model may successfully describe the likelihood that a household will relinquish their dog, not every variable included in the final model can be modified to prevent future relinquishment.

Worthy of mention, is the retrospective design of this study. Data used for model building were obtained from a case-control study (Chapter 4, Section 2). However, this type of study design lends itself to the presence of unmeasured confounding factors. As discussed in Chapter 4, Section 4, attachment to the dog is a variable that was not directly measured and may be responsible for confounding i.e. owners who are more attached to their dog will be less likely to relinquish their pet and more likely to seek veterinary care. However a multitude of variables were included in the multivariable logistic regression analysis, even after pre-screening, reducing the chance that unmeasured confounding was responsible for the associations identified.

5.4.3 Summary

In this study, data were entered into a multivariable logistic regression model to identify factors which may be used to assess the probability of relinquishment for a dog. Variables retained in the final model associated with relinquishment included ownership of a small mammal pet, no history of previous pet ownership, young dogs, mixed breed dogs, lack of veterinary care, short duration of residence in the present home and no garden. Based on these seven dog and household characteristics, data can be entered into

the model to obtain an estimate of risk. After substitution of specified values of the explanatory variables into the model, dogs with a predicted probability (P) greater than 0.5 are assumed to be more likely to be relinquished than are those with a P less than 0.5. However, validity of the model was not assessed. This could involve application of the model to a cohort study or testing the model on new data (Reid *et al.*, 1994). Once validated, use of the model to assess the likelihood of future relinquishment could enable appropriate intervention and potentially decrease the number of dogs relinquished. In particular, application of the model in AWCs could decrease the number of adopted dogs that are subsequently relinquished.

CHAPTER VI

CRITIQUE OF THE STATISTICAL ANALYSES

CHAPTER VI

CRITIQUE OF THE STATISTICAL ANALYSES

6.1 INTRODUCTION

6.1.1 Introduction

The case-control study outlined in Chapter 4 identified a number of potential risk factors for canine relinquishment to an AWC. Establishment of these risk factors relied upon identifying associations between relinquishment and hypothesised causal household demographic and dog characteristics. Demonstrating associations entailed comparing a sample of households relinquishing dogs to an AWC with a control sample of 'successful' owners and their dogs, and was based on defined statistical criteria. Such an approach, referred to as hypothesis testing, has a wide application to both experimental and observational studies and comprises a large proportion of statistical analyses in medical and veterinary research (Thrusfield, 1995; Altman, 1997).

The purpose of a statistical hypothesis test is to permit inferences to be made about the value of a parameter in a population, using observations from a random sample of this population (Dawson-Saunders and Trapp, 1994). A hypothesis test first assumes that there is no difference and the distribution of variables are the same in the study groups to be compared. This constitutes the null hypothesis. The research or alternative hypothesis is the opposite of the null hypothesis i.e. that a difference does exist between the study groups. Using an appropriate test statistic, hypothesis testing makes use of probabilities to assess whether the sample provides sufficient evidence to reject the null hypothesis in favour of the research hypothesis.

The *P*-value, computed from the data using the chosen test statistic, is a continuous measure of the compatibility between the hypothesis and the data (Rothman and Greenland, 1998). It represents the probability of having obtained the observed data when the null hypothesis is true. The *P*-value is used to make a decision about rejection or retention of the null hypotheses. A defined level of significance (alpha) is selected as

the criterion by which to judge the *P*-value and represents the probability of incorrectly rejecting the null hypothesis when it is true. Observations are classified as either significant, if the *P*-value is less than alpha, in which case the null hypothesis is rejected, or non-significant, if the *P*-value is greater than alpha and the null hypothesis is not rejected. The smaller the *P*-value, the more untenable is the null hypothesis.

Use of a fixed cut-off level in hypothesis testing leads to the analysis being looked upon as a process for making a decision (Altman, 1997). Two possible errors can occur when relying on such statistical criteria. Rejecting the null hypothesis when the hypothesis is true (type I error) or failing to reject the null hypothesis when it is actually false i.e. not accepting the alternative hypothesis when it is true (type II error). The probability of committing these errors are denoted by the Greek letters α and β, respectively. The chance of a type I error, α, represents the fixed level of significance, as described above.

Two remaining decisions are possible in hypothesis testing, representing correct inferences rather than errors. Correct decisions include not rejecting the null hypothesis when no difference exists between the comparison groups i.e. demonstrating a non-significant difference when the null hypothesis is true, and rejecting the null hypothesis when a difference exists i.e. demonstrating a significant difference when the null hypothesis is false. The probability of correctly accepting the research hypothesis when it is true is defined as the statistical power of a test. The magnitude of the statistical power quantifies the capability of a study to detect an effect of specified size, when a difference really exists. In other words, the power of a hypothesis test is the probability of not committing a type II error (i.e. accepting a false null hypothesis) when inferences are made from the analysis of data. Obviously high power is desirable because all investigators seek to detect a significant result if actually present. Table 6-1 outlines the four possible decisions in hypothesis testing.

The concept of alpha level, type I and type II error and power arise because researchers attempt to dichotomise the results of their study into the categories 'significant' and 'non-significant' (Rothman and Greenland, 1998). Within this setting, it is conventional to consider that a statistically significant effect is a genuine one whereas a non-significant result indicates that no difference truly exists. However, considering

TABLE 6-1: Correct decisions and errors in hypothesis testing based on whether the null hypothesis is accepted or rejected and whether the null hypothesis is true in reality.

		True situation	
		Difference exists (H_1)	No difference (H_0)
Test decision	Difference exists (reject H_0)	**Correct 1**	**Type I error**
	No difference (accept H_0)	**Type II error**	**Correct 2**

Key

Type I error (α)	probability of rejecting the null hypothesis when it is true (incorrect rejection of the null hypothesis)
Type II error (β)	probability of failing to reject the null hypothesis when it is false (incorrect rejection of the research hypothesis)
Correct 1*	probability of rejecting the null hypothesis when it is false (correct rejection of the null hypothesis)
Correct 2	probability of not rejecting the null hypothesis when it is true (correct rejection of the research hypothesis)
*Power (1- β)	probability of detecting a real difference of a specific magnitude

Table adapted from Dawson-Saunders and Trapp, 1994.

statistical analysis as a test that forces a choice between two possible outcomes, obscures the uncertainty present when inferences are made from a study, and ignores the non-equivalence of statistical significance and clinical importance (Altman, 1997).

According to Rothman (1986), an epidemiological study should be viewed as an exercise in measurement, with accuracy as the goal. To accomplish this, all studies should be designed with the aim of minimising the sources of error, both systematic and random, thus optimising the precision and validity of results obtained. An inverse relationship exists between type I and type II errors which precludes setting both to zero. Fortunately, both α and β can be simultaneously reduced by increasing the sample size. Obtaining the most appropriate sample size for a study depends on both statistical and non-statistical considerations. Consequently, whilst increasing the sample size will expand the amount of information available and reduce the errors inherent in any estimate, the sample size attainable is often hindered by non-statistical limitations.

The importance of determining the most appropriate sample size prior to beginning an investigation is mentioned by most authors on the subject of good study design (Lachin, 1977; Rothman, 1986; Dawson-Saunders and Trapp, 1994; Thrusfield, 1995; Altman, 1997). Several statistical formulae are available for calculating the desired sample size to compare two independent study groups. These formulae specify the sample size necessary to detect an effect of postulated magnitude, with both the desired level of statistical significance (α error) and the chance of missing a real effect (β error) taken into consideration. There is a relationship, namely power, between sample size and the ability to detect a true effect (Dawson-Saunders and Trapp, 1994). As sample size increases, the power to detect an actual difference also increases. As a result of this relationship, determining the most appropriate sample size for a study is referred to as power analysis.

Statistical power analysis involves designing and interpreting research with attention to the statistical power (probability) of a study to detect, as statistically significant, a real or clinically relevant difference of a specified magnitude (Parks, Shewokis and Costa, 1999). The power of a test is influence by the significance level adopted, the variability of data being analysed, the effect size of interested and the number of observations available. Formulae for calculating the appropriate sample size are especially useful for

the inverse problem of estimating power when the sample sizes are given (Fleiss, Tytun and Ury, 1980). In general, power and sample size calculations are interchangeable, when the aim is to ascertain a high probability of detecting a biologically meaningful effect if present and thus, to be reasonably sure that no difference exists if found to be non-significant. The greater the power of a hypothesis test, the better able it is to correctly detect small but real differences between two study groups, with a power of between 80 to 90% traditionally considered adequate (Altman, 1997).

Besides being crucial for the design of meaningful experiments, consideration of power is particularly important for the interpretation of non-significant results (Searcy-Bernal, 1994). Failure to reject a null hypothesis should not be equated with the assertion that the null hypothesis is true, due to the arbitrariness of relying on a fixed level of significance. Missing a significant difference, a type II error, can occur, for example, when the sample size is too small to detect the desired effect. Altman (1997) and Rothman and Greenland (1998) highlight a review that outlined published clinical trials that found a non-significant difference between treatments, when there was little chance of detecting an effect due to an inadequate sample size. Consequently, whenever results are non-significant, the statistical power should be stated to permit accurate conclusions about such results.

Although it is preferable to address the issue of power and sample size calculations prior to undertaking a study, retrospective analysis is better than not at all (Dawson-Saunders and Trapp, 1994). Performing power analysis after completion of a study assures readers that the number of observations was sufficient to allow detection of any clinically meaningful effects. Despite being an indispensable component of well designed research, statistical power analysis is often ignored by researchers. According to Altman (1997), the medical literature contains many studies that were too small to detect important differences between comparison groups, with power and sample size calculations neglected.

6.1.2 Purpose

The purpose of this investigation was to apply statistical power analysis to the data set obtained from the investigation described in Chapter 4. According to Dawson-Saunders and Trapp (1994), for studies involving multiple independent variables, a sample size

ten times as large as the number of variables will provide a high level of confidence in the results obtained. The number of households available for inclusion in the study described in Chapter 4 only marginally conformed to this recommendation. Moreover, due to issues outlined in Chapter 4, Section 4, the recruitment of case households was less than anticipated and fell notably short of the number of control household available for comparison. Consequently, the sample size of the two comparison groups were unequal, with a case:control household ratio of 1:6.5. While anecdotal evidence suggests that a case:control ratio of 1:4 is ideal, it has been reported that the objective of testing the null hypothesis is best attained using equal numbers of cases and controls (Schlesselman, 1982). Fleiss, Tytun and Ury (1980) demonstrated that the power of a hypothesis test that compares two independent groups is highest for studies with an equal allocation of the sample to each comparison group, and as the disparity in size of each group increases, a corresponding decrease in power occurs. The disproportionate sample size allocation present in the study outline in Chapter 4 may, therefore, have compromised statistical power. In addition, although the study detected significant associations between a multitude of variables and the outcome of relinquishment, a number of non-significant results were obtained, some of which conflicted with the findings of others. Under these circumstances, the investigation may have had insufficient power. Consequently, it was considered prudent to assess the study's power in detecting various magnitudes of risk. The aim was to ascertain that statistically significant associations were not associated with a high type I error (incorrectly rejecting the null hypothesis) and that small but clinically important differences were not missed, by failing to achieve the level of significance compatible with rejecting the null hypothesis.

6.2 MATERIALS AND METHODS

6.2.1 Research design

A case-control study was undertaken to establish risk factors for relinquishment of a pet dog to an AWC (Chapter 4). Once data collection and analysis was complete, statistical power analysis of the study was undertaken.

6.2.2 Data collection and analysis

Questionnaires were used to secure data from 49 case households and 321 control households, representing a study group apportionment of 1 to 6.5 (Chapter 4, Section 2). Details were obtained from these households on a total of 41 human demographic and dog characteristics (Appendix 8). Initial univariable analysis was performed to ascertain which of these 41 variables demonstrated a significant difference between case and control households. The two sample t test and the chi-square test for independence or the Fisher's exact test were the tests used to analyse continuous and categorical variables, respectively (Chapter 4, Section 2). The effect of the combination of risk factors identified during univariable analysis was evaluated using the multiple logistic regression model. A total of 31 factors were considered eligible for inclusion in the multivariable model (Chapter 5).

6.2.2.1 *Statistical power analysis*

As discussed previously (Chapter 6, Section 1), the statistical power of a hypothesis test is the probability of correctly rejecting the null hypothesis when it is false. It is calculated by subtracting the probability of committing a type II error from 1, usually expressed as:

$$\begin{aligned}\text{Power} &= \text{Probability (reject } H_0 \text{ given that } H_1 \text{ is true)}\\ &= 1 - \text{probability (accept } H_0 \text{ given that } H_1 \text{ is true)}\\ &= 1 - \text{probability (type II error)}\\ &= 1-\beta\end{aligned}$$

where H_0 represents the null hypothesis, H_1 is the research hypothesis and β represents the probability of committing a type II error. The maximum power a test can have is 1 (100%) and the minimum, is 0.

The power of any hypothesis test depends on the significance level adopted, the components of the calculation of the test statistic and the research hypothesis under consideration (Prophet Statguide, 1999). In the present investigation, the specific research hypothesis was that for the variables under investigation, the magnitude of effect between case and control households was some non-zero value. The magnitude of

effect represented the difference in mean values for continuous variables, the difference in the proportion of households with the characteristic of interest for dichotomous variables and the difference in apportionment of households to each level for categorical variables. The ratio of the difference of interest to the standard deviation of the observations is the critical feature of power analysis and this quantity is known as the effect size or standardised difference (Altman, 1997). The smaller this ratio is, the smaller the statistical power of the test hypothesis will be.

Statistical methods for calculating the power of a study which compares two independent groups vary depending on the type of variable that is being assessed and consequently the test statistic used. A selection of continuous, dichotomous and categorical variables were analysed in the study described in Chapter 4. Consequently, three different formulae for determining power were applied. Statistical power analyses were performed in nQuery Advisor Release 3.0 (Study Planning Software). Power was calculated for the 41 variables for which data were available, with each treated as a separate hypothesis test.

To estimate the power of a test hypothesis involving continuous variables, the following parameters were entered into the study planning software: the number of case households (n_1) and the number of control households (n_2), the mean value of the variable for case households (μ_1) and the mean value of the variable for control households (μ_2), the common standard deviation of the means for the two comparison groups (σ), the selected level of significance related to the null hypothesis (α level) and the choice of alternative hypothesis i.e. one tailed or two tailed. After input of the above data, the software calculated the total sample size ($n_1 + n_2$), the ratio of case to control households (n_2 / n_1), the magnitude of difference between the means of the two comparison groups ($\mu_1 - \mu_2$) and the effect size (δ) which was derived from the difference in group means divided by the common standard deviation [$(\mu_1 - \mu_2) / (\sigma)$]. From these parameters, the power (%) of the test hypothesis was computed. The calculation of statistical power for hypothesis tests that compared means, assumed that the variable had a normal distribution.

With respect to dichotomous variables, the following information was specified to permit power analysis: the number of case households (n_1) and the number of control

households (n_2), the proportion of all case households that had the characteristic in question as opposed to those case households which did not (π_1), the proportion of all control households that had the characteristic in question as opposed to those control households which did not (π_2), the selected level of significance related to the null hypothesis (α level) and the choice of alternative hypothesis i.e. one tailed or two tailed. Once these data were specified, the study planning software calculated the total sample size ($n_1 + n_2$), the ratio of case households to control households (n_2 / n_1) and the odds ratio (ψ) for the comparison group proportions where $\psi = \pi_2 (1 - \pi_1) / [(\pi_1 (1 - \pi_2)]$. From these parameters, the power (%) of the test hypothesis was calculated. For variables analysed by the Fisher's exact test, power analysis proceeded as described above for dichotomous variables. The calculation of statistical power for hypothesis tests that compared variables with two possible outcomes, made use of the normal approximation to the binomial distribution.

Estimation of power for a test hypothesis involving categorical variables required the following parameters to be specified: the number of case households (n_1) and the number of control households (n_2), the number of groups (levels) within the categorical variable (G), the average proportion of case households that had the characteristic in question for each level of the categorical variable (π_0), as opposed to those cases and controls which did not and the test significance level (α). The average apportionment of case households to each level of the categorical variable (π_0) was calculated as outlined in Table 6-2.

TABLE 6-2: Apportionment of case households to each level within a categorical variable for statistical power analysis.

Group	Proportion (π_i)	Group size (n_i)	Ratio ($r_i = n_i / n_1$)
level 1	π_1	n_1	1.000
level 2	π_2	n_2	n_2 / n_1
level 3	π_3	n_3	n_3 / n_1
level 4	π_4	n_4	n_4 / n_1

where n_i represents the total number of case and control households that constituted this level and π_i represents the number of case households that constituted this level divided by the total number of case and control households that constituted this level (n_i). The average proportion (π_0) was calculated as $\Sigma r_i \pi_i$ / Σr_i. A categorical variable with four levels is used in the example above. The number of levels for all categorical variables analysed ranged from three to eight.

After input of the above data, the study planning software calculated the total sample size (N), N as a multiple of n_1 ($\Sigma r_i = \Sigma n_i / n_1$), the variance (V) of the proportions where $V = \Sigma r_i (\pi_i . \pi_o)^2 / \Sigma r_i$ and the effect size (Δ^2) where $\Delta^2 = V / [\pi_o(1-\pi_0)]$. From these parameters, the power (%) of the test hypothesis was calculated. Power determination for research hypotheses involving categorical variables made use of the non-central chi-square distribution.

Once the initial power analysis was complete, if the power of any test hypothesis was less than 80%, analysis was extended. This second analysis entailed fixing the power of the hypothesis test at 80%, with subsequent calculation of:

1. the total sample size required to detect a difference of the same magnitude as that determined in the hypothesis test under consideration.

2. the smallest magnitude of effect detected with the number of cases and controls available in this study.

As discussed in Chapter 5, Section 2, levels within categorical variables were collapsed, where appropriate, prior to proceeding to multivariable logistic regression analysis. Consequently, the power of the hypothesis test for the 'collapsed' categorical variable was also determined. A significance level of 5% ($\alpha = 0.05$) and a research hypothesis with two tails was specified throughout.

6.3 RESULTS

6.3.1 Statistical power of hypothesis tests for the univariable analysis

Based on data available from 49 case households and 321 control households, univariable analysis was performed on the 41 variables hypothesised to be possible risk factors for canine relinquishment, as outlined in Chapter 4. A number of respondents

from these households inadvertently omitted one or more of the 41 questions included in the questionnaire. Moreover, some of the questions asked were applicable only to certain households, such that a response from all households was not attained. Consequently, the number of case and control households, and therefore the total sample size, was not constant for every variable analysed.

A number of the 41 variables assessed, particularly categorical variables, were subject to multiple comparisons at the univariable stage of analysis. Details pertaining to the categorical variable 'other pets owned in the household' were subdivided into eight separate dichotomous variables. 'Sexual status of the dog', a dichotomous variable, was primarily analysed with respect to all dogs, followed by analysis considering dogs six months of age or older only. Data regarding 'when information or advice about canine behaviour and training was gained' were supplied as a three level categorical variable. However, these three levels were transformed into two dichotomous variables for comparison between case and control households. These were 'obtained information before acquiring the dog' or 'obtained information after acquiring the dog'. Data pertaining to the 'type of behavioural problems displayed by dogs' from case and control households were assessed with each of the eight levels within this categorical variable treated like a separate dichotomous variable. The variable 'frequency of veterinary attendance' was initially analysed as a categorical variable. A further comparison was then made after the six levels for veterinary attendance were combined to form a dichotomous variable. The new options for frequency of veterinary care were 'less than once a year' or 'once a year and greater'. Data regarding the 'living accommodation' of case and control households were initially analysed as a categorical variable. Following this step, this variable was subsequently assessed as two dichotomous variables representing living in a flat as opposed to a house and home ownership status (owned or rented). The above procedures resulted in a total of 59 hypothesis tests undertaken at the univariable stage of analysis.

Statistical power analysis was performed on each of the 59 hypothesis tests completed. Table 6-3 outlines the power achieved for each test at a significance level of 0.05, with each test assessed as a two-sided hypothesis. Regarding all 59 hypothesis test, the maximum power achieved was 99% whereas the minimum power was 2%. Over forty

TABLE 6-3: Power of 59 univariable statistical hypothesis tests comparing case and control households in Strathclyde Region, Scotland, at a test significance level of 0.05 and each test assessed as a two sided hypothesis.

CHARACTERISTIC ASSESSED		VARIABLE	CASES	CONTROLS	TOTAL N	*P*-VALUE	POWER (%)
Other pets owned	any other pet	Dichotomous	49	321	370	0.07	50
	dog	Dichotomous	49	321	370	0.08	51
	cat	Dichotomous	49	321	370	0.26	27
	small mammal	Dichotomous	49	321	370	<0.001	98
	bird	Dichotomous	49	321	370	1.00	2
	fish	Dichotomous	49	321	370	1.00	2
	miscellaneous	Dichotomous	49	321	370	1.00	2
	multiple species	Dichotomous	49	321	370	0.58	11
Previous pet ownership		Dichotomous	49	318	367	<0.001	99
Age of dog		Continuous	49	319	368	<0.001	99
Breed of dog		Dichotomous	49	321	370	<0.001	99
Sex of dog		Dichotomous	49	321	370	0.68	8
Sexual status of dog	all dogs	Dichotomous	49	319	368	0.34	19
	dogs > 6 months only	Dichotomous	40	314	354	1.00	3
Reasons for not neutering dog		Categorical	30	171	201	<0.001	99
Age when dog was neutered		Continuous	18	137	155	<0.001	65
Reasons for neutering dog		Categorical	18	143	161	<0.01	92
Has dog had a litter of pups		Dichotomous	27	162	189	0.82	9
Was litter of pups an accident or planned		Dichotomous	4	18	22	0.02	61
Age at acquisition		Continuous	47	316	363	0.52	7

TABLE 6-3: Continued.

CHARACTERISTIC ASSESSED	VARIABLE	CASES	CONTROLS	TOTAL N	*P*-VALUE	POWER (%)
Source of dog	Categorical	49	321	370	<0.001	99
Cost of dog	Continuous	42	257	299	<0.001	92
Household member responsible for decision to acquire dog	Categorical	48	320	368	<0.01	95
Degree of planning before acquisition	Categorical	49	318	367	<0.001	97
Factor important in decision to acquire dog	Categorical	47	306	353	<0.001	96
Role respondent expected dog to play	Dichotomous	48	314	362	0.60	7
How often dogs fulfil respondents expectations	Categorical	48	320	368	<0.001	99
Behavioural advice	Dichotomous	49	319	368	0.01	73
Source of behavioural advice	Categorical	14	153	167	0.26	59
Behavioural advice before acquisition	Dichotomous	14	153	167	0.42	20
after acquisition	Dichotomous	14	153	167	0.09	54
Where dog spends most of its time	Categorical	48	319	367	<0.01	91
Supervision/control of dog when outside	Categorical	48	315	363	0.26	35
Time respondent spends interacting with dog	Categorical	48	313	361	0.06	61
Attendance at obedience training	Dichotomous	49	317	366	0.05	59
Frequency of attendance at obedience training	Dichotomous	4	67	71	0.59	15
Does dog have a behaviour problem	Dichotomous	49	317	366	1.00	2
Frequency problem is displayed	Categorical	15	105	120	0.34	29

TABLE 6-3: Continued.

CHARACTERISTIC ASSESSED		VARIABLE	CASES	CONTROLS	TOTAL N	*P*-VALUE	POWER (%)
Type of problem	multiple problems	Dichotomous	15	110	125	0.74	10
	barking	Dichotomous	15	110	125	0.44	18
	chewing	Dichotomous	15	110	125	0.68	12
	hyperactivity	Dichotomous	15	110	125	0.22	37
	'messing' in the house	Dichotomous	15	110	125	0.87	4
	aggression to other pets	Dichotomous	15	110	125	0.57	10
	aggression to people	Dichotomous	15	110	125	0.73	6
	miscellaneous	Dichotomous	15	110	125	0.80	5
Veterinary attendance (a)		Categorical	49	320	369	<0.001	99
Veterinary attendance (b)		Dichotomous	49	320	369	<0.001	99
Respondent's expectations of dog ownership		Categorical	49	320	369	<0.001	99
Are dogs considered family members		Categorical	49	320	369	<0.001	99
Sex of respondent		Dichotomous	49	320	369	0.56	11
Family composition		Categorical	49	320	369	0.39	27
Accommodation	all categories	Categorical	49	315	364	<0.001	99
	flat or house	Dichotomous	49	315	364	<0.001	98
	rented or owned	Dichotomous	46	309	355	<0.001	99
Presence of a garden		Dichotomous	49	320	369	<0.001	96
Length of time in the present home		Categorical	49	319	368	<0.001	99
Highest level of education achieved		Categorical	47	304	351	<0.001	99
Household income		Categorical	48	289	337	<0.001	99

per cent (40.7%) of hypothesis test performed had greater than 90% power. Twenty-eight of the hypothesis tests performed had a *P*-value < 0.05 at univariable analyses. Considering these 28 variables, the maximum power achieved was 99% whereas the minimum power was 59%. Over eighty-five per cent (85.7%) of these hypothesis tests had greater than 90% power.

6.3.1.1 Sample and effect size adjustments to achieve a power of 80%

Statistical power analysis revealed that a number of the hypothesis test had a power less than 80% (Table 6-3). This appeared to reflect a combination of a smaller sample size, a reduced effect size, a low prevalence of the characteristic in question and a non-significant results at the univariable stage of analysis i.e. the null hypothesis was not rejected. Consequently, with power fixed at 80%, the required sample size to achieve this power, with no adjustment in effect size, and the smallest magnitude of effect detected with this power, with no adjustment in sample size, were calculated. Tables 6-4, 6-5 and 6-6 outline the necessary changes to sample size and effect size for continuous, dichotomous and categorical variables, respectively. A wide selection of sample sizes were necessary to achieve a power of 80% ranging from 249 to 5.24×10^7. Likewise, a wide selection of effect sizes were detected ranging from 0.03 to 0.09 for categorical variables, 0.44 to 0.71 (7.43 to 20.52 months) for continuous variables and odds ratios ranging from 0.09 to 5.

6.3.2 Statistical power of hypothesis tests for the multivariable analysis

Based on the results of the univariable analysis (Chapter 4, Section 3), a total of 30 factors showed a significant difference between case and control households at $P \leq 0.25$. Although the *P*-value associated with the neutering status of a dog was higher than the critical level set, it was decided a *priori* that this variable should be included. This step resulted in a total of 31 eligible factors for inclusion in the multiple logistic regression model. Sixteen categorical variables were included within this selection. Prior to multivariable analysis, levels within these categorical variables were collapsed where appropriate. Consequently, a second power analysis were performed on the hypothesis test associated with these 'collapsed' variables.

TABLE 6-4: Required sample size and effect size to achieve a power of 80% for tests involving continuous variables, comparing case and control households in Strathclyde Region, Scotland, at a test significance level of 0.05 and each test assessed as a two sided hypothesis.

				80% POWER	
CHARACTERISTIC ASSESSED	**TOTAL N**	**EFFECT SIZE**	**POWER (%)**	**REQUIRED N**	**REQUIRED EFFECT***
Age of dog	368	1.29	99	-	-
Age when dog was neutered	155	0.59	65	221	0.71
Age at acquisition	363	0.07	7	13397	0.44
Cost of dog	299	0.57	92	-	-

* Effect size = difference in group means / common standard deviation.

TABLE 6-5: Required sample size and effect size to achieve a power of 80% for tests involving dichotomous variables, comparing case and control households in Strathclyde Region, Scotland, at a test significance level of 0.05 and each test assessed as a two sided hypothesis.

CHARACTERISTIC ASSESSED		TOTAL N	EFFECT SIZE	POWER (%)	80% POWER REQUIRED N	80% POWER REQUIRED EFFECT*
Other pets owned	any other pet	370	1.85	50	738	2.40
	dog	370	0.25	51	595	0.12
	cat	370	1.58	27	1746	2.54
	small mammal	370	6.00	98	-	-
	bird	370	0.95	2	2.67×10^5	0.09
	fish	370	1.00	2	5.24×10^7	0.12
	miscellaneous	370	1.01	2	2.96×10^{10}	4.30
	multiple species	370	1.36	11	2431	3.14
Previous pet ownership		367	0.22	99	-	-
Breed of dog		370	0.05	99	-	-
Sex of dog		370	1.19	8	9122	2.46
Sexual status of dog	all dogs	368	0.71	19	2335	0.40
	dogs > 6 months only	354	0.97	3	2.63×10^5	0.36
Has dog had a litter of pups		189	1.39	9	5051	4.00
Role respondent expected dog to play		362	0.73	7	7375	0.32
Behavioural advice		368	0.41	73	419	0.40
Behavioural advice	before acquisition	167	0.55	20	1120	0.20
	after acquisition	167	0.27	54	365	0.17

TABLE 6-5: Continued.

CHARACTERISTIC ASSESSED		TOTAL N	EFFECT SIZE	POWER (%)	80% POWER REQUIRED N	80% POWER REQUIRED EFFECT*
Attendance at obedience training		366	0.33	59	537	0.23
Frequency of attendance at obedience training		71	0.31	15	462	0.00**
Does dog have a behaviour problem		366	1.10	5	3.13×10^4	2.37
Type of problem	multiple problems	125	1.47	10	2.40×10^3	4.70
	barking	125	1.76	18	964	4.70
	chewing	125	1.54	12	1904	4.70
	hyperactivity	125	2.55	37	437	5.00
	'messing' in the house	125	0.53	4	2515	0.20
	aggression to other pets	125	0.50	10	1104	0.00**
	aggression to people	125	0.45	6	1510	0.00**
	miscellaneous	125	0.49	5	1909	0.00**
Veterinary attendance		369	0.20	99	-	-
Sex of respondent		369	0.79	11	5238	0.42
Accommodation	flat or house	364	4.17	98	-	-
	rented or owned	355	6.40	99	-	-
Presence of a garden		369	6.16	96	-	-

* Effect size = odds ratio.

** Power never reached 80%.

TABLE 6-6: Required sample size and effect size to achieve a power of 80% for tests involving categorical variables, comparing case and control households in Strathclyde Region, Scotland, at a test significance level of 0.05 and each test assessed as a two sided hypothesis.

				80% POWER	
CHARACTERISTIC ASSESSED	**TOTAL N**	**EFFECT SIZE**	**POWER (%)**	**REQUIRED N**	**REQUIRED EFFECT***
Reasons for not neutering dog	201	0.28	99	-	-
Reasons for neutering dog	161	0.12	92	-	-
Source of dog	370	0.14	99	-	-
Household member responsible for decision to acquire dog	368	0.05	95	-	-
Degree of planning before acquisition	367	0.05	97	-	-
Factor important in decision to acquire dog	353	0.06	96	-	-
How often dogs fulfil respondents expectations	368	0.15	99	-	-
Source of behavioural advice	167	0.05	59	249	0.08
Where dog spends most of its time	367	0.04	91	-	-
Supervision/control of dog when outside	363	0.01	35	987	0.03
Time respondent spends interacting with dog	361	0.02	61	535	0.03
Frequency behavioural problem is displayed	120	0.03	29	410	0.09
Veterinary attendance	369	0.30	99	-	-
Respondents expectations of dog ownership	369	0.19	99	-	-

TABLE 6-6: Continued.

CHARACTERISTIC ASSESSED	TOTAL N	EFFECT SIZE	POWER (%)	80% POWER REQUIRED N	80% POWER REQUIRED EFFECT*
Are dogs considered family members	369	0.11	99	-	-
Family composition	369	0.01	27	1343	0.03
Accommodation	364	0.13	99	-	-
Length of time in the present home	368	0.14	99	-	-
Highest level of education achieved	351	0.08	99	-	-
Household income	337	0.09	99	-	-

* Effect size = variance of group proportions / multiple of the average group proportion.

Table 6-7 outlines the power for each of the 32 hypothesis tests that compared variables considered eligible for inclusion in the multivariable logistic regression model. These powers were achieved at a significance level of 0.05, with each hypothesis treated as a two sided test. The maximum power achieved was 99% whereas the minimum power was 19%. Approximately two thirds (64.5%) of all hypothesis test had greater than 90% power.

6.3.2.1 Sample and effect size adjustments to achieve a power of 80%

Statistical power analysis revealed that 11 of these 32 hypothesis test had a power less than 80% (Table 6-7). Consequently, with power fixed at 80%, the required sample size to achieve this power, with no adjustment in effect size, and the smallest magnitude of effect detected with this power, with no adjustment in sample size, were calculated. Tables 6-8 summarises the necessary changes to sample size and effect size as outlined above. A wide selection of sample sizes were necessary to achieve a power of 80%, ranging from 221 to 2335. Likewise, a wide selection of effect sizes were estimated including 0.03 for categorical variables, 0.71 (20.52 months) for continuous variables and odds ratios ranging from 0.12 to 5.

6.4 DISCUSSION

6.4.1 Discussion

The objective of this investigation was to assess the statistical power of a study designed to determine human and dog characteristics that contribute to owner dissatisfaction and the decision to relinquish a pet dog to an AWC. Many of the techniques for power and sample size determination are restricted to research aimed at detecting a difference between two independent comparison groups with a single binomial outcome (Lachin, 1977). In addition, equal sample size allocation to each comparison group comprise the most readily available and easily performed calculations. Many tables are available to assist the investigator in selecting the most appropriate number of study subjects for such studies (Machin and Campbell, 1987). However, consideration of financial constraints, availability, relative costs or other factors may make it desirable to select samples of unequal size from the study populations. Likewise, more than two possible outcomes may be the subject of the inquiry. With regard to the study outlined in Chapter

TABLE 6-7: Power of statistical tests involving variables eligible for entry to multiple logistic regression, comparing case and control households in Strathclyde Region, Scotland, at a test significance level of 0.05 and each test assessed as a two sided hypothesis.

CHARACTERISTIC ASSESSED		VARIABLE	CASES	CONTROLS	TOTAL N	*P*-VALUE	POWER (%)
Other pets owned	any other pet	Dichotomous	49	321	370	0.07	50.00
	dog	Dichotomous	49	321	370	0.08	51.00
	small mammal	Dichotomous	49	321	370	<0.001	98.00
Previous pet ownership		Dichotomous	49	318	367	<0.001	99.00
Age of dog		Continuous	49	319	368	<0.001	99.00
Breed of dog		Dichotomous	49	321	370	<0.001	99.00
Sexual status of dog		Dichotomous	49	319	368	0.34	19.00
Reasons for not neutering dog		Categorical	30	171	201	<0.001	99.00
Age when dog was neutered		Continuous	18	137	155	<0.001	65.00
Reasons for neutering dog		Categorical	18	143	161	<0.01	92.00
Was litter of pups an accident or planned		Dichotomous	4	18	22	0.02	61.00
Source of dog		Categorical	49	321	370	<0.001	99.00
Cost of dog		Continuous	42	257	299	<0.001	92.00
Household member responsible for decision to acquire dog		Categorical	48	320	368	<0.01	95.00
Degree of planning before acquisition		Categorical	49	318	367	<0.001	97.00
Factor important in decision to acquire dog		Categorical	47	306	353	<0.01	97.00

TABLE 6-7: Continued.

CHARACTERISTIC ASSESSED	VARIABLE	CASES	CONTROLS	TOTAL N	*P*-VALUE	POWER (%)
How often dogs fulfil respondents expectations	Categorical	48	320	368	<0.001	99.00
Behavioural advice	Dichotomous	49	319	368	0.01	73.00
Behavioural advice after acquisition only	Dichotomous	14	153	167	0.09	54.00
Where dog spends most of its time	Categorical	48	319	367	0.01	54.00
Time respondent spends interacting with dog	Categorical	48	313	361	0.06	61.00
Attendance at obedience training	Dichotomous	49	317	366	0.05	59.00
Dog displays hyperactivity	Dichotomous	15	110	125	0.22	37.00
Veterinary attendance	Categorical	49	320	369	<0.001	99.00
Respondents expectations of dog ownership	Categorical	49	320	369	<0.001	99.00
Are dogs considered family members	Categorical	49	320	369	<0.001	99.00
Accommodation	Categorical	49	315	364	<0.001	99.00
Presence of a garden	Dichotomous	49	320	369	<0.001	96.00
Length of time in the present home	Categorical	49	319	368	<0.001	99.00
Highest level of education achieved	Categorical	47	304	351	<0.001	99.00
Household income	Categorical	48	289	337	<0.001	99.00

TABLE 6-8: Required sample size and effect size to achieve a power of 80%, for tests involving variables eligible for entry to multivariable logistic regression, comparing case and control households in Strathclyde Region, Scotland, at a test significance level of 0.05 and each test assessed as a two sided hypothesis.

CHARACTERISTIC ASSESSED		TOTAL N	EFFECT SIZE	POWER (%)	80% POWER REQUIRED N	80% POWER REQUIRED EFFECT
Other pets owned	any other pet	370	1.85	50.00	738	2.40
	dog	370	0.25	51.00	595	0.12
	small mammal	370	6.00	98.00	-	-
Previous pet ownership		367	0.22	99.00	-	-
Age of dog		368	1.29	99.00	-	-
Breed of dog		370	0.05	99.00	-	-
Sexual status of dog		368	0.71	19.00	2335	0.39
Reasons for not neutering dog		201	0.17	99.00	-	-
Age when dog was neutered		155	0.59	65.00	221	0.71
Reasons for neutering dog		161	0.11	92.00	-	-
Was litter of pups an accident or planned		22	-	61.00		-
Source of dog		370	0.14	99.00	-	-
Cost of dog		299	0.57	92.00	-	-
Household member responsible for decision to acquire dog		368	0.05	95.00	-	-
Degree of planning before acquisition		367	0.05	97.00	-	-
Factor important in decision to acquire dog		353	0.06	97.00	-	-

TABLE 6-8: Continued.

CHARACTERISTIC ASSESSED	TOTAL N	EFFECT SIZE	POWER (%)	80% POWER REQUIRED N	80% POWER REQUIRED EFFECT*
How often dogs fulfil respondents expectations	368	0.15	99.00	-	-
Behavioural advice	368	0.41	73.00	419	0.40
Behavioural advice after acquisition only	167	0.27	54.00	365	0.17
Where dog spends most of its time	367	0.02	54.00	633	0.03
Time respondent spends interacting with dog	361	0.02	61.00	535	0.03
Attendance at obedience training	366	3.02	59.00	537	4.30
Dog displays hyperactivity	125	2.55	37.00	437	5.00
Veterinary attendance	369	0.26	99.00	-	-
Respondents expectations of dog ownership	369	0.19	99.00	-	-
Are dogs considered family members	369	0.08	99.00	-	-
Accommodation	364	0.13	99.00	-	-
Presence of a garden	369	6.16	96.00	-	-
Length of time in the present home	368	0.14	99.00	-	-
Highest level of education achieved	351	0.08	99.00	-	-
Household income	337	0.09	99.00	-	-

4, the sample size of the two comparison groups were markedly unequal, with a case:control household ratio of 1:6.5. In addition, due to the multitude of hypothesised risk factors for canine relinquishment, multiple comparisons were performed. During this study, 59 statistical comparisons were undertaken at the univariable analyses, with each constituting a separate hypothesis test. Although some of these tests permitted only two outcomes, a high proportion were associated with multiple possible results.

Fortunately, statistical power analysis for research involving more than two outcomes is possible from consideration of the non-centrality parameter and the power function of the corresponding chi-square test (Lachin, 1977). Appropriate calculations for assessment of case and control groups of unequal size have also been described, and stem from simple adaptations of formulae available for equal sized comparison groups (Fleiss, Tytun and Ury, 1980; Schlesselman, 1982; Machin and Campbell, 1987). Such formulae were applied to the data obtained from the case-control study described in Chapter 4, with a wide range of power achieved for each hypothesis test. Due to inadvertent item non-response by households during questionnaire completion and selective non-eligibility for some households on certain questions, the total sample size varied between each analysis. In addition, the effect size detected varied widely among the hypothesis tests. It is not surprising that a diverse range of power values were calculated for this study considering these points.

Conventionally, between 80 to 90% is regarded as the desirable power a study should achieve (Altman, 1997). Clearly, a number of the analyses in the present investigation fell short of this recommendation. However, consistently achieving a statistical power of this magnitude would seem unlikely, due to the diversity of effect sizes among the many variables assessed. Considering only hypothesis tests that detected, as statistically significant, a difference between case and control households, the average power (92.8%) was good, with over eighty-five per cent of tests achieving a power greater than 90%. It can be concluded, therefore, that the hypothesised risk factors for canine relinquishment, as detected in the investigation outlined in Chapter 4, accurately reflect genuine differences in household demographic and dog characteristics between case and control households at a significance level of 0.05.

Low power was associated with those hypothesis tests that detected non-significant differences between case and control households and thus failed to reject the null hypothesis. Since power reflects the ability to correctly detect a difference if one exists, these low powers should be anticipated, because if a true clinically meaningful difference does not exist, the probability of detecting an effect will be low. As the *P*-value associated with a hypothesis test increased towards and beyond the non-significance cut off, the corresponding power of the analysis decreased. Alternatively, as power is the compliment of type II errors, low power may infer high β. As discussed in Chapter 6, Section 1, Altman (1997) and Rothman and Greenland (1998) highlight a review of 71 clinical trials that reported no 'significant' difference between the comparison groups but were later shown to be associated with a moderate effect. This disparity reflected inappropriate acceptance of the null hypothesis and high type II errors for many of these 'negative' results.

Type II errors occur when the magnitude of an effect, biases and random variability combine to give results compatible with the null hypothesis, either because the difference is small or the observations are too few (Rothman and Greenland, 1998). Ideally, α and β should be specified by investigators prior to commencing a research hypothesis. In common with the present investigation, the probability of committing a type I error is almost always stated in advance, with the alpha level conventionally set at 5%. In contrast, depending on the research hypothesis, the probability of committing a type II error, β, may or may not be determinable (Thrusfield, 1995). The value of β depends on a number of factors including the significance level adopted, the variability of the sample data, the effect size that one is interested in and the number of observations available, and is thus difficult to estimate. Since power equates to the probability of not committing a type II error, factors influencing β will directly influence power. Therefore, when interpreting low power, the fundamental problem of having an inadequate sample size must be taken into consideration. Consequently, the possibility that the low powers achieved in the present investigation reflected the unequal sample size allocation, as well as an inappropriately small total sample size, cannot be ignored. With such a scenario, small but biologically significant differences would be neglected as risk factors for canine relinquishment. The original power analysis undertaken simply

reports that the power was inadequate to apportion significance to the small effect sizes present.

In the present study, failure to achieve a power of 80% was investigated further by performing additional analyses. With power fixed at 80%, the necessary sample size to detect the difference determined by the hypothesis test under consideration, and the smallest magnitude of effect that would be detected with a power of 80% and no adjustment in sample size, were calculated. From this second analysis, many of the sample sizes calculated were considered to exceed practical limitations. Interpretation of the magnitude of effect detected with a power of 80% is more complicated. Statistical methods to assess the power of a hypothesis test which compares two groups of specified size, usually requires that the smallest difference, to infer that the effect is biologically or clinically valuable, is specified. It is this requirement that is somewhat artificial and difficult to define (Altman, 1997). Such detail is often determined by a arbitrary judgement unless results from prior research are available (Rothman, 1986). Lack of data on canine relinquishment precluded such a specification in the present investigation. As an alternative, the smallest magnitude of effect that would be detected, with power fixed at 80%, was calculated and an attempt made to confer biological significance to this value.

With regard to continuous variables, the effect size represents the difference in group means divided by the common standard deviation for the study groups. Consequently, multiplying the required effect by the common standard deviation would illustrate the difference in means which would be detected with a power of 80%. For example, an effect size of 0.44 would be detected with 80% power for the variable 'age at acquisition'. Multiplied by the common standard deviation (16.9 months), reveals that a 7.4 month difference in age at acquisition between case and control households would be associated with a power of 80% and the conclusion that this variable was a significant risk factor for canine relinquishment. Similar manipulations to the detected magnitude of effect for the variable 'age when neutered' revealed a 20.5 month difference between case and control households. While effect sizes less than those stated above would have failed to reject the null hypothesis due to low power, deciding whether a smaller difference would represent a clinically important effect is difficult. As mentioned above, this difficulty stems from lack of previous studies to characterise the

association of these two factors with relinquishment. It is therefore impossible to know, whether the 'non-significant' effects detected in the univariable analysis represent small but clinically meaningful differences that require a larger sample size or less disparate apportionment of comparison groups to correctly identify them as risk factors for canine relinquishment.

For hypothesis tests involving dichotomous variables, the effect size specified was the odds ratio. The odds ratio represents the odds that a case is exposed to the hypothesised risk factor divided by the odds that a control is exposed. A ratio of one indicates that the variable in question is equally distributed in case and control households. A ratio greater than or less than one indicates that presence of the factor in question is associated with an increased or decreased risk of relinquishment, respectively. The magnitude of the departure from one is related to the strength of this association. If one was to consider odds ratios of 0.5 or less and 2 or greater as the criteria which would characterise a biologically significant effect size in association with relinquishment, examination of Table 6-5 reveals that the detectable effect size exceeds these values in each hypothesis test i.e. with power fixed at 80%, the smallest magnitude of effect that could be detected with the number of cases and controls available in this study are less than 0.5 and greater than 2. These findings suggest that for the hypothesis tests under consideration, only when the magnitude of effect exceeds that considered clinically significant would the test be associated with adequate power to correctly reject the null hypothesis. Consequently, small but clinically valuable differences may have been missed.

A number of the hypothesis tests with binomial outcomes and with non-significant or only marginally significant effects detected at the univariable stage of analysis, have been found by other researchers to be significant risk factors for relinquishment. For example, 'sexual status of the dog', 'the role the respondent expected their dog to play', 'attendance at obedience training', and 'behavioural problems' have all been reported to be associated with relinquishment (Bailey, 1992; Kidd *et al.*, 1992a; Kidd *et al.*, 1992b; Alexander and Shane, 1994; Hart and Kidd, 1994; Scarlett *et al.*, 1994; Houpt *et al.*, 1996; Miller *et al.*, 1996; Patronek *et al.*, 1996a; Patronek *et al.*, 1996b; Ledger, 1997; National Council on Pet Population Study and Policy, 1997; Salman *et al.*, 1997; Digiacomo, Arluke and Patronek, 1998). Failure to associate these variables with relinquishment in the present investigation may have reflected an inadequate sample

size and the unequal apportionment of comparison groups. However, analysis of Table 6-5 indicates that for 'sexual status of the dog', 'the role the respondent expected their dog to play', and 'the presence or absence of behavioural problems', to achieve a power of 80% and thus have confidence in the accuracy of our non-significant inference, sample size requirements would exceed practical limitations. This was interpreted as indicating that the small effect size detected with respect to these parameters, reflected a true, non-significant difference between case and control households and thus these variables were correctly rejected as risk factors for canine relinquishment.

Conversely, 'attendance at obedience training', would have achieved a power of 80% with a sample size of only 537. An inadequate number of observations may therefore, have contributed to the low power and incorrect retention of the null hypothesis for this variable. Interestingly, 366 households provided details about attendance at obedience training, similar to other hypothesis tests that achieved a power of greater than 80%. However, when observations are too few to achieve adequate power, both the number of study subjects available and the prevalence of the variable in the reference population should be considered. A low prevalence requires a larger sample size to detect a specific magnitude of effect. Consequently, low prevalence of attendance at obedience training for both case and control households was presumed to be a major contributory factor in achieving the less than desirable power for this analysis. The role of this variable as a risk factor for relinquishment can not be accurately inferred from this study and requires further analysis with a sample size as large as or exceeding that suggested in Table 6-5.

The non-significant association between behavioural problems and relinquishment was believed, as discussed above, to reflect a correct rejection of this research hypothesis. In contrast, behavioural problems have consistently been reported as a risk factor for canine relinquishment, as described in Chapter 1, Section 3. However, the specific types of problem behaviour have not always been specified. Whilst similar dog behaviour may be perceived differently by individual owners, certain behavioural characteristics are consistently considered as problematic (Ledger and Baxter, 1997a). Consequently, the role of behavioural problems in association with relinquishment may relate to certain types of problems only. Whilst the type of behavioural problem displayed by dogs was not found to be associated with relinquishment in the study outlined in Chapter 4, the power of these hypothesis tests were very low. These research hypotheses were

associated with a sample size of only 125. To achieve a power of 80% and thus have confidence in the accuracy of our non-significant inference, sample size requirements exceed practical limitations for most of these behavioural problems. This suggested true, non-significant difference between case and control households for these variables. However, the magnitude of the effects detected with a power of 80% were greater than twice the odds ratio considered clinically significant. Moreover, for the hypothesis test involving the variables 'aggression to people', 'aggression to other pets' and 'miscellaneous behavioural problems', power analysis revealed that with the available case and control households, a power of 80% was not achievable, irrespective of effect size increases. Consequently, an inadequate number of observations may have contributed to rejection of the research hypothesis with respect to these variables and small but clinically valuable differences may have been missed. Inferences regarding the association of specific types of behavioural problems and relinquishment can therefore, not accurately be made from the present investigation.

Considering categorical variables, interpretation becomes even more complex. Some of the sample sizes required to achieve a power of 80% exceed what would be considered practically achievable. However, for others, the sample size estimates are reasonable and easily met. One therefore needs to assess the magnitude of effect that would be detected with a power of 80%, and consideration given to whether these effect sizes exceed what would be considered biological significant. Difficulty arises, however, because the effect size specified reflects the common variance of group proportions divided by a multiple of the average group proportion. Neither of these values are easily interpretable with any clinical relevance. Moreover, the smallest effect size necessary to infer that the difference is biologically or clinically valuable is extremely difficult to define. Such a requirement entails estimating the expected proportion with each possible outcome for both comparison groups. Normally, previous knowledge allows one to estimate the proportion with each outcome in the control group. The requirement for the researcher is therefore, to specify the proportion with each outcome in the case group that would represent a biologically significant difference. However, departure of the case group data from the null hypothesis that states that apportionment for the two comparison groups are the same, can occur in any direction. In addition, lack of previous research may preclude predictions of control group apportionment, as was the case in the present

investigation. Moreover, specifying the proportion with each outcome is based on the expressions for the non-centrality parameter of the appropriate chi-square test, a complex statistical issue. Therefore, the adequacy of the power of hypothesis tests involving 'non-significant' categorical variables remains questionable and requires due caution when making inferences.

6.4.2 Summary

Statistical power analysis was undertaken to assess the inferences made regarding risk factors for canine relinquishment to an AWC in Strathclyde Region, Scotland. This analysis was based on data obtained from the case-control study outlined in Chapter 4. While the issue of power and sample size at the level of univariable analysis was assessed, the complex issues associated with power in multivariable analyses were not addressed. Results revealed that power of hypothesis tests were of an adequate magnitude to confer confidence in the risk factors detected. However, with regard to non-significant hypothesis, further assessment is necessary. Besides duplicating the findings of the study outlined in Chapter 4, guidelines for estimating the smallest magnitude of effect that would be considered clinically significant could be gained from such investigations. Such knowledge would permit accurate power and sample size calculations and thus ensure precision and validity in future studies. According to Dawson-Saunders and Trapp (1994), the calculation of sample size in studies with multiple independent variables requires special handling. If a researcher is interested in multiple objectives, a separate sample size analysis must be conducted for each variable. In this event, each analysis will likely yield different power and sample size requirements. Whilst the largest of the resultant estimates, or the most appropriate considering cost, may then be employed, assessment of hypothesised risk factors for relinquishment on an individual basis, should be considered. This would allow more detailed assessment of each variable and ensure that any inferences made, would accurately reflect true differences between case and control households while small, but clinically significant differences were not missed.

This chapter provides important information for future researchers seeking to formulate similar studies with appropriate sample sizes, information that is often lacking at the study design stage.

CHAPTER VII

GENERAL DISCUSSION AND CONCLUSION

CHAPTER VII

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7.1 OVERVIEW

The studies outlined in this thesis applied epidemiological and statistical techniques to investigate the pet population of Strathclyde Region, Scotland. In particular, the owned and relinquished dog populations, and the human populations that had, at some point, chosen to care for these dogs, were analysed and compared.

7.2 EPIDEMIOLOGY

Epidemiology is primarily concerned with investigating a population, with respect to the relationship between cause and effect, in terms of disease (Rothman, 1986; Mellor, 1997). One of the main objectives is to identify causal associations between exposure to potential risk factors and outcomes such as disease, with multiple interacting factors assumed to influence outcome. To succeed in its aims, every epidemiological investigation requires an appropriate, scientifically sound study design, sensible data analysis and careful data collection from the target population (Rothman and Greenland, 1998). While a census can give an accurate measurement of variables for all members of a population, they are prohibitively expensive and often not feasible to conduct. As an alternative, data for epidemiological studies are typically derived from observations made on a sample of the target population. If this subset of the population is representative, measurements taken from the sample can be generalised to the target population. An important application of epidemiological surveys is to estimate the prevalence of disease among the target population. For such estimations, a knowledge of the population size is essential (Lengerich *et al.*, 1992).

There are several types of epidemiological study designs, two of which were used in the present investigation. Cross-sectional or prevalence studies analyse data collected from a group of subjects at one point in time and as such, have no direction of inquiry.

Surveys are generally cross-sectional studies, as was the survey outlined in Chapter 2. This chapter described an epidemiological survey to estimate the pet population of Strathclyde Region, in particular the population of dogs and cats. These estimations were based on data gathered from a sample of the human population, with regard to their pet ownership status. Extrapolation of these data to the general population, allowed estimation of the population of dogs and cats. Using an area based approach, the association between deprivation, community setting and pet ownership were assessed by supplementing the information collected during the telephone survey with data retrieved from the 1991 census, together with non-census indicators of deprivation.

Case-control studies begin with a group of diseased individuals (cases) and a group of non-diseased individuals (controls). The previous events, or exposures, of these two groups are then compared to identify any potential predisposing characteristics or risk factors for the disease in question. Hence, in case-control studies the nature of the inquiry is backward (retrospective) in time. Chapter 4 described a case-control study in which the 'disease' under investigation was canine relinquishment. This particular study identified a multitude of characteristics that increased the risk of relinquishment of a dog. As a result, Chapter 5 described the application of multivariable statistical techniques in an attempt to unravel the complex relationships between the identified risk factors and relinquishment, and assess the relative importance of each. This chapter led to the development of a statistical model which could be used to quantify the odds ratios of the factors involved in relinquishment.

7.3 QUESTIONNAIRE SURVEYS

Questionnaires are one of the main instruments for epidemiological data collection and are used in a wide variety of study designs (Vaillancourt *et al.*, 1991; Bourque and Fielder, 1995; Hartge and Cahill, 1998). The method by which questionnaires are administered to a research sample determines the study strategy. There are three broad types of questionnaire strategies: personal interview, telephone or mail, which can be used individually or in combination to follow-up non-respondents (Siemiatycki, 1979). The objective of any questionnaire strategy is to collect sufficient quantities of relevant, reliable data, as efficiently as possible (Dillman, 1978; Vaillancourt *et al.*, 1991). To achieve this goal, crucial components of the study include administrative ease, cost and

time efficiency, questionnaire design, rate of response, adequacy of completion and the reliability and validity of data collected.

Scrutinising the success of data collection using questionnaires most often centres around the response rate achieved. Higher response rates increase the cost and time efficiency of a study and reduce the probability of introducing non-response bias (Battistutta *et al.*, 1983). Optimising response rates to questionnaire studies has been the subject of many investigations, with a multitude of topics addressed (Dillman, 1978; Childers and Ferrell, 1979; Battistutta *et al.*, 1983; Choi *et al.*, 1990). Along with efforts to gain a response to questionnaires, ensuring the quality of these raw data is paramount, to ascertain the accuracy of information obtained (Vaillancourt *et al.*, 1991). Such data quality assessment encompasses the adequacy or completeness and validity and reliability of responses obtained, with validity defined as the degree to which answers reflect the true state of nature, whereas reliability is the ability of a question to give consistent information on multiple trials (O'Toole *et al.*, 1986; Vaillancourt *et al.*, 1990; Slater *et al.*, 1992; Reeves *et al.*, 1996; Doherr *et al.*, 1998; Sargeant and Martin, 1998).

Several investigators have compared the efficiency of different questionnaire strategies on the above issues, with variable results reported (Hochstim, 1967; Locander *et al.*, 1976; Dillman, 1978; Siemiatycki, 1979; Battistutta *et al.*, 1983; Siemiatycki *et al.*, 1984; O'Toole *et al.*, 1986). Traditionally, the personal interview was viewed as the only reliable technique for data elicitation using questionnaires, with both mail and telephone strategies considered as poor substitutes (Siemiatycki *et al.*, 1984). Mail studies were fraught with difficulties as extremely low response rates were achieved (Dillman, 1978) and illiteracy among lower income households increased the risk of non-response bias. Telephone studies were criticised because of lower response rates and until more recent years, many households did not possess a telephone and those that did were inclined to be better educated and have higher incomes than the population average (Dillman, 1978). Both methods were also considered likely to produce a lower quality of response than the response achieved by a personal interview (Siemiatycki *et al.*, 1984).

Recently, the success of personal interviews has been questioned, with reports of declining response rates and prohibitive costs (Dillman, 1978; Siemiatycki, 1979). At

the same time, the criticism against mail and telephone strategies no longer appears to be valid in developed countries. Improvements in the administration procedure have increased response rates, there is no evidence that the quality of response is inferior and, in the UK, 91% of households have a telephone and 92% of the adult population are literate (Mellor, 1997). The use of mail and telephone strategies has thus flourished, with reports that either method, with vigorous follow-up procedures to non-respondents, can provide response rates as high as the personal interview method but at half the cost (Hochstim, 1967; Siemiatycki, 1979).

While research continues to assess the efficiency, validity and reliability of each of these questionnaire study strategies, all three methods are now extensively used. Each strategy has individual strengths and weaknesses and the best method to employ depends on the study topic, the target population and the study objectives (Dillman, 1978). Choice of strategy is often dictated by factors such as cost, time and manpower resources, questionnaire content and required response rates, and is often heavily influenced by the geographic distribution of the study population. Questionnaires were used to collect data in the present investigation applying two, appropriately selected, administration strategies. Chapter 2 utilised the telephone for questionnaire administration, whereas Chapter 4 relied on a mail strategy. The reasons for these selections have been discussed previously (Chapters 2 and 4, Sections 4). Vaillancourt *et al.* (1991) evaluated 120 veterinary articles that collected data using questionnaires and reported that mail studies were employed most frequently (45.8%), followed by personal interview (29.2%) and then telephone surveys (8.3%), with only a small percentage of researchers using a combination of these techniques. Irrespective of method used, this investigation has provided strong support for the use of questionnaires to collect data regarding animal populations. Both survey strategies achieved excellent response rates, were not overly expensive and were efficiently conducted by the author (mail strategy), with some aid from a second interviewer (telephone survey).

7.4 PET POPULATIONS

Growth in pet ownership throughout the twentieth century has been dramatic and dogs and cats have become increasingly important companions (Carding, 1975; Council for Science and Society, 1988). Besides dogs and cats, several other species are adopted as

pets (Kremzier Smith, Salman and Wimsatt, 1998). In most developed countries, roughly half of all households now own companion animals (Council for Science and Society, 1988; Beck and Meyers, 1996). Unfortunately, this rise in the owned pet population has been accompanied by an increase in the number of abandoned, unwanted companion animals, identified as a surplus of ownerless pets. Consequently, since 1970 there has been growing concern about a critical overpopulation problem in dogs and cats. Despite this, there has been little objective study into companion animal ownership, the population of dogs and cats or the problem of abandoned and euthanatised pets.

While data gathered from pet population studies would provide fundamental information for many considerations, no accurate estimates of the total canine and feline populations in the UK are available. In the present investigation, through a telephone survey of a randomly selected sample of households, the dog and cat populations of Strathclyde Region were estimated to be 248,649 and 170,044, respectively. This dog population was owned by 185,589 households and the cat population resided in 121,235 households. These data provide baseline dog and cat population statistics for Strathclyde, based on the owned pet population but take no account of the numbers of feral and stray animals or the AWC population of dogs and cats.

From the above figures, one could attempt to estimate the proportion of the owned dog and cat populations that were abandoned and euthanatised during 1997 and gauge the extent of pet overpopulation in Strathclyde. This could be achieved by applying these figures to the data available from the four SSPCA AWCs operating within the study region (Tables 4-1 and 4-2). For example, 8,290 dogs were handled by these centres and 1495 of these dogs were euthanatised, which represents 3.3% and 0.6% of the estimated canine population, respectively. Likewise, 2,435 cats were handled and 290 were euthanatised, representing 1.4% and 0.2% of the feline population, respectively.

While these calculations provide a rough approximation of the magnitude of the pet population problem in Strathclyde, they are not accurate. Based on anecdotal evidence, it was assumed that the animals handled by the four participating SSPCA centres originated exclusively from within the study region. However, no direct confirmation of this was made i.e. by postcode evaluation of persons that relinquished animals. One of

the centres, Stirling AWC, was positioned at the periphery of the study region and as a result, could have received animals from the adjoining area, with a dog and cat population not accounted for in this study. Additionally, a fifth SSPCA AWC and an AWC operated by the Canine Defence League were situated in close proximity to the study region. Consequently, it is possible that additional unwanted dogs and cats from Strathclyde Region were preferentially relinquished to these centres, as opposed to the centres within the study region. In addition, a proportion of companion animal euthanasia performed at veterinary practices occurs without medical indication, with reports that as much as 40% of all euthanasias performed are for reasons other than ill health (Stead, 1982; Gorodetsky, 1997; Edney, 1998). Such euthanasia could potentially occur in veterinary practices within the study region. Finally, as discussed in Chapter 4, Section 4.1, the four participating SSPCA centres experienced overcrowding during the study period due to the large number of impounded strays. This necessitated the creation of a waiting list for households wishing to relinquish their pet, resulting in a system that may have reduced the number of relinquished pets that were handled. Due to these considerations, it would be inappropriate to discuss further the percentage estimations of unwanted and euthanatised animals presented above, until further studies can support these figures.

The figures calculated from the present telephone survey provide estimates of the numbers of dogs and cats in Strathclyde Region, but give no indication of the structure and dynamics of these pet populations. For example, birth rate, death rate and the cause of death, neutering rate and reproduction, the dynamics of the four local AWC populations, including strays, and the interaction between pet populations and human demographic factors, all affect pet population size and composition. Accordingly, to gauge whether there is a persistent surplus of dogs and cats, such information is essential. Of equal importance, is information regarding the optimum and or maximum number of companion animals supportable by the responsible pet owning population. Unfortunately, the precise nature of pet overpopulation and the severity of this problem in Strathclyde Region remains unknown.

Naturally the question arises, 'does dog and cat 'overpopulation' truly exist in Strathclyde Region, Scotland?' As discussed in Chapter 1, Section 3.8, there is a growing body of evidence from North America that the pet overpopulation problem in

the USA is improving (Anonymous, 1995a; Digiacomo, Arluke and Patronek, 1998). However, a more disturbing view suggests that the dimensions of pet overpopulation may have been exaggerated initially (Arkow, 1994). It has been estimated that some 500,000 companion animals are abandoned at AWCs in the UK each year, of which 200,000 represent dogs (Council for Science and Society, 1988; Ledger, 1995). While these statistics attest to the large number of owner-pet relationships that fail, they do not support the assumption that this is a consequence of genuine overpopulation. Likewise, although AWCs handle and euthanatise a significant number of dogs and cats, previous studies have indicated that those euthanatised are not puppies and kittens (Patronek and Glickman, 1994; Murray and Speare, 1995; Patronek *et al.*, 1995), with reports from North America that in some areas, with insufficient supplies of puppies and kittens for adoption, AWCs have resorted to importing animals from other areas to meet demands (Kahler, 1992; Patronek *et al.*, 1995; Digiacomo, Arluke and Patronek, 1998). Consequently, although AWC euthanasia has been called the leading cause of death for dogs and cats (Olson, 1991; Kahler, 1993a; Sturla, 1993; Arkow, 1994; Patronek, 1996; Patronek *et al.*, 1996a; Stubbs, Salmeri and Bloomberg, 1996; Giacomo, Arluke and Patronek, 1998), it seems more appropriate to define the problem as the destruction of healthy animals, as a result of unwanted and abandoned pets.

The overbreeding of companion animals, dubbed 'pet overpopulation', was targeted as the leading cause of companion animal euthanasia (Digiacomo, Arluke and Patronek, 1998). A problem defined as overpopulation appeared easy to resolve. The most obvious method to control further growth in the canine and feline populations was to prevent reproduction (Schneider, 1975). However, despite an increased number of surgically neutered pets, AWCs are still overwhelmed with homeless dogs and cats and destruction of healthy companion animals continues (Lane, 1998). Consequently, as discussed in Chapter 1, Section 4, researchers are now sceptical as to whether neutering the pet population will ever work. Instead, it has been recognised that the factors that contribute to unwanted and abandoned companion animals must be established through appropriate studies and analysis.

With regard to Strathclyde Region, inspection of Tables 4-1 and 4-2 suggests that the problem stems from stray animals and relinquished pets. As discussed in Chapter 1, Section 3.9, most recent investigators have reported that approximately one half or less

of the AWC population are represented by impounded stray animals. Analysis of the AWC data available for Strathclyde Region suggests that this appears to be true for cats. However, impounded strays are much more prevalent in the AWC dog population, with a ratio of 2.37 strays to every one relinquishment. This finding may reflect the overcrowding in the SSPCA centres due to the large number of impounded strays, causing an artificially lowered proportion of relinquished dogs. Irrespective of this, these data imply that Strathclyde Region is experiencing a problem of excessive numbers of stray dogs. Intuitively, one could assume that stray animals are a consequence of inadequate supervision, restraint and control of a pet by its owner. However, certain dogs, in particular males, may be more prone to escaping confinement and roaming. According to the available AWC data, only 30.1% of the stray dogs impounded in 1997 were redeemed. Knowledge that about two thirds of strays remain unclaimed may indicate that many owners are not even trying to locate their lost pet. Meanwhile, these pets contribute a significant encumbrance on the Strathclyde SSPCA AWCs. Hence, methods must be sought to decrease the number of strays impounded and increase the numbers redeemed.

While research can establish the characteristics of stray animals, their owner characteristics often remain unknown. This highlights the requirement for compulsory identification of dogs, with the establishment of traceable methods. Consequently, legislation ensuring that all animals are registered and permanently identified, using implanted microchips or tattoos, is desirable in the UK. Besides substantially increasing the number of identifiable stray animals that can be returned home, such legislation will assist the research community in their ability to define the characteristics of households abandoning their pets. As discussed in Chapter 1, Section 3.6, if compulsory registration at the point of acquisition necessitated paying a reasonable fee, it may also discourage casual and impulsive pet acquisition (Carding, 1975; Woodrow, 1975; Council for Science and Society, 1988; Murray, 1992b).

7.5 CANINE RELINQUISHMENT

Relinquished pets are the other main category of animals that inundate the SSPCA AWCs. With regard to these, Chapter 4 described an epidemiological investigation of surrendered dogs and their relinquishing owners. Specifically, this case-control study

directly compared information about dog and household characteristics of the relinquished population with a sample of successfully owned dogs and their owners. The results of this study indicated that several risk factors were associated with canine relinquishment, implying that many variables may influence the success of a relationship between an owner and their dog. Although certain dog characteristics were identified as important contributors to the risk of relinquishment, most of the predisposing characteristics identified were related to the owner.

Although circumstances may arise during an animal's life that may force the owner, through no fault of their own, to relinquish ownership of that animal, AWCs have become a 'dumping' ground for unwanted pets. The results of Chapter 4 suggested that in a high proportion of cases these unwanted animals are acquired impulsively by people who become reluctant to commit the time, effort and money necessary for responsible pet ownership. According to Arkow (1991), these animals then become 'products of broken bonds, people pet relationships that failed to mature or are severed because of trivial reasons, lack of planning or patience by the owner or by the animal failing to meet the owners expectations'. This opinion was supported by the findings of the present investigation. Unfortunately, solutions to prevent relinquishment, a breaking of the human-companion animal bond, are less obvious than simply decreasing companion animal reproduction (Patronek, 1996). Perhaps measures of attachment between owners and companion animals and the factors underlying and enhancing this bonding, could be the focus of future research. Determining these factors may maximise the opportunity for owner-dog relationship to be successful (Miller *et al.*, 1996; Ledger, 1997). To accomplish such a task, human psychology may have a role to play.

The role of socio-economics in pet relinquishment may also pose as an important area for future investigation, especially in light of the findings of the study outlined in Chapter 3. The results of this investigation suggested that pet ownership is less likely in households that are materially poor and socially disadvantaged. Accordingly, besides decreasing the propensity to own a pet, financial pressures may also put the human-companion animal relationship and the welfare of companion animals at risk. It has been reported for example, that instances of companion animal abuse, neglect and presumably abandonment occur more frequently in families with low incomes (Council for Science and Society, 1988). While lower household income was found to be significantly more

prevalent in case households than control households in the study described in Chapter 4, the non-equivalence of household income and deprivation has been discussed previously (Chapter 3, Section 1). However, one could hypothesise that a significant number of the risk factors identified in Chapter 4 were related to the socio-economic status of households and appropriate to consider in terms of deprivation. For example, living in rented accommodation, living in a flat, absence of a garden and insufficient veterinary care could be consistent with inadequate financial resources. In addition, mixed breeds were over represented in the relinquished dog population and Godwin (1975) reported that ownership of a pedigree dog was significantly less in the lower socio-economic groups. Thus, household deprivation may be featuring as a risk factor for relinquishment. However, as discussed in Chapter 4, Section 4, although owners who genuinely can no longer afford the basic care for their pet may have encountered some unexpected poverty, more often they cannot afford to properly maintain the pet from the outset. Consequently, ensuring that potential pet owners are informed about the financial commitments involved in owning a companion animal may be a requirement.

A disturbing finding from the present study was the high proportion of relinquished animals that originated from an SSPCA AWC. Although the preferential adoption system that was in operation during the study period may have artificially raised this proportion, other researchers have described similar findings, with reports that between 19 to 50% of dogs adopted from an AWC are later returned (Van der Borg, Netto and Planta, 1991; Netto, Van der Borg and Planta, 1993; Patronek and Glickman, 1994; Ledger, 1995; Ledger and Baxter, 1997a). These statistics suggest that a reasonable proportion of dogs that are rehomed by AWCs are contributing to these failed owner-dog relationships. However, the reasons for unsuccessful placement of dogs are unclear. Some researchers have suggested that dog factors may be important, implying that AWCs are simply recycling problem animals (Arkow and Dow, 1994; Council for Science and Society, 1988). In most AWCs, limited kennel space and funding creates a situation where staff must decide which animals should be euthanatised and which should be made available for adoption. With regard to this, both the physical health and behaviour of dogs are assessed.

AWCs are high risk environments for many infectious diseases and carry the reputation of re-homing sick animals, with evidence to suggest that dogs purchased from AWCs

are often unhealthy (Levine, 1984a; Wells and Hepper, 1999b). Physical ailments have also been reported to be the most common reason that dogs are returned within the first few weeks of adoption (Scarlett, Saidla and Pollock, 1994; Wells and Hepper, 1999b). Accordingly, careful management practices are imperative steps to reduce the risk of disseminating contagious diseases in the AWC environment and therefore, reduce the number of adopted animals that are subsequently returned (Vonesch, 1975; Levine, 1984a; Levine, 1984b; Wells and Hepper, 1999b).

Considering dog behaviour, the use of standardised temperament and behavioural test have been advocated to ensure that only dogs suitable as pets are adopted (Van der Borg, Netto and Planta, 1991; Netto, Van der Borg and Planta, 1993; Ledger, 1995; Ledger, 1997; Ledger and Baxter, 1997a; Ledger and Baxter, 1997b; Bailey, Hetherington and Sellors, 1998). In one study, the use of such tests predicted 74% of the problem behaviours, whereas only one third was correctly predicted by AWC staff (Van der Borg, Netto and Planta, 1991). Based on certain dog characteristics reported by the previous owner, Posage, Bartlett and Thomas (1998) built a logistic regression model to predict successful adoption of dogs from AWCs. However, the results indicated that the model failed to predict significantly more successful adoptions than AWC staff were already achieving, using their own subjective measures to assess dogs. This finding suggests that while animal factors may be important, owner characteristics and other unidentified factors may also influence the variability in adoption success. Accordingly, besides the physical and behavioural evaluation of animals, future schemes for rehoming stray and relinquished animals should encompass an assessment of owner suitability (Netto, Van der Borg and Planta, 1993; Ledger and Baxter, 1997b).

While many AWCs have elaborate screening procedures for people wishing to adopt a new pet, AWCs may need to place greater emphasis on ensuring that a suitable owner-dog match is made. 'Selectadog', a programme which has been in operation in the UK since 1975, is designed to match the main characteristics of popular dog breeds to the circumstances of potential owners, as identified by means of a questionnaire (Edney, 1987). AWCs could adapt this programme to give guidance to anyone thinking of adopting a dog and aid in the selection of future pet owners. Having a policy whereby it was compulsory for potential adopters to complete a questionnaire, should encourage people to think about points relevant to caring for a dog before they commit to a

prolonged period of responsible pet ownership. Likewise, in the present investigation, Chapter 5 outlined a multivariable logistic regression model that could be used to assess the likelihood of canine relinquishment, based on dog and household characteristics. Although no external validation of this model has taken place, if proven to be accurate, use of this model in the AWC environment may be applicable to the reduction of the number of unsuccessful dog-household combinations.

Worthy of mention at this point, is the role AWCs may play in maintaining a permanent supply of unwanted and abandoned pets. For example, AWCs actively market cheap, readily obtainable animals which may encourage the haphazard and impulsive buyer. As suggested by Mann (1975), 'it is often true that those things most easily acquired are least valued'. A large number of AWCs exist in the UK, provided and run by animal welfare societies and by private individuals and trusts. This easy availability of surplus pets in AWCs may encourage many casual owners to adopt (Carding, 1975). For example, in a study conducted in Northern Ireland, AWCs were mentioned most frequently as a place to purchase dogs (Wells and Hepper, 1992). As discussed previously (Chapter 1, Section 3.9), the knowledge that AWCs exist to offer temporary shelter and to re-home unwanted pets, also offers an appealing and cheap disposal option for uncommitted pet owners. Consequently, it has been suggested that this efficient provision for unwanted pets, may paradoxically be acting as a positive contributing cause of pet owner carelessness and perpetuating the problem of abandonment (Woodrow, 1975; Murray, 1992b). On the other hand, one study revealed that attempts to prevent relinquishment, by poorly informed pet owners, are frequently unsuccessful and AWCs are then viewed as a last resort (Digiacomo, Arluke and Patronek, 1998). Undeniably, AWCs are indispensable for the shelter and care of injured, abandoned and homeless animals. However, current policies with regard to relinquishment and adoption may require some re-evaluation.

7.6 CONCLUSION

Despite many new observations, much remains unknown about the factors that cause animals to become dispensable and left unclaimed at an AWC. Dog and cat ownership patterns and the question of pet neglect, abandonment and surrender must be characterised further. Primarily, the determinants of responsible pet ownership must be

defined including registration, training and regular veterinary care. In addition, multicentre epidemiological studies are required to collect comprehensive data that will characterise the animal population abandoned or surrendered to AWCs and their owners. Included in such an analysis should be companion animal veterinary practices due to the proportion of the unwanted pet population, albeit small, that are euthanatised there. Additional research should directly compare the characteristics of surrendered pets and the households that relinquish ownership of them, with successful owner-pet relationships, to duplicate the findings of this study. The dynamics of animals within AWCs and the factors influencing the likelihood of reclaim, adoption or euthanasia should also be the focus of future research. Such information will aid in identifying appropriate intervention measures to ensure the future welfare of our pet population.

APPENDIX I

BRITISH CENSUS 1991

TABLE I-1: Demographic statistics for Strathclyde Region, Scotland as accessed from the 1991 Census on CD-ROM: subdivision of the human population into ethnic groups.

ETHNIC GROUP	POPULATION
White	2 213 585
Black Caribbean	411
Black African	1 152
Other Black	1 156
Indian	6 795
Pakistan	14 627
Chinese	327
Other Asian	5 201
Other ethnic groups	1 863
Born in Ireland	3 589
TOTAL	2 248 706

APPENDIX II

BRITISH TELECOMMUNICATIONS PHONE BOOKS

TABLE II-1: BT phone books used to select the research sample, for a telephone survey undertaken in Strathclyde Region, Scotland to determine the pet ownership status of 2000 randomly selected households.

PHONE BOOK NUMBER (Date book was published)		AREA WITHIN STRATHCLYDE REGION THAT PHONE BOOK COVERS
276	(March 1996)	CLYDE VALLEY
277	(April 1996)	CLYDE COAST
278	(Sept. 1995)	LOMOND & ARGYLL
518	(Aug. 1996)	GLASGOW (CITY) NORTH
519	(July 1996)	GLASGOW (CITY) SOUTH

TABLE II-2: Proportion of the research sample selected from each regional BT phone book, for a telephone survey undertaken in Strathclyde Region, Scotland to determine the pet ownership status of 2000 randomly selected households.

BT PHONE BOOK	NUMBER OF PAGES LISTING RESIDENTIAL NUMBERS	NUMBER OF RESIDENTIAL LISTINGS*	PROPORTION OF RESEARCH SAMPLE**
276	288 (pp193 - 480)	138528	329
277	495.5 (pp205 - 700)	238335.5	565
278	295.5 (pp157 - 452)	142135.5	337
518	305.5 (pp299 - 604)	146945.5	348
519	369.5 (pp299 - 668)	177729.5	421
TOTAL	1754	843674	2000

* Number of residential telephone numbers listed within each BT phone book

Number of pages listing residential telephone numbers x 481
(481=approximate number of telephone entries in 1 page of a phone book)

** Calculation of the proportion of research sample to be selected from each book

$$\frac{\textit{Number of residential listings in each book}}{\textit{Total number of residential listing for all five books}} \times 2000 = \textit{Proportion of sample}$$

APPENDIX III

RANDOM NUMBER GENERATION

TABLE III-1: Formulae used to generated three lists of random numbers within Microsoft Excel for Windows 95, Version 7, for each of five regional BT phone books that were used to select the research sample, for a telephone survey undertaken in Strathclyde Region, Scotland to determine the pet ownership status of 2000 randomly selected households.

LIST NUMBER	CATEGORY	FORMULA
1	Page number	=(RAND()*X)+Y ♦
2	Column number	=(RAND()*3)+1
3	Row measurement	=(RAND()*27.5)+0.5 ♦♦

♦ X = Number of pages listing residential phone numbers for each BT phone book

Y = Page number of each BT phone book that represents the first page listing residential phone numbers

♦♦ 0.5 (cm) - measurement from the top of the page to the first entry in each page of the BT phone book

28.0 (cm) - measurement from the top of the page to the last entry in each page of the BT phone book

27.5 (cm) - measurement between the first and the last entry on each page

TABLE III-2: Example of part of the three lists of randomly generated numbers, for one of the five BT phone books used to randomly select the research sample

RANDOM DIALLING FROM DIRECTORY

PHONE BOOK CLYDE VALLEY 276

288 pages residential numbers

329 numbers to be selected

Random Selection

	PAGE	COLUMN	ROW(CM)
1	292	4	24.8
2	412	3	2.8
3	442	1	7.8
4	244	2	6.7
5	321	1	10.1
6	478	3	27.5
7	418	3	8.3
8	304	2	6.9
9	213	2	26.4
10	477	3	10.1
11	291	3	15.3
12	291	3	18.5
13	353	3	6.9
14	353	1	7.9
15	323	1	2.8
16	314	3	0.6
17	402	4	0.7
18	269	4	16.4
19	441	3	14.3
20	196	4	4.0
21	209	3	25.8
22	418	1	25.9

APPENDIX IV

QUESTIONNAIRE FOR TELEPHONE SURVEY

Hello. Is that the ..... residence?

Response 1a. NO

I am sorry, I appear to have dialled the wrong number.

Terminate call.

Response 1b. YES

My name is Fiona Gregory.

I am a Vet. Surgeon working at the University of Glasgow Vet. School.

We are currently undertaking a research study to determine information about pet ownership.

Could I ask you if you own any pets at present ?

Response 2a. NO

Thank you very much for your time.

Terminate call.

Response 2b. YES

Please specify / what pet animals do you own?

----------*(record details of pet on sheet)*

Response 3a.

Cat owned but no dog owned.

Could I ask you how many cats you currently own ?

Response 3b.

Pet owned other than dog or cat.

Thank you very much for you time.

Terminate call.

----------*(record details of number on sheet)*

Thank you very much for your time.

Terminate call.

OR

Response 2b. YES

Please specify / what pet animals do you own?

----------*(record details of pet on sheet)*

Response 3c.

Dog and cat owned.

Could I ask you how many cats you currently own ?

----------*(record details of numbers on sheet)*

Response 3d.

Dog owned but no cat owned.

Could I ask you how many dogs do you currently own?

----------*(record details of number on sheet)*

We would like to ask you to share your experience of dog ownership and how you interact with your pet. To prevent taking up too much of your time on the phone, we are conducting our survey by means of a mailing questionnaire. Would you be willing to participate in our survey ?

Response 4. NO

Thank you very much for your time.

Terminate call.

Response 5. YES

Can I just confirm your name and address.

Read from phone book

If correct copy details onto sheet

If incorrect request details from respondent

Households will be randomly selected from our telephone list of dog owners. Questionnaires will be distributed to households over the next few weeks so you may receive a questionnaire during this period.

If you do receive a questionnaire, I would be most grateful for your time and co-operation with this survey.

Thank you very much for your time this evening.

Terminate call.

APPENDIX V

DATA RECORDING AND STORAGE (1)

I.D No	BT Phone Book No	Page No	Column No	Telephone No	Name & address	Postcode	1st call*	2nd call*	3rd call*	Pets owned
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										

CODES*

No answer	**NA**	Answer machine	**AM**	Invalid telephone number	**NN**
Response - do not own pet	**RNP**	Response - dog owner	**RD**	Response - cat owner	**RC**
Response - own other pets	**RP (specify pet)**				

ID Number	20
BT phone book number	519
Postcode2	G75 8XU
1st Call	NA
2nd Call	RD
3rd call	
Dog Owner	✔
Number of dogs	1
Cat Owner	☐
Number of cats	0
Rabbit Owner	✔
Hamster Owner	✔
Gerbil Owner	☐
Mouse/Rat Owner	☐
Guinea Pig Owner	☐
Bird Owner	☐
Fish Owner	✔
Horse Owner	☐
Other	

Combo boxes

APPENDIX VI

DEFINITION OF CATEGORIES USED WITHIN AN ANIMAL WELFARE CENTRE

Incoming category	Animals that are admitted to each animal welfare centre are classified into one of three categories (see below).
Surrendered animal	An animal relinquished to the centre by their owner.
Stray animal	An animal found running at large in the community by a member of the public, police officer, dog warden or SSPCA inspectorate.
Temporary refuge	An abused, injured or sick animal brought into the centre by an SSPCA inspectorate enforcing anti-cruelty status.
Outcome	Animals within the animal welfare centre have three options as to their fate (see below).
Reclaimed animal	A stray or surrendered animal returned to its original owner.
Adopted	A stray or surrendered animal that is rehomed to a new household.
Euthanasia	The humane destruction of animals due to ill health, temperament problems or healthy animals that are not rehomed and no space exists for them in the animal welfare centre.
No kill centres	Animal welfare centres that do not euthanatise any animals unless for health problems.
Pure breed rescue organisation	An organisation of dog breeders that temporarily adopt purebreed dogs from an animal welfare centre, with the goal of rehabilitating them and then finding a suitable permanent home.

APPENDIX VII

DATA RECORDING AND STORAGE (2)

I.D No	NAME	STREET	TOWN 1	TOWN 2	POST CODE	NEW ID No	OWNER
1056	Mrs A. Brown	41 .....Avenue	Clydebank		G82.....	1	Mrs Brown
1098	Mrs V. Smith	2 .....Drive	Glasgow		G12 ...	2	Mrs Smith
1099	Mr Black	115..... Road	Bearsden	Glasgow	G33 ...	3	Mr Black
1123	Mr Smith	78 .....Avenue	Cumbernauld	Glasgow	G62.....	5	Mr Smith
1178	Mrs Reid	27.....Drive	Glasgow		G14. ...	6	Mrs Reid
1299	Mr White	225..... Road	Dumbarton		G44.....	7	Mr White
1307	Mr Brown	5 .....Avenue	Kilmarnock		KA.....	9	Mr Brown
1311	Mrs Clark	52 .....Drive	Paisley		PA ...	10	Mrs Clark
1345	Mrs Black	85.....Road	Bearsden	Glasgow	G33 ...	11	Mrs Black

ID Number	76	10 Already neutered	0	20 Breeding	0
1 Dog	1	10 Instructed	0	20 Showing	0
1 Cat	0	10 Adviced by source	0	20 Sport or work	0
1 Rabbit	2	10 Adviced by vet	0	20 Guard dog	3
1 Hamster/Gerbil	0	10 Non breeder	0	20 Exercise	0
1 Mouse/Rat	0	10 Male behaviour	0	20 Other	
1 Guinea-Pig	3	10 Inconvenience	0	21 Fulfil role	Always
1 Bird	0	10 Health reasons	1	22 Behavioural advice	✔
1 Fish	0	10 Other		23 Source of advice	More than one sourc
1 Other		11 Litter of pups		23 Other	Book, vet
2 Previous pets	✔	12 Litter was		24 Advice given	After acquisition only
3 Natural death	1	13 Accidental	0	25 Dog spends time	Free to roam in hom
3 Euthanaisa	0	13 Benefit of dog	0	26 Dog outside	Supervised at all tim
3 Killed	0	13 Benefit of children	0	26 Other	
3 Relinquished	0	13 Benefit of family	0	27 Dog interaction	2 to 3 hours
3 Given away	0	13 Advised by vet		28 Obedience training	No
3 Sold	0	13 Advised by non vet		28 Reason	
3 Went missing	1	13 Make money	0	29 Problem behaviour	
3 Other		13 Other		30 Type of problem	
4 Years	14	14 Years	0	30 Other	
4 Months	2	14 Months	0	31 How often	
4 Weeks	0	14 Weeks	5	32 Visit vet	Once a year
5 Type of dog	Mixed breed	15 Source	Amateur breeder	33 Expectation	Less than expected
5 Breed of dog	X Labrador/collie	15 Other	Advertisement "free t	34 Family member	Strongly believe
6 Sex of dog	Male	16 Cost	£0.00	35 Sex	Male
7 Neutered	✔	17 Responsibl	You alone	36 Household	Family with children
8 Disagree	0	17 Specify		36 Number of children	2
8 Personal preference	0	18 Decision	Vaguely discussed	37 Accomodation	Rented house
8 Advised by vet	0	19 Physical character	0	37 Other	
8 Advised by non vet	0	19 Behaviour	0	38 Garden	Yes and fenced
8 Cost of surgery	0	19 Cost	3	39 Time in present home	5 years to less than 1
8 Safety	0	19 Breed	0	40 Qualifications	Attended further edu
8 Side effects	0	19 Breeder	0	41 Taxable income	Between £21,000 an
8 Breed in future	0	19 Timing	2	41 Other	
8 Neuter in future	0	19 Homeless	1		
8 Other		19 Other			
9 Years	11	20 Companion to family	1		
9 Months	0	20 Companion to pets	0		
9 Weeks	0	20 Teach children	2		

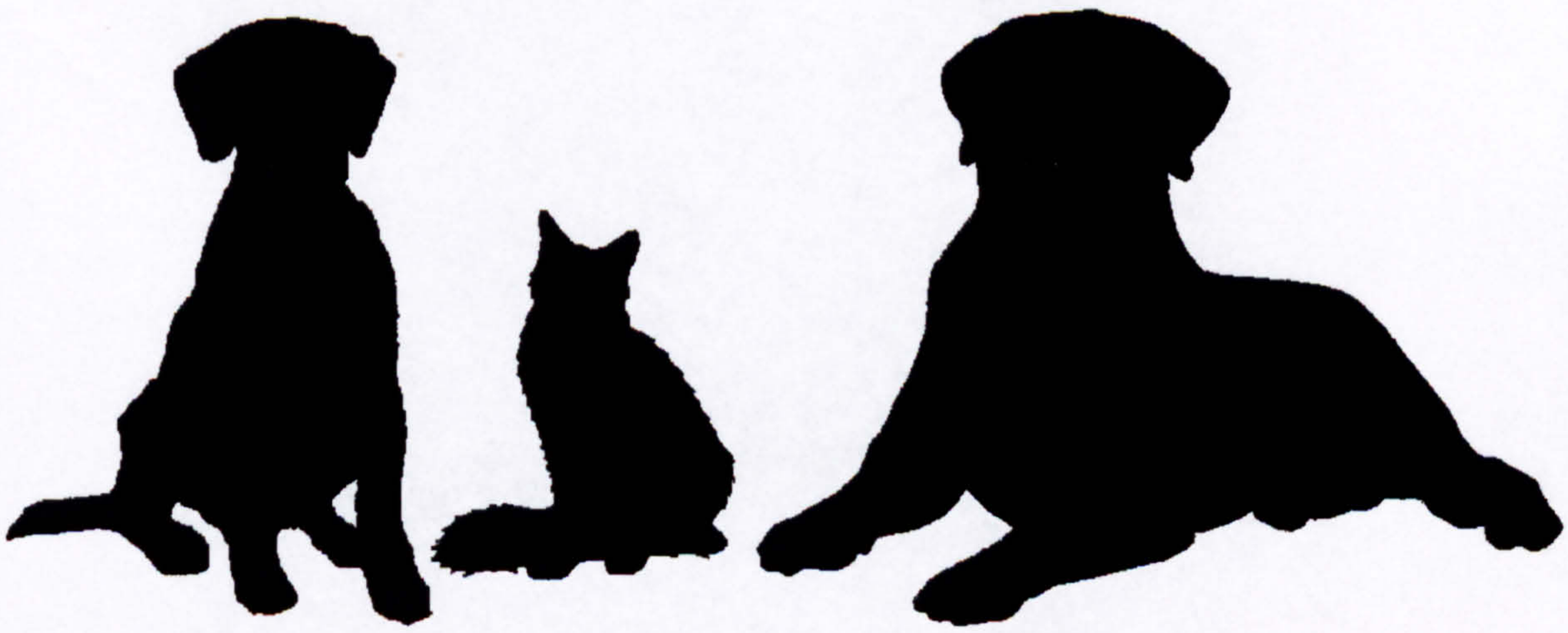
APPENDIX VIII

QUESTIONNAIRE - CASE AND CONTROL HOUSEHOLDS

FRONT COVER (CONTROLS)

UNIVERSITY
of
GLASGOW

COMPANION ANIMAL OWNERSHIP

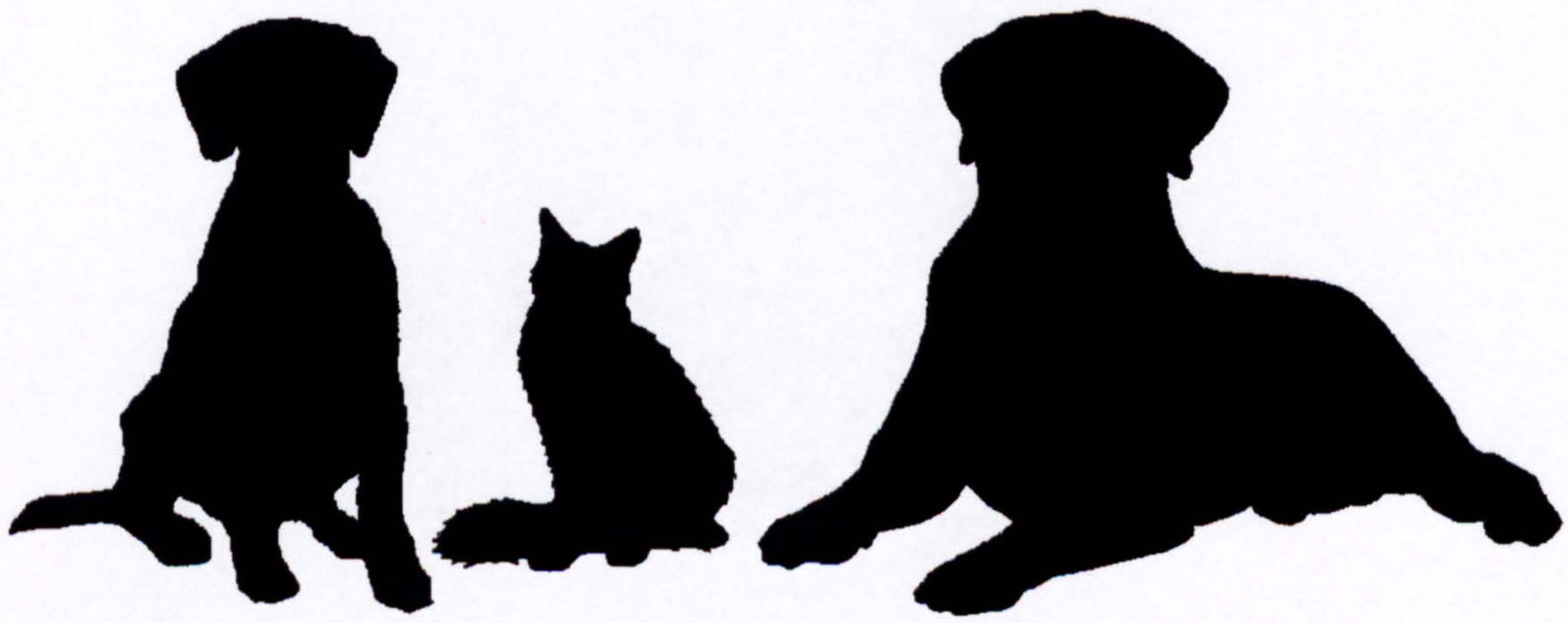


.I.D. No

FRONT COVER (CASES)

UNIVERSITY
of
GLASGOW

COMPANION ANIMAL OWNERSHIP



Information regarding the current population of companion animals, household characteristics associated with companion animal ownership and the way in which owners interact with their pets is not known.

In order to gain this information, a survey is currently being undertaken at the University of Glasgow Veterinary School. We would like to ask people to share their experience of dog owning and how they interacted with their dog by means of a questionnaire. These questionnaires are being randomly distributed to a sample of all households, who have experienced owning a dog, in this area.

You may be assured of complete confidentiality. People who complete a questionnaire are not identified. Your name will never appear on the questionnaire.

We would like to take this opportunity to thank you for your co-operation and time.

I.D. N°

DOG OWNERSHIP QUESTIONNAIRE

Please answer the following questions regarding your experience of owning a dog. Unless otherwise stated, indicate your choice of answer by placing a tick in the box next to the category chosen. If several categories apply to you please tick all the appropriate boxes.

1. Do you currently own any of the following pets ? **(please indicate the number of each in the box)**

   - ☐ DOG
   - ☐ CAT
   - ☐ RABBIT
   - ☐ HAMSTER/GERBIL
   - ☐ MOUSE/RAT
   - ☐ GUINEA-PIG
   - ☐ BIRD
   - ☐ FISH
   - ☐ OTHER **(please specify)** _____

2. Have you previously owned <u>any</u> of the above pets (whether currently owned or not) but no longer do ?

   - ☐ YES
   - ☐ NO **(go to page 2, question 4)**

3. What was/were the reason(s) for the loss of this/these pet(s) that you no longer own ?

If more than one pet falls into one category, please replace the tick in the appropriate box with the number of pets

- ☐ NATURAL DEATH DUE TO OLD AGE OR OTHER DISEASE
- ☐ EUTHANASIA (PUT TO SLEEP) BY A VETERINARY SURGEON
- ☐ KILLED IN AN ACCIDENT
- ☐ GIVEN UP TO AN ANIMAL WELFARE SHELTER/DOG AND CAT HOME/
- ☐ GIVEN AWAY TO ANOTHER OWNER
- ☐ SOLD TO ANOTHER OWNER
- ☐ WENT MISSING FROM HOME AND DID NOT RETURN
- ☐ OTHER **(please specify)** _____

Please answer the following questions regarding the dog you currently own. If you have more than one dog, select one and answer the questions with regard to this dog only.

4. How old is your dog ? **(please indicate the approximate age if exact age is not known)**

☐ YEARS ☐ MONTHS ☐ WEEKS

5. What breed is your dog ? **(please write pure breed/predominant breed type in the box)**

☐ PUREBRED KENNEL CLUB REGISTERED
☐ PUREBRED NOT KENNEL CLUB REGISTERED
☐ MIXED BREED/MONGREL

6. What sex is your dog ?

☐ MALE (DOG)
☐ FEMALE (BITCH)

7. Is your dog neutered ('sterilised', spayed or castrated, 'dressed') ?

☐ NO
☐ YES **(go to page 3, question 9)**

8. Why have you not had this dog neutered ?

If more than one category applies to you, please replace the tick in the appropriate boxes with a number where 1-most important, 2-2nd most important, 3-3rd most important ect.

☐ DISAGREE WITH NEUTERING OF ANY DOGS UNLESS IT IS FOR HEALTH REASONS
☐ PERSONAL PREFERENCE NOT TO HAVE YOUR OWN DOG NEUTERED
☐ ADVISED BY A VET NOT TO NEUTER YOUR DOG
☐ ADVISED BY SOMEONE OTHER THAN A VET NOT TO NEUTER YOUR DOG
☐ THE COST OF THE SURGERY IS TOO EXPENSIVE
☐ WORRIED ABOUT THE SAFETY OF THE PROCEDURE
☐ WORRIED ABOUT POSSIBLE SIDE AFFECTS OF THE PROCEDURE
☐ PLAN TO USE YOUR DOG FOR BREEDING IN THE FUTURE
☐ PLAN TO HAVE YOUR DOG NEUTERED IN THE FUTURE
☐ OTHER **(please specify)** _____

Please now go to page 3, question 11

What age was this dog when it was neutered ? **(approximate age if exact age not known)**

❑ YEARS ❑ MONTHS ❑ WEEKS

10. Why was this dog neutered ?

If more than one category applies to you, please replace the tick in the appropriate boxes with a number where 1-most important, 2-2nd most important, 3-3rd most important ect.

❑ ALREADY NEUTERED WHEN YOU ACQUIRED IT
❑ INSTRUCTED, WHEN YOU ACQUIRED THE DOG, THAT IT MUST BE NEUTERED
❑ ADVISED TO BY THE PERSON/PLACE YOU ACQUIRED THE DOG FROM
❑ ADVISED BY A VET - REASONS NOT RELATED TO THE DOGS CURRENT HEALTH
❑ DID NOT WANT TO USE THE DOG FOR BREEDING/RISK UNWANTED PREGNANCY
❑ MALE BEHAVIOURAL PROBLEMS (ROAMING, MOUNTING, AGGRESSION)
❑ INCONVENIENCE OF SEASON/HEAT (BLOODY DISCHARGE, MALE INTEREST)
❑ CURRENT HEALTH REASON - DISEASE OF THE REPRODUCTIVE ORGANS
❑ OTHER **(please specify)** _____

11. Has this dog ever had a litter of pups ?

❑ YES
❑ NO **(go to page 4, question 14)**

12. Was the litter of pups _____ ?

❑ A PLANNED BREEDING AND SPECIFICALLY TIMED WITH A CHOSEN MATE
❑ ACCIDENTAL WITH A NON SPECIFIC OR UNKNOWN MATE

13. What was the reason for allowing this dog to have a litter of pups ?

If more than one category applies to you, please replace the tick in the appropriate boxes with a number where 1-most important, 2-2nd most important, 3-3rd most important ect.

❑ IT WAS ACCIDENTAL
❑ FOR THE BENEFIT OF YOUR DOG
❑ FOR THE EDUCATIONAL BENEFIT OF YOUR CHILDREN
❑ FOR THE BENEFIT OF FAMILY MEMBERS OTHER THAN CHILDREN
❑ YOU WERE ADVISED TO BY A VET OR SOMEONE OTHER THAN A VET
❑ TO MAKE MONEY FROM THE SALE OF PUPS
❑ OTHER **(please specify)** _____

14. What age was this dog when you first acquired it ?

If the dog was born in your own home please write the number 0 in all 3 boxes

☐ YEARS ☐ MONTHS ☐ WEEKS

15. From what source did you acquire this dog ?

☐ BORN IN YOUR HOME FROM A LITTER BY ONE OF YOUR OWN DOGS
☐ RECEIVED AS GIFT
☐ FOUND AS A STRAY
☐ ADOPTED FROM AN ANIMAL WELFARE CENTRE/DOG & CAT HOME
☐ A PRIVATE OWNER/FAMILY/FRIEND WHO DID NOT BREED THE DOG
☐ AN AMATEUR BREEDER (ONE OFF LITTER AND DO NOT ROUTINELY BREED DOGS)
☐ A PET STORE OR COMMERCIAL BREEDER (BREED DOGS FOR A LIVING)
☐ A SHOW/HOBBY BREEDER (BREED PEDIGREE DOGS FOR SHOWING/SALE)
☐ OTHER **(please specify)** _____

16. If bought, how much did you pay for this dog (£) ?

☐

17. Who was responsible for the decision to have this dog in the house ?

☐ YOU ALONE
☐ ANOTHER ADULT MEMBER OF THE HOUSEHOLD ALONE
☐ A CHILD MEMBER OF THE HOUSEHOLD ALONE (LESS THAN 18 YEARS)
☐ EVERYONE IN THE HOUSEHOLD DECIDED TOGETHER
☐ MOST MEMBERS OF THE HOUSEHOLD AGREED BUT OBJECTIONS WERE RAISED

(please specify) _____

18. Was the decision to get this dog _____ ?

☐ NOT PLANNED AND A SPUR OF THE MOMENT DECISION
☐ VAGUELY DISCUSSED BUT NOT PLANNED FOR A SPECIFIC TIME
☐ CAREFULLY THOUGHT OUT AND PLANNED BEFORE AQUIRING THE DOG

19. What factor(s) influenced your decision to obtain this dog ?

If more than one category applies to you, please replace the tick in the appropriate boxes with a number where 1-most important, 2-2nd most important, 3-3rd most important ect.

- ❑ PHYSICAL CHARACTERISTICS OF THE DOG (SIZE, COLOUR, APPEARANCE)
- ❑ BEHAVIOURAL CHARACTERISTICS OF THE DOG
- ❑ COST OF THE DOG
- ❑ THE REPUTATION OF A PARTICULAR BREED
- ❑ THE REPUTATION OF A PARTICULAR BREEDER/SOURCE OF DOG
- ❑ THE TIMING OF THIS DOG BECOMING AVAILABLE
- ❑ THE DOG WAS HOMELESS/ABANDONED/MADE YOU FEEL SORRY FOR IT
- ❑ OTHER **(please specify)** _____

20. What role did you expect this dog to play in the house ?

If more than one category applies to you, please replace the tick in the appropriate boxes with a number where 1-most important, 2-2nd most important, 3-3rd most important ect.

- ❑ AS A COMPANION TO HOUSEHOLD MEMBERS
- ❑ AS A COMPANION TO OTHER PETS IN THE HOUSE
- ❑ TO TEACH THE CHILDREN RESPONSIBILITIES
- ❑ FOR BREEDING PURPOSES
- ❑ FOR SHOWING OR COMPETITIONS
- ❑ FOR SPORT, HUNTING OR WORKING PURPOSES (OTHER THAN GUARD DOG)
- ❑ AS A GUARD DOG
- ❑ AS A STIMULUS FOR YOU TO EXERCISE
- ❑ OTHER **(please specify)** _____

21. Does this dog fill <u>these</u> expectations and fulfil the desired role ?

- ❑ ALWAYS
- ❑ MOST OF THE TIME
- ❑ OCCASIONALLY
- ❑ RARELY
- ❑ NEVER

22. Have you or any other member of the household ever gained information or sought advice on dog behaviour and training ?

- ❑ YES
- ❑ NO **(go to question 25)**

23. Where was this information gained ?

- ❑ FROM A BOOK/VIDEO
- ❑ FROM ATTENDANCE AT A SPECIAL CLASSES
- ❑ FROM A VETERINARY SURGEON
- ❑ FROM A VETERINARY NURSE/VETERINARY RECEPTIONIST
- ❑ FROM A DOG BREEDER/TRAINER
- ❑ FROM A FRIEND/NEIGHBOUR
- ❑ FROM AN ANIMAL WELFARE CENTRE/DOG & CAT HOME
- ❑ OTHER **(please specify)** _____

24. Was this information sought before or after acquiring this dog ?

- ❑ BEFORE ACQUISITION ONLY
- ❑ BEFORE AND AFTER ACQUISITION
- ❑ AFTER ACQUISITION ONLY

25. Where does this dog generally spend most of its time (excluding when out for walks) ?

- ❑ FREE TO ROAM IN ALL/MOST PLACES INSIDE THE HOME
- ❑ INSIDE THE HOME BUT CONFINED TO A SPECIFIC AREA
- ❑ LOCKED IN A GARAGE/BASEMENT/SHED
- ❑ LOCKED IN A DOG KENNEL
- ❑ LOOSE OUTSIDE BUT CONFINED WITHIN A GARDEN/YARD
- ❑ LOOSE OUTSIDE AND NOT CONFINED TO A GARDEN/YARD

26. When this dog is outdoors how do you know where it is ?

- ❑ IT IS SUPERVISED BY SOMEONE AT ALL TIMES
- ❑ IT IS RESTRAINED BY A CHAIN/ROPE
- ❑ IT IS CONFINED BY A FENCE (GARDEN FENCE/KENNEL FENCE)
- ❑ IT'S WHERE ABOUTS IS UNKNOWN AS IT IS FREE TO ROAM
- ❑ OTHER **(please specify)** _____

27. On average, how much time is spent each day by household members interacting with this dog (e.g. walking, playing, training) ?

- ❑ LESS THAN 15 MINS
- ❑ 15 MINUTES TO LESS THAN 1 HOUR
- ❑ 1 TO LESS THAN 2 HOURS
- ❑ 2 TO 3 HOURS
- ❑ GREATER THAN 3 HOURS

28. Did you or any other member of the household ever attend obedience-training classes with this dog after acquiring it ?

- ❑ NO
- ❑ YES AT REGULAR INTERVALS UNTIL THE DOG WAS FULLY TRAINED
- ❑ YES BUT ONLY ON A FEW OCCASIONS **(please specify reason)** _____
  _____
- ❑ YES BUT ONLY ONCE **(please specify reason)**_____
  _____

29. Do you think that this dog ever behaves/behaved in an undesirable/problematic way ?

- ❑ YES
- ❑ NO **(go to page 8, question 32)**

30. What is/was the undesirable behaviour this dog shows/showed ?

- ❑ UNWANTED BARKING
- ❑ UNWANTED CHEWING/DESTROYING INSIDE THE HOUSE
- ❑ HYPERACTIVITY
- ❑ INAPPROPRIATE URINATION/DEFAECATION (DOING THE TOILET) IN THE HOUSE
- ❑ AGGRESSIVENESS TOWARDS OTHER PETS (GROWLING, SNARLING, BITING)
- ❑ AGGRESSIVENESS TOWARDS OTHER PEOPLE
- ❑ OTHER **(please specify)** _____

31. How often is/was this behaviour displayed ?

- ❑ DAILY
- ❑ WEEKLY
- ❑ 2 - 3 TIMES A MONTH
- ❑ ONLY ONCE

32. On average, how often does this dog attend a veterinary surgery appointment (due to illness, accidents or simply for routine health checks and vaccination) ?

- ❑ NEVER ATTENDED A VET
- ❑ ATTENDED A VET WHEN YOU FIRST ACQUIRED THE DOG BUT NEVER AGAIN
- ❑ ATTENDS A VET LESS THAN ONCE A YEAR
- ❑ ATTENDS A VET ONCE A YEAR
- ❑ ATTENDS A VET TWICE A YEAR
- ❑ ATTENDS A VET MORE THAN TWICE A YEAR

33. How would you describe the time and work involved in keeping this dog ?

- ❑ MUCH MORE THAN EXPECTED
- ❑ MORE THAN EXPECTED
- ❑ SAME AS EXPECTED
- ❑ LESS THAN EXPECTED
- ❑ MUCH LESS THAN EXPECTED

34. Do the members of your household believe that dogs are family members ?

- ❑ STRONGLY BELIEVE
- ❑ BELIEVE
- ❑ NOT SURE
- ❑ DO NOT BELIEVE
- ❑ STRONGLY DO NOT BELIEVE

Finally, we would like to ask you some personal questions to help us interpret the results.

35. What sex are you ?

- ❑ MALE
- ❑ FEMALE

36. Please indicate which situation below best describes your household ?

- ❑ SINGLE ADULT ONLY
- ❑ ADULT COUPLE ONLY
- ❑ MORE THAN ONE ADULT BUT NOT COUPLE
- ❑ FAMILY WITH CHILDREN **(please indicate the number of children in the box)**

37. What type of accommodation do you live in ?

- ❑ RENTED FLAT
- ❑ RENTED HOUSE
- ❑ OWNED/BOUGHT FLAT
- ❑ OWNED/BOUGHT HOUSE
- ❑ MOBILE HOME/CARAVAN
- ❑ FARM
- ❑ OTHER **(please specify)** _____

38. Does your home have a garden/accessible yard ?

- ❑ NO
- ❑ YES BUT NOT FENCED ROUND/ENCLOSED
- ❑ YES AND IS FENCED ROUND/ENCLOSED

39. How many years have you lived in your present accommodation ?

- ❑ LESS THAN 1 YEAR
- ❑ 1 YEAR TO LESS THAN 2 YEARS
- ❑ 2 YEARS TO LESS THAN 5 YEARS
- ❑ 5 YEARS TO LESS THAN 10 YEARS
- ❑ 10 YEARS OR MORE

40. What is the highest level of education completed by any household member ?

- ❑ SECONDARY SCHOOL BUT GAINED NO QUALIFICATIONS
- ❑ SECONDARY SCHOOL AND GAINED 'O' GRADES
- ❑ SECONDARY SCHOOL AND GAINED 'H' GRADES
- ❑ FURTHER EDUCATION BUT DID NOT GAIN A FORMAL QUALIFICATION
- ❑ FURTHER EDUCATION AND WAS AWARDED A FORMAL QUALIFICATION

41. What is the annual income, before deductions, of the household ?

- ❑ UNEMPLOYED WITH NO TAXABLE INCOME
- ❑ EMPLOYED AND TAXABLE INCOME LESS THAN £10,000
- ❑ EMPLOYED AND TAXABLE INCOME BETWEEN £11,000 AND £20,000
- ❑ EMPLOYED AND TAXABLE INCOME BETWEEN £21,000 AND £30,000
- ❑ EMPLOYED AND TAXABLE INCOME GREATER THAN £30,000
- ❑ OTHER **(please specify)** _____

APPENDIX IX

MAIL SURVEY - INTRODUCTORY LETTER

From: *Fiona Gregory BVMS MRCVS*
Resident in Companion Animal Clinical Epidemiology

UNIVERSITY
of
GLASGOW

«Name»
«Street»
«Town_1»
«Town_2»
«Post_Code»

18 February 1997

Dear «Owner»,

Following our telephone conversation, please find enclosed details of the survey we are currently undertaking and a copy of our questionnaire. We would be grateful if you (or another adult member of the household) would complete this and return it in the prepaid envelope provided.

For millions of people, companion animals are cherished members of the family, featured in family photographs and deeply mourned after death. They bond with humans and give and receive love, loyalty, and companionship. Despite this, it is common for pets to become unwanted after only a short period of ownership. Euthanasia (humane killing) of healthy but unwanted pets accounts for one third of the deaths in companion animals. Clearly this is very upsetting for all those involved. However, surprisingly little is known about why one owner may have a strong bond with their pet and keep it for many years while another may never form this bond.

A survey is currently being undertaken at the University of Glasgow Veterinary School. The aim of this is to try to improve the understanding of this problem in an attempt to prevent the continued loss of so many pets. In order to achieve this, basic information regarding the current population of companion animals, household characteristics associated with companion animal ownership and the way in which people interact with their pets must be collected. This is where I believe you can help.

Your household is one of a small number in which people are being asked to share their experience of dog owning and describe how they interact with their dog. Households receiving questionnaires have been randomly selected from the total dog owning population in this area. It should not take more than approximately 15 minutes of your time for you to complete the questionnaire and the information gathered will ultimately be of great benefit in decreasing the number of pets without homes whose fate is often death.

You may be assured of complete confidentiality. The questionnaire has an identification number for mailing purposes only. This is to allow us to check your name off the mailing list when your questionnaire is returned. Your name will never appear on the questionnaire.

If you have any questions, please contact me directly by telephone at the number below.

I would like to take this opportunity to thank you for your time.

Yours sincerely,

FIONA GREGORY

SMALL ANIMAL CLINICAL STUDIES and
VETERINARY INFORMATICS and EPIDEMIOLOGY
Department of Veterinary Clinical Studies
University of Glasgow Veterinary School
Bearsden Road, Bearsden, Glasgow G61 1QH
Tel: 0141-330 5700 ext. 2458 *Fax:* 0141-942 7215 *E-mail: F.Gregory@vet.gla.ac.uk*

APPENDIX X

MAIL SURVEY - FOLLOW-UP LETTER 1

From: *Fiona Gregory BVMS MRCVS*
Resident in Companion Animal Clinical Epidemiology

UNIVERSITY
of
GLASGOW

«Name»
«Street»
«Town_1»
«Town_2»
«Post_Code»

25 February 1997

Dear «Owner»,

Last week a questionnaire was sent to you asking you to share your experience of dog owning and describe the way in which you interact with your pet. Your name was drawn in a random sample of dog owners in this area.

If you have already returned a completed questionnaire, I would like to thank you for your time and co-operation. If you have not, may I ask that you please do so today. It is extremely important that all questionnaires are completed by the small sample of households selected. Accurate representation of the dog owning population in this area depends upon your response.

If you did not receive a copy of this questionnaire or it has been misplaced since it arrived, please contact me to allow a new questionnaire to be posted to you as soon as possible.

Once again, thank you for your time.

Yours sincerely,

FIONA GREGORY

SMALL ANIMAL CLINICAL STUDIES and
VETERINARY INFORMATICS and EPIDEMIOLOGY
Department of Veterinary Clinical Studies
University of Glasgow Veterinary School
Bearsden Road, Bearsden, Glasgow G61 1QH
Tel: 0141-330 5700 ext. 2458 *Fax:* 0141-942 7215 *E-mail: F.Gregory*@vet.gla.ac.uk

APPENDIX XI

MAIL SURVEY - FOLLOW-UP LETTER 2

From: *Fiona Gregory BVMS MRCVS*
Resident in Companion Animal Clinical Epidemiology

UNIVERSITY
of
GLASGOW

«Name»
«Street»
«Town_1»
«Town_2»
«Post_Code»

11 March 1997

Dear «Owner»,

About three weeks ago, a questionnaire was posted to your home. The purpose of this, was to determine your experience as a dog owner and also to seek information about how you and any other members of the household interact with your dog. To date, I have not yet received your completed questionnaire.

This survey of 'successful pet owning households' has been undertaken as a vital starting point in the quest to understand and hopefully eliminate the problem of failed pet ownership. Millions of healthy but unwanted dogs and cats are humanely destroyed each year, and it is believed that the main contributing factor to this, is failure of the owner-pet bond.

The whole of the West of Scotland dog owning population is being covered by this survey. It would be an enormous undertaking to contact directly all dog-owning households in this area, so a small sample was randomly selected. It is extremely important that a response from everyone in this sample is obtained, in order that the sample will accurately represent the rest of the population.

I have enclosed a replacement questionnaire in case your original one has been misplaced.

Your co-operation in this survey is greatly appreciated.

Yours sincerely,

FIONA GREGORY

SMALL ANIMAL CLINICAL STUDIES and
VETERINARY INFORMATICS and EPIDEMIOLOGY
Department of Veterinary Clinical Studies
University of Glasgow Veterinary School
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Tel: 0141-330 5700 ext. 2458 *Fax:* 0141-942 7215 *E-mail:* *F.Gregory@*vet.gla.ac.uk

APPENDIX XII

MAIL SURVEY - FOLLOW-UP LETTER 3

From: *Fiona Gregory BVMS MRCVS*
Resident in Companion Animal Clinical Epidemiology

UNIVERSITY
of
GLASGOW

«Name»
«Street»
«Town_1»
«Town_2»
«Post_Code»

08 April 1997

Dear «Owner»,

I am writing to you regarding the current survey that is being undertaken to determine the experience of dog owners and the way in which they interact with their dog. There has been an excellent response to this survey, and the large number of completed questionnaires that have been returned is very encouraging.

Unfortunately, we have not received your completed questionnaire and together with the small number of others not returned yet, these may affect the results of the survey. The reason for this, is that this small section may represent information from a completely diverse group of dog owning households. It is therefore essential, that experience and opinions of dog owners in these households are recorded to produce valid survey results.

Previous studies to identify dog and household characteristics associated with the development of successful human-animal bonds have been very limited in the UK. In the United States of America there is a large dog and cat overpopulation problem, and failure of the human-animal bond has been identified as the main contributor to this. If we wish to address the problem in the UK, the success of this survey is vital to provide baseline information about our interactions with companion animals and the development of the human-animal bond, and to encourage the development of future more detailed investigations.

It is for this reason that I am sending this final letter to you. In case you have misplaced the previous correspondence I have mailed to you (or never received them), I have enclosed a replacement questionnaire for your use. May I urge you to complete and return it as soon as possible.

Your contribution to the success of this survey will be greatly appreciated.

Yours sincerely,

FIONA GREGORY

SMALL ANIMAL CLINICAL STUDIES and
VETERINARY INFORMATICS and EPIDEMIOLOGY
Department of Veterinary Clinical Studies
University of Glasgow Veterinary School
Bearsden Road, Bearsden, Glasgow G61 1QH
Tel: 0141-330 5700 ext. 2458 *Fax:* 0141-942 7215 *E-mail: F.Grgory*@vet.gla.ac.uk

APPENDIX XIII

CASE-CONTROL STUDY: DESCRIPTIVE STATISTICS

STATISTIC	*AGE		*AGE WHEN NEUTERED		*AGE AT ACQUISITION		COST (£)	
	CASE	CONTROL	CASE	CONTROL	CASE	CONTROL	CASE	CONTROL
Number of dogs	49	319	18	137	47	316	42	257
Mean	22.43	87.96	11.89	29.09	6.45	7.67	39.55	100.66
Standard error	2.92	2.72	3.00	2.56	1.59	0.99	7.40	7.04
Standard deviation	20.46	48.52	12.73	29.99	10.94	17.65	47.98	112.88
Range	70.00	196.00	54.00	134.50	60.00	144.00	200.00	750.00
Minimum	2.00	2.00	6.00	5.00	0.00	0.00	0.00	0.00
25th percentile	7.50	48.00	6.75	9.00	2.00	2.00	0.00	10.00
Median	15.00	86.00	8.00	18.00	2.50	2.00	40.00	70.00
75th percentile	36.00	128.00	10.00	36.00	8.00	3.00	41.00	150.00
Maximum	72.00	198.00	60.00	139.50	60.00	144.00	200.00	750.00
Mode	2.00	72.00	6.00	6.00	2.00	2.00	0.00	0.00

* Age in months

APPENDIX XIV

MULTIVARIABLE LOGISTIC REGRESSION - ILL-FITTING COVARIATE PATTERNS

ID	STA	SMP	PP	AGE	B	G	VC	LTH1	LTH2	LTH3	LTH4
26	0	0	1	10	0	1	1	1	0	0	0
29	0	0	1	12	1	1	1	0	0	0	0
74	0	1	1	39	0	1	1	0	1	0	0
177	0	1	1	18	0	1	0	1	0	0	0
240	0	0	0	7	0	1	0	0	0	0	1
258	0	1	0	13	1	1	0	0	0	1	0
262	0	1	0	36	0	1	0	0	0	0	0
310	0	1	1	6	0	1	1	0	1	0	0
345	0	0	0	3	1	1	1	1	0	0	0
509	1	0	0	36	1	1	1	0	0	0	1
520	1	0	1	18	1	1	1	0	0	0	1
521	1	0	1	6	1	0	0	0	0	0	0
522	1	0	1	9	1	1	1	1	0	0	0
710	1	1	1	60	0	1	0	1	0	0	0
805	1	0	1	60	1	1	1	1	0	0	0
807	1	1	1	4	0	1	0	0	0	0	0
809	1	1	1	72	0	1	0	0	0	0	1
811	1	1	1	24	0	1	0	0	1	0	0

Key

ID	Identification number of household
STA	Status of household, coded as 1=case household, 0=control household
SMP	Ownership of a small mammal pet*
PP	Previous pet ownership*
B	Breed of dog, coded as 1=purebreed, 0=mixed breed
G	Presence of a garden*
VC	Veterinary care, coded as 1=less than once a year, 0=once a year or more
LTH	Length of time in the present home*
Referent variable	10 years or more
LTH1	5 years to less than 10 years
LTH2	2 years to less than 5 years
LTH3	1 year to less than 2 years
LTH4	Less than 1 year

* Coded as 1=yes/characteristic present, 0=no/characteristic absent

APPENDIX XV

LIST OF SUPPLIERS

Graphical Data Capture Ltd., 262 Regents Park Road, London, N3 3HN.

Hewlett-Packard Company, 3000 Hanover Street, Palo Albo, CA 94304, USA.

MapInfo Corporation, One Global View, Troy, New York 12180-8399, USA.

Microsoft Corporation, One Microsoft Way, Redmond, WA 98052-6399, USA.

Minitab Inc., 3081 Enterprise Drive, State College, PA 16801-3008, USA.

Neat Ideas, Sandal Stones Road, Kirk Sandal Industrial Estate, Doncaster, DN3 1BR.

Nquery Advisor Statistical Solutions, Stonehill Corporate Centre, Suite 104, 999 Broadway, Saugus, MA 01906, USA.

Statistix Analytical Software, P.O. Box 12185, Tallahassee, FL 32317-2185, USA.

Viglen Ltd., Viglen House, Alperton Lane, Alperton, Middlesex, HA0 1DX.

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