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Risk factors identified for owner-reported feline obesity at around one year of age: Dry diet and indoor lifestyle

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ABSTRACT

Obesity is considered the second most common health problem in pet cats in developed countries. Previous studies investigating risk factors for feline obesity have been cross-sectional, where reverse causality cannot be ruled out. This study is the first to use prospective data from a large scale longitudinal study of pet cats ('Bristol Cats') to identify early-life risk factors for feline overweight/obesity at around one year of age. Data analysed were collected via three owner-completed questionnaires (for cats aged 2–4 months, 6.5–7 months and 12.5–13 months) completed between May 2010 and August 2013. Owner-reported body condition scores (BCS) of cats at age 12.5–13 months, using the 5-point system, were categorised into a dichotomous variable: overweight/obese (BCS 4–5) and not overweight (BCS 1–3) and used as the dependent variable. Cat breed, neuter status, outdoor access, type of diet, frequency of wet and dry food fed and frequency of treats fed were analysed as potential risk factors. Of the 966 cats for which data were available, 7.0% were reported by their owners to be overweight/obese at 12.5–13 months of age. Descriptive data on type of diet fed at different cat ages suggest that a dry diet is the most popular choice for UK domestic cats. Significant potential explanatory variables from univariable logistic regression models were included in multivariable logistic regression models built using stepwise forward-selection. To account for potential hierarchical clustering of data due to multi-cat households these were extended to two-level random intercept models. Models were compared using Wald test *p*- values. Clustering had no impact on the analysis. The final multivariable logistic regression model identified two risk factors that were independently associated with an increased risk of feline obesity developing at 12.5–13 months of age: restricted or no outdoor access and feeding dry food as the only or major (>50%) type of food in the diet at age 12.5–13 months. The same relationship was revealed when only variables containing prospective data were included in the multivariable model. The study highlights the importance of a cat's early environment in the risk of obesity developing in early adulthood. The amount of food fed, opportunities for exercise and BCS of cats with no or restricted outdoor access and cats fed a dry diet should be monitored, especially whilst cats are aged below one year, to reduce the risk of overweight/obesity developing.

1. Introduction

Obesity is increasing in the pet population, mirroring the human obesity epidemic (German, 2006; Hoenig, 2006), and in some studies has been identified as the second most common health problem (after dental disease) in domestic cats in developed countries studied to date (Cave et al., 2012). The prevalence of overweight/obesity in pet cats in Great Britain was estimated to be between 39% and 52% in the 1990s and 2000s (Russell et al., 2000; Courcier et al., 2010), compared to an estimated 6–12.5% in the 1970s (Anderson, 1973). Obesity predisposes companion animals to a variety of health problems, including metabolic abnormalities, endocrinopathies, orthopaedic disorders, cardiorespiratory disease, urogenital disorders, and neoplasia (German, 2006). As well as decreasing quality of life it has been shown to reduce average lifespan in dogs by approximately two years (Kealy et al., 2002). To the authors' knowledge, an equivalent longitudinal study to investigate the effect of obesity on longevity in cats has not been conducted. However, in a follow-up study of a cohort of cats with

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a range of body conditions, mortality was found to be highest in middle-aged obese cats (between 6 and 11 years), as well as in cachectic cats, suggesting that longevity is reduced in obese (and severely underweight) cats (Scarlett and Donoghue, 1996).

Companion animals are considered obese when their body weight is 20% or greater than ideal, and overweight when between 10% and 19% above ideal (Burkholder and Toll, 2000). Rather than classification of obesity based on body weight, a body condition score (BCS) system is the most widely accepted and practical method of assessing overweight/obesity (German et al., 2006) and has been validated in domestic cats (Laflamme, 1997; Bjornvad et al., 2011). However, owner-reported body condition scores may have lower predictability (the ability of a score to reflect true body condition) than veterinarian-reported body condition scores, as previous research suggests that owners tend to underestimate their cat's body condition (Allan et al., 2000; Kienzle and Bergler, 2006; Colliard et al., 2009; Cave et al., 2012), or normalise their judgement, underestimating BCS of overweight cats and overestimating thin cats (Courcier et al., 2010). Despite this, in an evaluation of body condition score predictability, assessed by measuring correlation with duel-energy X-ray absorptiometry determined percentage body fat, scores reported by both a trained and an untrained owner were strongly and positively correlated with percentage body fat, albeit less so than scores reported by a veterinarian (Shoveller et al., 2014). Therefore caution should be taken when relying on owner-reported body condition scores in investigations of risk factors for feline obesity, and should not be used when assessing prevalence.

Factors which increase the risk of feline overweight/obesity identified from previous studies include being male (Robertson, 1999; Lund et al., 2005; McGreevy et al., 2008; Colliard et al., 2009; Courcier et al., 2012), neutered (Sloth, 1992; Scarlett et al., 1994; Fettman et al., 1997; Robertson, 1999; Russell et al., 2000; Lund et al., 2005; Colliard et al., 2009; Courcier et al., 2010, 2012), mixed breed or non-pedigree (Scarlett et al., 1994; Robertson, 1999; Lund et al., 2005; McGreevy et al., 2008), living in single- or two-cat households (Robertson, 1999), confinement indoors (Sloth, 1992; Scarlett et al., 1994; Robertson, 1999), living in a rural or semi-rural area (McGreevy et al., 2008), inactivity (Scarlett et al., 1994), middle age (Sloth, 1992; Scarlett et al., 1994; Harper, 1998; Russell et al., 2000; Kienzle and Bergler, 2006; McGreevy et al., 2008; Colliard et al., 2009; Courcier et al., 2012), increasing age (Cave et al., 2012) longer leg length (Allan et al., 2000; Cave et al., 2012), owner underestimation of their cat's body condition (Allan et al., 2000; Colliard et al., 2009; Cave et al., 2012), feeding ad libitum or free-choice (both terms used to describe food made continuously available) (Russell et al., 2000; Harper et al., 2001; Kienzle and Bergler, 2006), feeding in meals two or three times a day (Courcier et al., 2010), feeding treats two-three times a week (Russell et al., 2000), premium or therapeutic food (Lund et al., 2005), fresh meat, kitchen scraps or additional treats added to a cat's regular food, using extra food or a cat's favourite dish as a treat instead of play, more frequently providing food rewards when cat begs for food, watching a cat eating, and a close owner-cat relationship (Kienzle and Bergler, 2006). These previous studies have all been cross-sectional in design, resulting in uncertainty over the causal direction of associations observed between putative risk factors and obesity. The first longitudinal study (to the authors' knowledge) to investigate risk factors for feline obesity was conducted on a small scale (80 cats) using colony cats rather than pet cats (Serisier et al., 2013). The authors found that a higher percentage change in body weight between 3 and 12 months (as well as male sex, in agreement with previous studies) was significantly associated with increased risk of obesity in adulthood.

Studies have shown that the prevalence of overweight and obesity in pet US cats (that are mainly confined indoors) was already high (20–31%) by the age of two years (Scarlett et al., 1994; Lund et al., 2005). This, along with the evidence from Serisier et al. (2013) that growth rate in kittenhood was associated with obesity in adulthood, suggests that factors which increase a cat's risk of obesity occur early in life. This in turn is supported by the literature on early-life critical periods in childhood for the development of human obesity (Dietz, 1994).

The aim of this study was to use prospective data from a large-scale longitudinal feline health and welfare study (the 'Bristol Cats' study) to identify and quantify early-life risk factors, from the age of two months onwards, associated with overweight/obesity at age 12.5–13 months in owned pet cats, as identified by owner-reported feline BCS. Potential risk factors, for example a cat's diet and their outdoor access, may vary over time. Therefore the current longitudinal study design will enable an aspect of this time dependence to be captured by measuring variables at different time points (i.e., questionnaires), and examining whether the measures at different time points affect obesity. Based on results of previous studies it was hypothesised that cats confined indoors, neutered cats, non-pedigree cats, cats fed two or three times a day and cats fed treats several times a week would be at higher risk of obesity. Type of diet fed was investigated with no prior hypotheses as there was inconsistent evidence from the existing literature for a relationship between diet type and overweight/obesity. Risk factors identified in this study can be targeted to develop effective preventive strategies for feline obesity, in order to tackle this increasingly prevalent problem in pet cats.

2. Materials and methods

2.1. Subjects

Data used in this analysis were from a longitudinal UK-wide study of pet cats, the 'Bristol Cats' study. The inclusion criteria for the 'Bristol Cats' study were that owners must live in the UK, be aged 18 years and over and own a cat aged approximately two to four months in order to participate. Owners could enrol more than one cat to the study. Owners were recruited between May 2010 and December 2013 through a variety of advertising methods such as posters in veterinary practices, advertisements on cat- related websites (e.g., International Cat Care), animal welfare organisations (e.g., Cats Protection website and posters at homing centres) and publications (e.g., Veterinary Record, Your Cat magazine). By the end of 2013, 2189 cats formed the study cohort for the full 'Bristol Cats' study.

2.2. Data collection

Data were collected using questionnaires completed by owners when their cats reached specific ages. Questionnaires one (2–4 month old cats), two (6.5–7 month old cats) and three (12.5–13 month old cats), completed between May 2010 and August 2013, were included in this analysis. Most questions were 'closed questions' with multiple choice answers and questionnaires took 10–15 min to complete. The majority of owners completed electronic questionnaires, although some elected to complete paper questionnaires. Copies of the questionnaires can be obtained from the corresponding author.

2.3. Dependent variable

In questionnaire three, owners were provided with a 5-point body condition score (BCS) system from the 'Pet Food Manufacturers' Association' (PFMA, 2014), chosen as it was considered to be 'user-friendly' for untrained owners. This system provides images of cats from the side and above, as well as written descriptions about body condition, for each score. Owners and