

Caring practices of pet cat and dog owners in Northern Ireland vs potential implications for animals' health and welfare

V Naughton^{*†}, T Grzelak[‡], MS Mulhern[†], RC Moffett[†] and PJ Naughton[†]

[†] School of Biomedical Sciences, University of Ulster, Cromore Road, Coleraine BT52 1SA, Northern Ireland, UK

[‡] Department of Physiology, Poznan University of Medical Sciences, Poznan, Poland

* Contact for correspondence: v.naughton@ulster.ac.uk

Abstract

This prospective, descriptive study assessed caring practices of pet cat and dog owners in Northern Ireland with a survey questionnaire, focusing primarily on feeding and exercising. Owners of both pet cats and dogs reported that they fed their pets either twice or three times a day (53 and 78% for cats and dogs, respectively). However, in the case of nearly 40% of pet cat owners it transpired that they fed their cat(s) as often as the animal demanded (18.8%) or that food was available all the time (20.7%). Cat owners reported that their pets had access to outdoors (84%) and were not provided with any play time (53.1%). The highest number of pet dogs (46.1%) were reported as being walked daily for less than 1 h, and the highest number (38.4%) were played with daily for less than 1 h. Both cat (60%) and dog (61%) owners perceived the body condition of their animal 'as it should be' for animal age/sex. However, both pet cat (76%) and dog (63%) owners reported that neither their pet's bodyweight nor its body condition was monitored. Our results suggest not all pet cat and dog owners are aware of the fundamentals of their animals' feeding requirements as regards health and many provide insufficient physical activity required for their animals' health and welfare. The major strengths of the study include the size and geographic distribution of the study population allowing the generalisation of the results to other locations.

Keywords: animal welfare, body condition, exercise, feeding pattern, pet cat welfare, pet dog welfare

Introduction

Excessive accumulation of fat in adipose tissue in the body, commonly termed as obesity, results from a positive energy balance, ie energy intake that is higher than required for maintenance/stage of development/physiological status and a given level of physical activity (Studdert *et al* 2012; Okada *et al* 2017). In pets, as in humans, obesity has been shown to either directly result in or be associated with numerous diseases and a shortened lifespan (Chandler *et al* 2017; Teng *et al* 2018; Salt *et al* 2019). Hence, obesity prevention and a modification of care for weight loss in overweight/obese companion animals are of importance in the current obesogenic environment.

From a physiological point of view, obesity prevention in pets should be considered as a gold health and welfare standard as: i) the energy balance in general terms shows much stronger opposition to weight loss than weight gain (Hill *et al* 2012); and ii) a healthy bodyweight in pets, resulting from energy intake being matched with energy expenditure, is readily achievable since owners can manage their pets' energy intake (via feed intake) as well as energy expenditure (via physical activity). However, reported incidences of obesity in pet cats and dogs are high. For cats, reported incidence of obesity varies from ~11% to as high

as 52% (Lund *et al* 2005; Hill 2009; Courcier *et al* 2010a, 2012; Cave *et al* 2012; Corbee 2014), while in dogs it ranges from ~20% to as high as ~60% (McGreevy *et al* 2005; Lund *et al* 2006; Hill 2009; Courcier *et al* 2010b; Corbee 2013; Mao *et al* 2013). Moreover, the results of a recent survey of pet owners in the UK carried out by The People's Dispensary for Sick Animals in their PAW report (PDSA 2017) indicate an inability of pet owners to recognise obesity in their pets. The PAW report (PDSA 2017) showed that only ~17% (out of 2,076 surveyed) of pet cat owners responded that their cat was overweight/obese, albeit ~50% of the respondents matched images of Body Condition Scores (BCS) of overweight/obese animals to their cats. Furthermore, according to the PAW report (PDSA 2017) for dogs, the discrepancy between the owners' perceived body condition of their pets and their revised opinion, with the help of BCS images was not high, with only 15% of pet dog owners (out of 1,814 surveyed) stating their dog to be overweight/obese, compared to ~18% of owners who matched images of BCS of overweight/obese animal to their dog's current body shape. Similar misclassification of animal body condition has been reported in horse owners in Scotland (Wyse *et al* 2008). Furthermore, other PAW report results (PDSA 2017) for the UK indicate that

Table 1 An overview of the questionnaire used in the study.

Questionnaire section	Data collected
Owner demographics	Age, years (18–25, 26–67, > 67)
	Household type and number of persons living and involved with the care of pets (one person/single occupancy household, two adults, three or more people, including children)
Pet(s) characteristics and their living environment	Species and number(s)
	Age, years (< 1, 1–7, > 7)
	Sex/physiological status (intact male or female or neutered male or female)
	Breed/breed type (pure- or cross-breed)
	Coat type (short- or long-haired)
	Body condition, as perceived by the owner (underweight, as it should be, ie appropriate for age/gender, overweight, obese)
Care	Living environment (in/out; size of area available for roaming)
	Bodyweight monitoring, including the frequency
	Knowledge and use of Body Condition Scoring
	Feeding and diet, type, frequency, amounts, pattern
	Frequency of using food treats
	Exercising (time, frequency), including play time and walk time

The questionnaire consisted of information about the study, the consent page and 20 close-end questions. The questions format allowed for the answers to be cross-linked in cases where more than one pet was kept in a household.

pet owners' care practices (lifestyle management of their pets), in particular overfeeding and under exercising are contributing to, if not leading to, the positive energy balance in their pets.

To our knowledge, no data are currently available on pet owner practices directly affecting the energy intake and expenditure of their pets in Northern Ireland (NI). Downes *et al* (2009) reported differences in the level of pet dog and cat ownership on the island of Ireland as compared to the UK. Furthermore, the NI population is characterised by an altered socio-economic status, including employment status and qualifications held by working age adults compared to the rest of the UK (Haase & Galova 2018; UKETS 2018). A previous study by Ortega-Pacheco *et al* (2007) has shown that in the case of pet dogs, both the owners' opinions about pets as well as the level of animal supervision was significantly influenced by their socio-economic status. Furthermore, it has been acknowledged that socio-economic status and, in particular, the level of education, plays a role in the relative healthiness of human food choices (Pechey & Monsivais 2016) as well as showing a significant correlation with the level of human physical activity (Gidlow *et al* 2006). It can thus be suggested that the care, the diet/feeding of pets and, particularly, the level of physical activity provided to pets in NI may differ from the rest of the UK owing to population differences. Therefore, the aim of this study was to explore caring practices of pet cat and dog owners in NI, focusing on those practices directly related to animals' energy intake (feeding practices) and energy expenditure (living environment and exercise).

Materials and methods

A survey questionnaire was developed to investigate the fundamental care practices of pet cat and dog owners that can influence their pets' energy intake and expenditure and, by association, their health and welfare. The draft questionnaire and accompanying cover letter were piloted in-house with the help of random samples of pet-owning volunteers ($n = 20$) via one-to-one interviews pertaining to each part of the questionnaire, collected in accordance with DeMaio *et al* (1998). The draft questionnaire underwent subsequent amending, including the phrasing of questions and the order in which they were presented. This revised version was utilised in the current study and consisted of questions grouped into the following sections: i) demographics, including number, age, gender, bodyweight and condition of pet cats and/or dogs in a household; ii) diet and feeding regime and the use of the information on the labels of commercial feed, if applicable; and iii) animals' living environment (indoor/outdoor; area available to roam) and daily level of exercise including walk/play-time; Table 1 presents a brief overview of the questionnaire used in the study.

The questionnaire consisted of information about the study, the consent page and 20 close-end questions. The questions format allowed for the answers to be cross-linked in cases where more than one pet was kept in a household.

The sample size was calculated based on data from the latest CENSUS (2011) regarding total household numbers (in NI) and the regional (NI) pet population (Pet Food

Manufacturer's Association [PFMA] 2019) and including 95% confidence interval, 5% margin of error and the sample proportion of 12 and 31%, respectively, for pet cats and dogs. It was estimated that an overall sample size of 492 households owning pet cats and/or dogs would be required to ensure an accurate representation of NI's pet cat- and dog-owning population. To account for missing/incomprehensible responses (while assuring representation of both species) the target sample size was increased to 677 questionnaires, including 50 additional questionnaires from pet cat-owning households and an extra 125 from households with pet dogs.

Ethical approval for the study was granted by the School of Biomedical Sciences Research Ethics Filter Committee, Ulster University. A proportionally stratified, random-sampling approach was used to select the households owning pet cats/dogs to be included in this study. A geo-demographic map based on population density of eleven council districts (local government) was used to select the proportional number of households (based on the latest CENSUS [2011] and pet population [PFMA 2019] in NI) in each district required for the study. Consequently, a proportional number of questionnaires were collected from the randomly selected sites ('drawn from the hat') in the given council district: 1) Antrim and Newtownabbey council, one site — total 51 (31 for dogs and 20 for cats); 2) Armagh City, Banbridge and Craigavon council, two sites — in total 72 (44 for dogs and for 28 cats); 3) Belfast council, three sites — in total 134 (82 for dogs and 52 for cats); iv) Causeway Coast and Glens council, one site — total 51 (31 for dogs and 20 for cats); 5) Derry City and Strabane council, one site — total 53 (33 for dogs and 20 for cats); 6) Fermanagh and Omagh, one site — in total 40 (25 for dogs and 15 for cats); 7) Lisburn and Castlereagh council, one site — total 50 (31 for dogs and 19 for cats); 8) Mid and East Antrim council, one site — total 51 (31 for dogs and 20 for cats); 9) Mid Ulster council, one site — in total 45 (28 for dogs and 17 for cats); 10) Newry, Mourne and Down council, one site — in total 59 (36 for dogs and 23 for cats); and 11) Ards and North Down council, one site — in total 61 (38 for dogs and 23 for cats).

The hard copies of the questionnaire were distributed and collected in January 2019 at the sites indicated above. At the time of questionnaire distribution, volunteers were asked to complete them on-site, however they were supplied with pre-paid envelopes to enable those unable to complete the questionnaire at the time of the acceptance to submit their copy. Each questionnaire came with a consent letter informing respondents that only one questionnaire would be accepted per household. Questionnaire completion was taken as consent to participate in the study and all responses were anonymous.

The data from all completed questionnaires were transferred into Excel® (Microsoft®) and 10% of transferred data were blind-checked for transfer accuracy. Questionnaires containing > 20% of missing/incomprehensible responses were omitted from the final database. Data in the final database were subsequently analysed with IBM SPSS for Windows (v25). Frequency tables were created for all collected responses; contingency tables with Chi-squared

tests were used to assess potential associations between respondents' demographic characteristics and their care practices. For the data subsets of smaller sample size, Fisher's exact test of independence was used to assess whether the proportions of one variable were different depending on the value of the other variable. Moreover, Spearman's correlation analysis for non-parametric distributions were used. Logistic regression was performed to identify independent risk factors for the animals that were categorised by the owners as overweight and obese (data for both categories were combined). In the logistic regression models, the following variables were included:

- Age of the animal in years (combined data from categories: < 1, and 1–7 vs > 7);
- Gender and physiological status (female intact vs female spayed vs male intact vs male neutered);
- Frequency of monitoring pets' bodyweight reported by the owners (regularly vs combined data from categories: occasionally and does not monitor);
- Feeding frequency (combined data form categories: once, twice and three times a day vs combined data from categories: on pets' demand and food always available);
- Frequency of feeding treats (combined data from categories: feeding on animals' demand and more than three times a day vs combined data from the following categories: three times a day; less than three times a day; once a week; occasionally; and never);
- Living environment (combined data from categories: indoors with free outdoors — small garden (< 0.25 ha); indoors with free outdoors — large garden (> 0.25 ha); free to roam (no space restrictions) vs indoors (no free access to outdoors);
- Walk, frequency and duration (combined data from categories: daily 1+ h and daily less than 1 h vs combined data form categories: 2/3 times a week and occasionally);
- Play-time, frequency and duration (combined data from categories: daily 1+ h and daily less than 1 h vs combined data from categories: 2/3 times a week and occasionally).

The significance of variables in the logistic regression models was tested using Wald Chi-squared statistics and corresponding *P*-value. The goodness-of-fit of the logistic regression models were assessed using the Hosmer-Lemeshow statistic and area under curve (AUC) in receiver operating characteristics curve (ROC). The 95% confidence interval (95% CI) was used to estimate the precision of the odds ratio (OR). The statistical significance threshold was set at 0.05.

Results

Out of 667 questionnaires collected from individual households, 20 were excluded due to missing or incomprehensible responses. Thus, the total number of pet cat- and dog-owning households included in the study were 647, representing an overall population of 940 pets, including 367 cats and 573 dogs. Of the 367 pet cats, 300 (82%) resided in cat-only households. Similarly, in the case of pet dogs, the majority, ie 88% (507 out 573) resided in dog-only households (Table 2).

Table 2 Characteristics of the ownership of pet cats (n = 367) and/or pet dogs (n = 573) according to the survey performed in Northern Ireland in January 2019.

Characteristic	Households with pet cats (%)	Households with pet dogs (%)
<i>Age of the respondent/owner (years)</i>		
18–25	187 (28)	189 (28.3)
26–67	309 (46)	303 (45.4)
> 67	171 (26)	173 (26)
Not stated	–	2 (0.3)
<i>Number of people living in the household</i>		
One person/single occupancy household	394 (59)	334 (50)
Two adults	185 (28)	277 (42)
Three or more people (including children)	87 (13)	56 (8)
Pets kept individually (one cat or one dog only)	186 (51)	254 (44)
Pets kept in single-species households (cats only or dogs only)	114 (31)	252 (44)
Pets kept with other species (cats with dogs and vice versa)	67 (18)	67 (12)

Household characteristics

The majority of the pets in this study, (46.3% of cats, 45.4% of dogs), were owned by individuals aged 26–67 years old. The remaining pets belonged to other age groups (younger than 25 and older than 67 years) in almost even numbers (see Table 2). Over half of the pets included in the current study were owned by single households, ie one person living in the household (59.1% for cats and 50.1% for dogs) with 13.1 and 8.4% of pet cats and dogs, respectively, residing in households with multiple occupancies, ie three or more people living in the household (Table 2).

There was a significant association between the age of the owners, type of household and pet species owned ($r_s = 0.248$; $P < 0.0001$) with senior respondents in single households, ie one person living in the household predominantly owning a pet cat, and adult respondents in single households, ie one person living in the household predominantly owning a pet dog.

Pets' characteristics and their living environment

The majority of households surveyed owned adult pets aged 1–7 years (47.4 and 50.4% for cats and dogs, respectively; Table 3). In terms of pets' sex, males tended to predominate with approximately 60 and 70% seen in cats and dogs, respectively.

Slightly over half (51.2%) of the households surveyed reported that they kept one pet dog, while the remaining 48.8% kept two (40.4%) or more (7.8%). Individual pet cats were kept by 59.8% of the households whilst 27.9 and 12.2% of households owned two or more than two, respectively.

With regard to animals' physiological status, ie intact vs spayed/neutered, the largest category for both species of

pets included intact males (42.5 and 36.6% for cats and dogs, respectively; Table 3). The majority of pets included in the study were cross-bred (49.3 and 51.1% for cats and dogs, respectively) and short-haired (64 and 53.4% for cats and dogs, respectively; Table 3). The highest number of pet cats (43.6%) in this study were kept indoors with free access to the outdoors, while the majority of pet dogs (48.3%) were kept outdoors (for more details on the living environment, see Table 3).

Owners' care practices

Body condition — owners' perception and assessment

When asked about the current body condition of their pets, the majority of both cat (60%) and dog (61%) owners reported that in their opinion their pet's body condition was ideal ('as it should be, considering age/sex'), while 24% of cat owners and 29% of dog owners reported their pets as being overweight. Only ~5% of cat owners and ~3% of dog owners indicated that they were unsure about the body condition of their pets.

The number of dogs reported to be of ideal bodyweight in the crossbreed category was significantly higher than in pure-breeds (exact $P = 0.0147$; Odds Ratio = 1.659 [95% CI: 1.116–2.465]) (Table 4). Furthermore, significantly more dogs reported as being overweight belonged to the short-haired category (vs long hair; exact $P = 0.0367$; Odds Ratio = 3.406 [95% CI: 1.142–10.162]) (Table 5).

The number of cats reported by their owners as being underweight was higher in the cross-breed category (as compared with the pure-breed category; exact $P = 0.0112$, Odds Ratio = 3.688, [95% CI: 1.321–10.292]) (Table 6).

In regard to the methods owners used to assess their pet's bodyweight, the majority of both cat (76%) and dog

Table 3 Characteristics of 940 pets, including 367 cats and 573 dogs in 647 households surveyed in Northern Ireland in January 2019.

Characteristic	Pet cats (%)	Pet dogs (%)
<i>Age (years)</i>		
< 1	83 (23)	131 (23)
1–7	174 (47)	289 (50)
> 7	85 (23)	137 (24)
Not stated	25 (7)	16 (3)
<i>Gender and physiological status (adult)</i>		
Female intact	66 (18)	78 (14)
Female spayed	63 (17)	94 (16)
Male intact	156 (43)	211 (37)
Male neutered	64 (17)	182 (32)
Owner unsure	18 (5)	8 (1)
<i>Breed</i>		
Pure-breed	75 (20)	213 (37)
Cross-breed	181 (49)	292 (51)
Owner unsure	111 (30)	67 (12)
<i>Coat</i>		
Short-haired	235 (64)	306 (53)
Long-haired	105 (29)	229 (40)
Owner unsure	27 (7)	38 (7)
<i>Living environment</i>		
Indoors (with no free access to outdoors)	98 (27)	51 (9)
Indoors (with free access to outdoors)		
Small garden (< 0.25 ha)	169 (44)	164 (29)
Large garden (> 0.25 ha)	33 (9)	277 (48)
Free to roam (no space restrictions)	73 (20)	75 (13)
No answer provided	3 (1)	6 (1)

(63%) owners reported that they did not weigh their pets. Occasional assessment of bodyweight was reported by ~19% of cat owners and ~28% of dog owners (Table 7). No associations were found between owners' age and household type and the monitoring of either pet dog or cat bodyweight ($P > 0.05$ for all relationships).

The Body Condition Scoring (BCS) method was only used by ~7% of pet cat and 8% of pet dog owners, with the majority of owners (~92% for each species) reporting that they did not use it, due either to a lack of knowledge of BCS or a declared lack of the necessary skills (Table 7).

Diets and feeding patterns

The results of the survey showed that 45.5% of cat owners feed their pets with commercially available cat food. In the case of pet dogs, 39.3% of owners declared that they fed their dogs with 'a little bit of everything', with a sole reliance on commercially available dog food reported by 31.1% of owners. Notably, 6.3% of cat owners and 10.5% of dog owners reported that they fed their pets with 'human food' (see Table 8).

In the case of feeding with a commercial pet food, the majority of both cat and dog owners reported providing food based on their pets' preferences (44 and 39% for cat

Table 4 Association between pet owners' perception of their dogs' body condition and breed type (pure-breed vs cross-breed).

Body condition (as classified by the owner)	Dog breed type (as identified by the owner)			n in a row
	Pure-breed	Cross-breed	Owner unsure	
Underweight	11	10	1	22
As it should be	115	196	38	349
Overweight	73	75	16	164
Obese	8	9	1	18
Owner unsure	6	2	8	16
n in a column	213	292	64	569
% Total	37.43	51.32	11.25	100

Associations were tested using Fisher's Exact Test; the row/column association was statistically significant: two-sided; $P = 0.0147$, Odds Ratio = 1.659, 95% Confidence Interval: 1.116 to 2.465 (using the approximation of Woolf). More dogs classified by owners as 'body condition — as it should be' belonged in the cross-breed category compared to pure-breed; no other associations were identified.

Table 5 Association between pet owners' perception of their dogs' body condition and animal coat type (short-haired vs long-haired).

Body condition (as classified by the owner)	Dog coat length (as identified by the owner)			n in a row
	Short-haired	Long-haired	Owner unsure	
Underweight	15	5	2	22
As it should be	191	144	11	346
Overweight	88	62	14	164
Obese	5	12	1	18
Owner unsure	5	5	6	16
n in a column	304	228	34	566
% Total	53.71	40.28	6.01	100

Associations were tested using Fisher's Exact Test; the row/column association was statistically significant: two-sided; $P = 0.0367$, Odds Ratio = 3.406, 95% Confidence Interval: 1.142 to 10.162. More dogs classified by owners as 'overweight' belonged in the short-hair category compared to long-hair; no other associations were identified.

Table 6 Association between pet owners' perception of their cats' body condition and breed type (pure-breed vs cross-breed).

Body condition (as classified by the owner)	Cat breed type (as identified by the owner)			n in a row
	Pure-breed	Cross-breed	Owner unsure	
Underweight	7	6	12	25
As it should be	39	118	64	221
Overweight	22	46	20	88
Obese	4	4	7	15
Owner unsure	3	6	8	17
n in a column	75	180	111	366
% Total	20.49	49.18	30.33	100

Associations were tested using Fisher's Exact Test; the row/column association was statistically significant: two-sided $P = 0.0112$, Odds Ratio = 3.688, 95% Confidence Interval: 1.321 to 10.292. More cats classified by owners as 'underweight' belonged in the category of owners being unsure of breed classification (pure-breed vs cross-breed); no other associations were identified.

Table 7 Pet-owner knowledge and own assessment of their animal(s)' body condition and bodyweight. Data collected in Northern Ireland in January 2019.

Body condition and bodyweight of pets	Pet cats (%)	Pet dogs (%)
<i>Respondents' own assessment of their animals' body condition</i>		
Underweight	25 (7)	22 (4)
Normal (ideal)	221 (60)	349 (61)
Overweight	88 (24)	164 (29)
Obese	15 (4)	18 (3)
Unsure	17 (5)	16 (3)
No answer provided	1 (0.3)	4 (0.7)
<i>Frequency of monitoring pets' bodyweight as reported by the owners</i>		
Regularly	15 (4)	43 (8)
Occasionally	70 (19)	163 (28)
Does not monitor	278 (76)	363 (63)
No answer provided	4 (1)	4 (1)
<i>Knowledge and use of Body Condition Score (BCS) as reported by the owners</i>		
Owner familiar and uses BCS	26 (7)	46 (8)
Owner familiar but unsure how to use it	80 (22)	142 (25)
Owner aware of BCS but not familiar enough to use it	178 (49)	258 (45)
Owner not sure what BCS is about	81 (22)	122 (21)
No answer provided	2 (0.5)	5 (1)
Pet cats: n = 367; pet dogs: n = 573.		

and dog owners, respectively) or on cost (30 and 33% for cat and dog owners, respectively). Importantly, the lowest number of pet cat and dog owners declared their choice of commercial pet food to be based on veterinary advice (3.8 for cats and 2.8% for dogs).

Furthermore, in instances where pet dogs were given commercial dog food, the majority (41%) were reported to be fed both dry and wet food equally, with 24% of respondents feeding their dogs mainly with a dry food. In cats, the type of commercial food reported, ie wet vs dry, showed a more even distribution among the three categories, ie 21% of pet cats were fed mainly wet food, 29% mainly dry food while 30% received both in equal amounts.

The majority of pet cat and dog owners reported feeding their pets twice or three times a day (53 and 78% for cats and dogs, respectively; Table 8). However, in the case of nearly 40% of pet cat owners, it was reported they fed their cat as often as it demanded (18.8%) or ensured food was permanently available (20.7%). Furthermore, in the case of pet cats, this 'unlimited feeding' was also reflected in the answers to a question regarding the rationale behind the amount of food fed daily to pet cats — the majority (36.8%) reporting that they fed their pets based on the animals'

appetite. However, for dogs, ~34% of pet owners reported that their animal's daily input was based on the recommendation obtained from their veterinarian (Table 8).

In households with more than one pet of the same species, all cat owners and 43.4% of dog owners did not provide the answer on individual vs group feeding of their pets. Of those pet dog owners who did reply, 4.9% said they fed their pet dogs individually, while 39.8% of dog owners reported that they made an attempt to feed their pets individually (Table 8).

In addition to daily food allowances, 92% of all pet owners (cat and dog owners combined) reported that they gave their pets food treats (Table 8). The reported frequency of this varied but 17.4% of pet cats and 17.8% of pet dogs were fed with treats either on demand from the animal or more than three times a day.

Exercise

Reported exercise levels for both pet cats and pet dogs (either as walks or via play-time) are shown in Table 9. The majority of cat owners reported that their pets had access to outdoors (84%) and were not provided with any play-time (53.1%). Of those cats afforded a play-time, the majority were played with for less than 1 h per day (14.5%) or occasionally (14.4%).

Table 8 Diets and feeding patterns provided by pet owners to their cats and dogs. Data collected in Northern Ireland in January 2019.

Diets and feeding pattern	Specification	Pet cats (%)	Pet dogs (%)
Type of diet fed to animals	Homemade (specially prepared for animals)	13 (4)	22 (4)
	Human food	23 (6)	60 (10)
	Commercial petfood	167 (46)	178 (31)
	Homemade and commercial petfood	42 (11)	85 (15)
	A little bit of everything	121 (33)	225 (39)
	No answer provided	1 (0.3)	3 (0.5)
Rationale behind the choice of commercial petfood fed	Ingredients	22 (6)	38 (7)
	Pet preference	162 (44)	224 (39)
	Cost	110 (30)	189 (33)
	Recommendation	27 (7)	53 (9)
	Veterinary advice	14 (4)	16 (3)
	No data available	32 (9)	53 (9)
Type of commercial petfood fed	Mainly wet	77 (21)	76 (13)
	Mainly dry	106 (29)	140 (24)
	Both equally	109 (30)	235 (41)
	Switch between both wet and dry	45 (12)	74 (13)
	No answer provided	30 (8)	48 (8)
Feeding frequency	Once a day	22 (6)	26 (5)
	Twice a day	96 (26)	198 (35)
	Three times a day	100 (27)	251 (44)
	On pets' demand	69 (19)	79 (14)
	Food always available	76 (21)	10 (2)
	No answer provided	4 (1)	9 (2)
Rationale behind daily amount of feed given	Animals' appetite	135 (37)	100 (17)
	Other person's advice/recommendation	49 (13)	104 (18)
	Veterinary advice	85 (23)	194 (34)
	Following information on food labelling	57 (16)	98 (17)
	Visual inspection of the pet	38 (10)	61 (11)
	No answer provided	3 (1)	16 (3)
Feeding individual animals in households with more than one pet	Animal are fed individually	0 (0)	28 (5)
	Owners attempt to feed individually	0 (0)	228 (40)
	No individual feeding	0 (0)	68 (12)
	No answer provided	367 (100)	249 (43)
Frequency of feeding treats to pets	On animals' demand	31 (8)	32 (7)
	More than three times a day	33 (9)	70 (12)
	Less than three times a day	81 (22)	140 (24)
	Once a week	119 (32)	182 (32)
	Occasionally	73 (20)	103 (18)
	Never	29 (8)	39 (7)
	No answer provided	1 (0.3)	7 (1)

Pet cats: n = 367; pet dogs: n = 573.

Table 9 Type and frequency of exercise provided by pet cat and dog owners surveyed in Northern Ireland in January 2019.

Type of exercise	Pet cats (%)	Pet dogs (%)
<i>Walk (frequency and duration)</i>		
Daily, > 1 h	0 (0)	90 (16)
Daily, < 1 h	1 (0.3)	264 (46)
2–3 times a week	3 (1)	147 (26)
Occasionally	20 (5)	31 (5)
Free outdoor access	309 (84)	31 (5)
No data available	34 (9)	10 (2)
<i>Play time (frequency and duration)</i>		
Daily, > 1 h	18 (5)	78 (14)
Daily, < 1 h	53 (15)	220 (38)
2–3 times a week	42 (12)	125 (22)
Occasionally	53 (14)	99 (17)
Free outdoor access	195 (53)	42 (7)
No data available	6 (2)	9 (2)

Pet cats: n = 367; pet dogs: n = 573.

Almost half (46.1%) of pet dogs were reported to be walked daily for less than 1 h, with 38.4% having daily play-time of less than 1 h.

In cats, a significant association was identified between exercise and household type ($r_s = 0.156$; $P = 0.00237$) with the highest level being provided to pet cats in adult-only households. Similarly, in pet dogs, the level of exercise provided showed a significant relationship with household type ($r_s = 0.086$; $P = 0.02976$) with the highest level provided to dogs in adult-only households. Owners' age showed no association with the level of exercise provided to pet cats ($r_s = 0.086$; $P > 0.5$) or dogs ($r_s = 0.049$; $P > 0.5$).

Factors associated with reported overweight/obese status in pet cats and dogs

In the case of pet cats reported by the owners as overweight or obese, the animal age, the frequency of feeding food treats, the frequency of body monitoring and frequency of feeding were all shown to be significant predictors in the final overweight/obesity logistic regression model (see Table 10); the Hosmer-Lemeshow statistic was 1.049 ($P > 0.800$) and, therefore, the model was judged to fit the observed data well (Hosmer *et al* 2013).

In instances where pet dogs were reported as being overweight or obese by their owners, the age of the animal, the time spent outside each day and daily exercising were significantly associated with overweight/obesity in the final logistic regression model (see Table 11); the Hosmer-Lemeshow statistic was 4.134 ($P > 0.530$) and, therefore, the model was judged to fit the observed data well (Hosmer *et al* 2013).

Discussion

The results of our study show the fundamental care practices of pet cat and dog owners in NI. As far as we are aware no available data exist on the care of pet cats and dogs in NI while the empirical data on fundamental care practices underlie research into animal diseases/health (Lund *et al* 1999; Egenvall *et al* 2000; Westgarth *et al* 2007), as well as informing research and policy on animal welfare (Collins *et al* 2010).

This study shows that at the current moment dog are kept more frequently as pets in NI compared to cats. These results are similar to those reported in the recent PAW report (PDSA 2019) for the UK. It has to be noted, however, that the profile of animals kept as pets in the UK currently differs from previously observed trends, in terms of specific species; for example, previous findings indicate that from 1980 to 2010, ownership of a cat or a dog in the UK was more evenly distributed (PFMA, Historical Pet Ownership 1965-2004 [2015]). However, Downes *et al* (2009) reported dog ownership to be more frequent compared to cat ownership on the island of Ireland. More international research into pet preferences identified various predictors for owning a pet dog, including having children of school age (Baldock 2003; Westgarth *et al* 2007), living in a house vs a condo or an apartment (Leslie *et al* 1994; Downes *et al* 2009, the American Veterinary Medical Association, [AVMA] 2018), and living rurally as opposed to in a city (Downes *et al* 2009). We did not observe any relationship between pet species preferences and multiple vs single-occupancy house-

Table 10 Factors associated with owners' perceived overweight/obesity (combined data) in pet cats (based on the results of a logistic regression model).

Factors	<i>b</i>	SE (<i>b</i>)	Odds ratio (OR) for association with overweight/obesity	95% CI	Significance level
Constant	-3.07	0.47	-	-	
<i>Age of the animal (years)</i>					
Combined data: < 1 and 1–7	0	-	1	Reference 1.6–5.0	<i>P</i> < 0.0001
> 7	1.02	0.29	2.8		
<i>Frequency of monitoring pets' bodyweight as reported by owners</i>					
Regularly	0	-	1		
Combined data: 'occasionally' and 'does not monitor'	1.38	0.40	4.0	Reference 1.8–8.7	<i>P</i> < 0.002
<i>Feeding frequency</i>					
Combined data: 'once a day', 'twice a day' and 'three times a day'	0	-	1		
Combined data: on 'pets' demand' and 'food always available'	0.98	0.34	2.7	Reference 1.4–5.1	<i>P</i> < 0.005
<i>Frequency of feeding treats to pets</i>					
Combined data: 'on animals' demand' and 'more than three times a day'	0	-	1		
Combined data: 'three times a day', 'less than three times a day', 'once a week', 'occasionally' and 'never'	0.88	0.47	2.4	Reference 1.0–5.8	<i>P</i> < 0.05

The Hosmer-Lemeshow statistic was 1.049 (*P* > 0.800) and, therefore, the model was judged to fit the observed data well (Hosmer *et al* 2013); *b* = regression coefficient in Wald-statistic; SE (*b*) = standard error in Wald-statistic.

holds, and we did not collect data on owners' living condition, eg an apartment vs a house. However, our results have shown owners' age to be significantly associated with species of pet, ie senior respondents predominantly owned a pet cat while adult respondents tended to prefer dogs. Further studies are required to explore the predictors of choice of pet species in NI since such data would potentially add to our understanding of owners' relinquishments of unwanted pets and perhaps help alleviate the difficulties associated with persuading sufficient numbers of households to adopt unwanted pets of a given species.

Our results showed the majority of pet cats in NI to be owned by single occupancy households, while dogs were owned by virtually equal numbers of single and multiple occupancy households. These results contrast with those of Westgarth *et al* (2007) who assessed a semi-rural community in Cheshire, UK and found that multiple occupancy households, especially those with older children (6–19 years of age) were more likely to own a dog. The demography study of pet cats and dogs on the whole island of Ireland, undertaken by Downes *et al* (2009), also showed dog ownership to be associated with multiple occupancy households. Indeed, the recent figures (2017–2018) by the AVMA (2018) also indicate household size as being positively associated with pet cat and dog ownership. Further studies are required, focusing on NI pet owners' socio-economic status vs pet species/numbers owned or relinquished to better understand the risk associated with unwanted pets.

The physiological status (ie intact vs neutered) of pet dogs and cats in NI is different to the most recently reported results from the rest of the UK and previous findings from the island of Ireland. Namely, our results showed pets in NI to be predominantly intact, ie 60.5% of the cats were intact (females and males, collectively), and 50.2% of the dogs (females and males, collectively). The PAW report (PDSA 2019) has shown that within the UK, 92% of cats and 74% of dogs were neutered with 76.1% of cats on the island of Ireland reportedly neutered (Downes *et al* 2009; PDSA 2019). However, Downes *et al* (2009) reported that 46.6% of pet dogs on the island of Ireland were neutered, findings more in keeping with our own. Literature indicates a number of factors affecting owners' decision to not neuter their pets, such as a perceived lack of benefit to the pet/owner (PDSA 2019), the young age of the pet (PDSA 2019) and the monetary cost of the procedure (Frank *et al* 2007). It is acknowledged that neutering is essential in controlling pet-dog and (especially) pet-cat overpopulation. However, neutering has been indicated as a risk factor for obesity in pet cats (eg Nguyen *et al* 2004; Lund *et al* 2006) and dogs (eg Schauf *et al* 2016; Muñoz-Prieto *et al* 2018; Bjørnvad *et al* 2019) and may also impact negatively on other feline and canine health aspects (Kustritz 2012). Therefore, there is a suggestion that neutering (supported with appropriate management) should be considered on a case-by-case basis.

Table 11 Factors associated with owners' perceived overweight/obesity (combined data) in pet dogs (based on the results of a logistic regression model).

Factors	b	SE (b)	Odds ratio (OR) for association with overweight/obesity	95% CI	Significance level
Constant	-1.76	0.26	-	-	
<i>Age of the animal (years)</i>					
Combined data: < 1 and 1-7	0	-	1	Reference 1.6-5.1	P < 0.0001
> 7	1.05	0.30	2.9		
<i>Walk, frequency and duration</i>					
Combined data: 'daily > 1 h' and 'daily < 1 h'	0	-	1		
Combined data: '2-3 times a week' and 'occasionally'	0.83	0.31	2.3	Reference 1.3-4.2	P < 0.008
<i>Play time, frequency and duration</i>					
Combined data: 'daily > 1 h' and 'daily < 1 h'	0	-	1		
Combined data: '2-3 times a week' and 'occasionally'	0.76	0.33	2.1	Reference 1.1-4.1	P < 0.03
<i>Living environment</i>					
Combined data: 'indoors with free outdoors, small garden (< 0.25 ha)', 'indoors with free outdoors, large garden (> 0.25 ha)' and 'free to roam (no space restrictions)'	0	-	1	Reference 1.0-5.3	P < 0.05
Indoors (no free access to outdoors)	0.86	0.41	2.4		

The Hosmer-Lemeshow statistic was 4.134 ($P > 0.530$) and, therefore, the model was judged to fit the observed data well (Hosmer *et al* 2013); b = regression coefficient in Wald-statistic; SE (b) = standard error in Wald-statistic.

Our results have shown that the majority, ie ~60% of 667 pet cat and dog owners included in the study, believed their pet's body condition to be ideal ('as it should be' for age/sex) while only ~26% of owners indicated their pet to be overweight/obese. The majority of our respondents (76 and 63% of dog and cat owners, respectively) reported that they did not monitor their pets' bodyweight. Furthermore, the majority of our respondents were either unfamiliar or unaware of the body scoring system for assessment of pet body condition. Lack of bodyweight and body condition monitoring of pets may have direct implications for dietary management of the animals. Hence, further NI studies, focusing on the professional vs owner-reported body condition assessment are required to better understand the risks associated with obesity in pets.

Our results have shown that in NI, 46% of pet cats and 31% of pet dogs were fed solely commercial petfood. In the case of 11% of cats and 15% of dogs, commercial petfood was included in their diet (the proportion of commercial vs homemade food fed not assessed), while an additional 33% of cats and 39% of dogs were fed with all types of food (commercial and non-commercial). Thus, it could be suggested that, collectively, ~90% of pet cats and ~85% of pet dogs in our study have received commercial petfoods as part of their daily diets. Those figures resemble the findings from work on pet-feeding practices in the USA and Australia

by Laflamme *et al* (2008) and Michel *et al* (2008). Commercially manufactured complete petfood is required to adhere to the set standards (eg Fediaf 2019) thereby meeting the animals' nutritional requirements (in terms of stage of development, physical and physiological activity). Thus, it seems that ~one-third of all households in NI feed their pet with a diet containing only part of a nutritionally appropriate food, combined with food of unknown nutritional value (eg home-made/scraps). It is well acknowledged that such imbalanced diets increase the risk of a variety of nutrition-based diseases in both cats and dogs (Earle 1942; Fascetti 2010). Thus, the feeding practices observed in our study may pose a risk to pet well-being, in turn, indicating the need for further investigations to establish the potential effects of these feeding practices on animal health.

The majority of the respondents in this study who feed their pets solely with a commercially made petfood reported that food selection was based either on cost or on their pet's individual preferences, not on professional advice. In a study investigating dog-owner preferences when purchasing pet food, Suarez *et al* (2012) showed that owners of obese dogs were more likely to choose lower priced petfood compared to owners of normal weight dogs. Regarding animals' food preferences, pet dogs and cats are sensitive to numerous palatability drivers and petfood must not only be nutritionally balanced but also attractive to the animals. Current

methods of assessment of food preferences in dogs and cats include owners' perception of their pets' feeding enjoyment, however the owners' interpretation of petfood preferences should be treated with caution owing to potential subjectivity bias (Tobie *et al* 2015).

Nearly half of all households included in this study reported that they owned more than one pet of the same species. Yet, when asked about individual feeding of animals of the same species, all pet cat owners (100%) and a large number of pet dog owners (43.4%) did not provide an answer. Negative results are difficult to interpret, albeit we speculate that animals of the same species in multiple pet households in this study were not fed individually. To our knowledge no published data exist on feeding management of pets in multiple pet owning households. However, common knowledge and practice indicate that group feeding leads to over- and/or underfeeding of individual animals thus potentially leading to malnutrition, and/or under- or overnutrition and obesity.

This study has shown that in addition to daily food allowances, nearly all (92%) pet owners reportedly gave their pets food treats. Bland *et al* (2009) surveyed 219 pet dog owners and reported that 99% fed food treats in addition to main meals. Similar results were reported by Heuberger and Wakshlag (2011) for 61 dogs. The significance of frequent feeding of food treats to pets needs to be further investigated to assess the potential risks to animal health.

Our study revealed that walking a dog once a day for less than 1 h was the most prevalent type of physical activity provided to dogs. These results are in accordance with the PAW report (PDSA 2019) for the UK with regards to the average duration of walks (up 1 h), but not the frequency of walks as ~50% of the UK owners walked their dogs more than once a day. Additionally, our results have shown that in pet dogs the type of household affects the level of activity they are afforded, ie pet dogs in adult-only households were walked and played with more often than those owned by multiple occupancy households. We can only speculate that time and care commitments to other family members, either children or the elderly, impinges on the time available to the pet. Therefore, associations between physical activity levels provided to pet dogs and owners' characteristics require further investigation to establish the factors potentially affecting pet dogs' welfare.

The results of the current study showed the majority of pet cats to reportedly have free outdoor access but be provided with little or no physical activity. Cat owners seem to perceive free access to the outdoors as being sufficient to cover their pets' physical activity needs. Courcier *et al* (2010a) reported no difference in the risk of obesity between cats that had outdoor access and those that did not. Similarly, Öhlund *et al* (2018) did not report any association between obesity and outdoor access or indoor confinement. However, it has recently been reported that lean cats are more active (voluntary activity) compared to obese animals (de Godoy & Shoveller 2017). The level of outdoor activity of domestic cats depends on the home location and the neighbourhood, as it has been shown that home ranges of pet cats are larger

rurally compared to in urban sites (Metsers *et al* 2010; Hall *et al* 2016) and both home ranges and spatial movement of pet cats are determined by the density of cats in the area (Barratt 1997). Therefore, our results suggest the need for further assessment of the relationship between the living environment of pet cats (eg urban vs rural) and its potential impact on their health and welfare.

This study was descriptive in nature and, thus, the results do not allow for an identification of any specific risks for the well-being of pets in NI and we recognise this as a primary limitation of the study. However, our results indicate some potential risks to animal welfare, eg lack of weight/body condition monitoring, and hence further research is recommended to identify the actual risk factors that may negatively affect the health and welfare of pet cats and dogs.

Animal welfare implications and conclusion

This study has shown current fundamental care practices provided to pet cats and dogs in NI. The results indicate that a number of pet cat and dog owners in NI are not aware of, or failing to adhere to, the fundamentals of animal care — including animal nutrition and appropriate levels of physical activity required to promote the health and welfare of their pets. Therefore there is a suggestion that pet owners might benefit from species-specific education on how to care for their animals as well as hands-on training on how to assess their animals' BCS.

This study has identified areas for future research, in particular investigation into predictors for the choice of pet species and exploration of pet owners' attitudes towards the management of physical activity in their pets.

Acknowledgements

Financial support for this study has been provided by the School of Biomedical Sciences, Ulster University. The authors declare that they have no competing interests.

References

- American Veterinary Medical Association (AVMA)** 2018 *AVMA Report for 2017-2018*. <https://www.avma.org/sites/default/files/resources/AVMA-Pet-Demographics-Executive-Summary.pdf>
- Baldock FC, Alexander L and More SJ** 2003 Estimated and predicted changes in the cat population of Australian households from 1979 to 2005. *Australian Veterinary Journal* 81(5): 289-292. <https://doi.org/10.1111/j.1751-0813.2003.tb12577.x>
- Barratt DG** 1997 Home range size, habitat utilisation and movement patterns of suburban and farm cats *Felis catus*. *Ecography* 20(3): 271-280. <https://doi.org/10.1111/j.1600-0587.1997.tb00371.x>
- Bjørnvad CR, Gloor S, Johansen SS, Sandøe P and Lund TB** 2019 Neutering increases the risk of obesity in male dogs but not in bitches. A cross-sectional study of dog-and owner-related risk factors for obesity in Danish companion dogs. *Preventative Veterinary Medicine* 170: 104730. <https://doi.org/10.1016/j.prevetmed.2019.104730>
- Bland IM, Guthrie-Jones A, Taylor RD and Hill J** 2009 Dog obesity: owner attitudes and behaviour. *Preventative Veterinary Medicine* 92(4): 333-340. <https://doi.org/10.1016/j.prevetmed.2009.08.016>

- Cave NJ, Allan FJ, Schokkenbroek SL, Metekohy CAM and Pfeiffer DU** 2012 A cross-sectional study to compare changes in the prevalence and risk factors for feline obesity between 1993 and 2007 in New Zealand. *Preventative Veterinary Medicine* 107(1-2): 121-133. <https://doi.org/10.1016/j.prevetmed.2012.05.006>
- CENSUS** 2011 *Key statistics for Northern Ireland 2012*. Northern Ireland Statistics and Research Agency, Department of Finance and Personnel, Belfast, Northern Ireland, UK
- Chandler M, Cunningham S, Lund EM, Khanna C, Naramore R, Patel A and Day MJ** 2017 Obesity and associated comorbidities in people and companion animals: a one health perspective. *Journal of Comparative Pathology* 156(4): 296-309. <https://doi.org/10.1016/j.jcpa.2017.03.006>
- Collins LM, Asher L, Summers JF, Diesel G and McGreevy PD** 2010 Welfare epidemiology as a tool to assess the welfare impact of inherited defects on the pedigree dog population. *Animal Welfare* 19(S1): 67-75
- Corbee RJ** 2013 Obesity in show dogs. *Journal of Animal Physiology and Animal Nutrition* 97(5): 904-910. <https://doi.org/10.1111/j.1439-0396.2012.01336.x>
- Corbee RJ** 2014 Obesity in show cats. *Journal of Animal Physiology and Animal Nutrition* 98(6): 1075-1080. <https://doi.org/10.1111/jpn.12176>
- Courcier EA, O'Higgins R, Mellor DJ and Yam PS** 2010a Prevalence and risk factors for feline obesity in a first opinion practice in Glasgow, Scotland. *Journal of Feline Medicine and Surgery* 12(10): 746-753. <https://doi.org/10.1016/j.jfms.2010.05.011>
- Courcier EA, Thomson RM, Mellor DJ and Yam PS** 2010b An epidemiological study of environmental factors associated with canine obesity. *Journal of Small Animal Practice* 51(7): 362-367. <https://doi.org/10.1111/j.1748-5827.2010.00933.x>
- de Godoy MR and Shoveller AK** 2017 Overweight adult cats have significantly lower voluntary physical activity than adult lean cats. *Journal of Feline Medicine and Surgery* 19(12): 1267-1273. <https://doi.org/10.1177/1098612X17694252>
- DeMaio TJ, Rothgeb J and Hess J** 1998 *Improving survey quality through pre-testing* pp 50-58. US Bureau of the Census: Washington, DC, USA
- Downes M, Canty MJ and More SJ** 2009 Demography of the pet dog and cat population on the island of Ireland and human factors influencing pet ownership. *Preventative Veterinary Medicine* 92(1-2): 140-149. <https://doi.org/10.1016/j.prevetmed.2009.07.005>
- Earle IP** 1942 *Nutritional diseases in dogs and cats*. Yearbook of Agriculture pp 1203-1215. United States Department of Agriculture: Washington, USA
- Egenvall A, Hedhammar A, Bonnett BN and Olson P** 2000 Gender, age, breed and distribution of morbidity and mortality in insured dogs in Sweden during 1995 and 1996. *Veterinary Record* 146(18): 519-525. <https://doi.org/10.1136/vr.146.18.519>
- Fascetti AJ** 2010 Nutritional management and disease prevention in healthy dogs and cats. *Revista Brasileira de Zootecnia* 39(S): 42-51. <https://doi.org/10.1590/S1516-35982010001300006>
- Fediaf (European Pet Food Industry Federation)** 2019 *Nutritional guidelines for complete and complementary pet food for cats and dogs*. www.fediaf.org
- Frank JM and Carlisle-Frank PL** 2007 Analysis of programs to reduce overpopulation of companion animals: Do adoption and low-cost spay/neuter programs merely cause substitution of sources? *Ecological Economics* 62(3-4): 740-746. <https://doi.org/10.1016/j.ecolecon.2006.09.011>
- Gidlow C, Johnston LH, Crone D, Ellis N and James D** 2006 A systematic review of the relationship between socio-economic position and physical activity. *Health Education Journal* 65(4): 338-367. <https://doi.org/10.1177/0017896906069378>
- Haase D and Galova V** 2018 *The economic, social and territorial situation of Northern Ireland. In-depth analysis requested by the REGI committee*. Policy Department for Structural and Cohesion Policies, EU PE 617.459. Directorate-General for Internal Policies, European Parliament, Policy Department for Structural and Cohesion Policies, Brussels. [http://www.europarl.europa.eu/RegData/etudes/IDAN/2018/617459/IPOL_IDA\(2018\)617459_EN.pdf](http://www.europarl.europa.eu/RegData/etudes/IDAN/2018/617459/IPOL_IDA(2018)617459_EN.pdf)
- Hall CM, Bryant KA, Haskard K, Major T, Bruce S and Calver MC** 2016 Factors determining the home ranges of pet cats: A meta-analysis. *Biological Conservation* 203: 313-320. <https://doi.org/10.1016/j.biocon.2016.09.029>
- Heuberger R and Wakshlag J** 2011 The relationship of feeding patterns and obesity in dogs. *Journal of Animal Physiology and Animal Nutrition* 95(1): 98-105. <https://doi.org/10.1111/j.1439-0396.2010.01024.x>
- Hill JO, Wyatt HR and Peters JC** 2012 Energy balance and obesity. *Circulation* 126(1): 126-132. <https://doi.org/10.1161/CIRCULATIONAHA.111.087213>
- Hill RC** 2009 Nutritional therapies to improve health: Lessons from companion animals. *Proceedings of the Nutrition Society* 68(1): 98-102. <https://doi.org/10.1017/S0029665108008835>
- Hosmer DW, Lemeshow Jr SA and Sturdivant RX** 2013 *Applied Logistic Regression, Third Edition* pp 153-226. Wiley: Hoboken, NJ, USA. <https://doi.org/10.1002/9781118548387>
- Kustritz MVR** 2012 Effects of surgical sterilization on canine and feline health and on society. *Reproduction in Domestic Animals* 47: 214-222. <https://doi.org/10.1111/j.1439-0531.2012.02078.x>
- Laflamme DP, Abood SK, Fascetti AJ, Fleeman LM, Freeman LM, Michel KE, Bauer C, Kemp BL, Doren JRV and Willoughby KN** 2008 Pet feeding practices of dog and cat owners in the United States and Australia. *Journal of American Veterinary Medical Association* 232(5): 687-694. <https://doi.org/10.2460/javma.232.5.687>
- Leslie BE, Meek AH, Kawash GF and McKeown DB** 1994 An epidemiological investigation of pet ownership in Ontario. *Canadian Veterinary Journal* 35(4): 218-222
- Lund E, Armstrong P, Kirk C, Kolar L and Klausner J** 1999 Health status and population characteristics of dogs and cats examined at private veterinary practices in the United States. *Journal of American Veterinary Medical Association* 214: 1336-1341
- Lund EM, Armstrong PJ, Kirk CA and Klausner JS** 2005 Prevalence and risk factors for obesity in adult cats from private US veterinary practices. *International Journal of Applied Research into Veterinary Medicine* 3(2): 88-96
- Lund EM, Armstrong PJ, Kirk CA and Klausner JS** 2006 Prevalence and risk factors for obesity in adult dogs from private US veterinary practices. *International Journal of Applied Research into Veterinary Medicine* 4(2): 177-186

- Mao J, Xia Z, Chen J and Yu J** 2013 Prevalence and risk factors for canine obesity surveyed in veterinary practices in Beijing, China. *Preventative Veterinary Medicine* 112(3-4): 438-442. <https://doi.org/10.1016/j.prevetmed.2013.08.012>
- McGreevy PD, Thomson PC, Pride C, Fawcett A, Grassi T and Jones B** 2005 Prevalence of obesity in dogs examined by Australian veterinary practices and the risk factors involved. *Veterinary Record* 156(22): 695-702. <https://doi.org/10.1136/vr.156.22.695>
- Metsers EM, Seddon PJ and van Heezik YM** 2010 Cat-exclusion zones in rural and urban-fringe landscapes: how large would they have to be? *Wildlife Research* 37(1): 47-56. <https://doi.org/10.1071/WR09070>
- Michel KE, Willoughby KN, Abood SK, Fascetti AJ, Fleeman LM, Freeman LM, Laflamme DP, Bauer C, Kemp BL and Doren JRV** 2008 Attitudes of pet owners toward pet foods and feeding management of cats and dogs. *Journal of American Veterinary Medical Association* 233(11): 1699-1703. <https://doi.org/10.2460/javma.233.11.1699>
- Muñoz-Prieto A, Nielsen LR, Dąbrowski R, Bjørnvad CR, Söder J, Lamy E, Monkeviciene I, Ljubić BB, Vasiu I, Savic S and Busato F** 2018 European dog owner perceptions of obesity and factors associated with human and canine obesity. *Scientific Reports* 8(1): 1-10. <https://doi.org/10.1038/s41598-018-31532-0>
- Nguyen PG, Dumon HJ, Siliart BS, Martin LJ, Sergheraert R and Biourge VC** 2004 Effects of dietary fat and energy on body weight and composition after gonadectomy in cats. *American Journal of Veterinary Research* 65(12): 1708-1713. <https://doi.org/10.2460/ajvr.2004.65.1708>
- Öhlund M, Palmgren M and Holst BS** 2018 Overweight in adult cats: a cross-sectional study. *Acta Veterinaria Scandinavica* 60(1): 5. <https://doi.org/10.1186/s13028-018-0359-7>
- Okada Y, Kobayashi M, Sawamura M and Arai T** 2017 Comparison of visceral fat accumulation and metabolome markers among cats of varying BCS and novel classification of feline obesity and metabolic syndrome. *Frontiers in Veterinary Science* 4: 17. <https://doi.org/10.3389/fvets.2017.00017>
- Ortega-Pacheco A, Rodriguez-Buenfil JC, Bolio-Gonzalez ME, Sauri-Arceo CH, Jiménez-Coello M and Forsberg CL** 2007 A survey of dog populations in urban and rural areas of Yucatan, Mexico. *Anthrozoös* 20(3): 261-274. <https://doi.org/10.2752/089279307X224809>
- Pechey R and Monsivais P** 2016 Socioeconomic inequalities in the healthiness of food choices: Exploring the contributions of food expenditures. *Preventative Medicine* 88: 203-209. <https://doi.org/10.1016/j.ypmed.2016.04.012>
- People's Dispensary for Sick Animals (PDSA)** 2017 *PDSA Animal Wellbeing (PAW) Report 2017*. PDSA: Telford, UK
- People's Dispensary for Sick Animals (PDSA)** 2019 *PDSA Animal Wellbeing (PAW) Report 2019*. PDSA: Telford, UK
- Pet Food Manufacturers' Association (PFMA)** 2015 *Historical Pet Ownership 1965-2004*. <https://www.pfma.org.uk/historical-pet-ownership-statistics>
- Pet Food Manufacturers' Association (PFMA)** 2019 *Regional pet population 2019*. <https://www.pfma.org.uk/regional-pet-population-2019>
- Salt C, Morris PJ, Wilson D, Lund EM and German AJ** 2019 Association between life span and body condition in neutered client-owned dogs. *Journal of Veterinary Internal Medicine* 33(1): 89-99. <https://doi.org/10.1111/jvim.15367>
- Schauf S, Salas-Mani A, Torre C, Bosch G, Swarts H and Castrillo C** 2016 Effect of sterilization and of dietary fat and carbohydrate content on food intake, activity level, and blood satiety – related hormones in female dogs. *Journal of Animal Science* 94(10): 4239-4250. <https://doi.org/10.2527/jas.2015-0109>
- Studdert VP, Gay CC, Blood DC and Grandge J** 2012 *Saunders Comprehensive Veterinary Dictionary, 4th Edition* p 773. Elsevier: Oxford, UK
- Suarez L, Peña C, Carretón E, Juste MC, Bautista-Castaño I and Montoya-Alonso JA** 2012 Preferences of owners of overweight dogs when buying commercial pet food. *Journal of Animal Physiology and Animal Nutrition* 96(4): 655-659. <https://doi.org/10.1111/j.1439-0396.2011.01193.x>
- Teng KT, McGreevy PD, Toribio JAL, Raubenheimer D, Kendall K and Dhand NK** 2018 Strong associations of nine-point body condition scoring with survival and lifespan in cats. *Journal of Feline Medicine and Surgery* 20(12): 1110-1118. <https://doi.org/10.1177/1098612X17752198>
- Tobie C, Péron F and Larose C** 2015 Assessing food preferences in dogs and cats: a review of the current methods. *Animals* 5(1): 126-137. <https://doi.org/10.3390/ani5010126>
- UKETS (Education and Training Statistics for the United Kingdom)** 2018 *Department of Education, National Statistics*. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/757675/UKETS_2018_Text.pdf
- Westgarth C, Pinchbeck GL, Bradshaw JW, Dawson S, Gaskell RM and Christley RM** 2007 Factors associated with dog ownership and contact with dogs in a UK community. *BMC Veterinary Research* 3(1): 5. <https://doi.org/10.1186/1746-6148-3-5>
- Wyse CA, McNie KA, Tannahil VJ, Murray JK and Love S** 2008 Prevalence of obesity in riding horses in Scotland. *Veterinary Record* 162: 590-591. <https://doi.org/10.1136/vr.162.18.590>