Recording of body weight and body condition score of cats in electronic health records from UK veterinary practices

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Abstract

Objective To determine how frequently bodyweight, body condition score (BCS) and terms pertaining to weight status are recorded in electronic health records (EHR) of veterinary practices in the UK. Additionally, to examine variables affecting recording, and variables associated with bodyweight where recorded.

Methods Data recorded in EHR were searched in two 3-month periods at the end of 2019 and 2020. For each visit, variables were recorded including type and time of consultation, signalment, recording of bodyweight, recording of BCS, weight (kg) and whether an overweight or weight loss term was used in free text recorded at the visit. Linear mixed-effects models were created to examine associations between bodyweight and variables, whilst mixed-effects logistic regression was used to determine associations between the same variables and weight or BCS recording.

Results The statistical dataset comprised 129,076 visits from 129,076 cats at 361 practices. Weight was recorded at most (95.2%) visits, BCS was only recorded at 22.5% of visits, and terms associated with weight loss and overweight status were recorded in 10.0% and 7.2% of free text records, respectively. Where BCS was recorded, approximately one third of cats had an overweight score (8.0% of total visits). Using either an overweight term (P<0.001) or weight loss term (P<0.001) was associated with increased odds of bodyweight being recorded, whilst being an out-of-hours consultation (P<0.001) or being a non-routine consultation (P<0.001) were associated with decreased odds. Increasing age (P<0.001), using a weight loss term (P<0.001) and using an overweight term (P<0.001) were all associated with increased odds of BCS being recorded, whilst being a non-routine consultation (P<0.001) was associated with decreased odds. Finally, recording BCS was negatively associated with recording bodyweight and vice versa.

Conclusions and relevance Cats are regularly weighed in UK practice, but BCS is less frequently recorded, and both are less often recorded in non-routine consultations. To improve both treatment and assessment of health and nutrition in cats, veterinary professionals should ideally record bodyweight and BCS concurrently at every consultation.

Introduction

Obesity is one of the most common medical disorders of pet cats [1,2] and is regarded as a significant welfare issue [3], given associations with multiple comorbidities[2,4] and mortality[5]. Cats in underweight condition also have a greater overall mortality risk and higher morbidity [5,6]. As a result, regular assessment of bodyweight and body condition score (BCS) are important for establishing a cat's health status, as well as for ensuring accurate medication dosing. Early identification of changes in either bodyweight, BCS or both enable prompt action, both in terms of diagnostic investigations and intervention.

Measuring bodyweight has the advantages of being quick, easy, repeatable and objective, but cannot alone be used to assess body composition as it cannot readily distinguish the contribution of different tissue types [7]. Nonetheless, regular bodyweight recording is a very sensitive method of monitoring weight change over time[8]. Body condition scoring is a rapid, semi-quantitative method estimating body fat percentage through visual assessment of body shape and palpation of body fat [9]. The most commonly-used systems include the 5-point or 9-pont scale, which are used based on individual preference. A 9-point body condition score scale has high inter-assessor agreement and correlates well with the gold standard duel-energy x-ray absorptiometry (DEXA) when estimating body fat percentage[9–12].

Previous studies suggest that veterinarians infrequently record bodyweight or BCS for dogs [13] and rarely record terms pertaining to weight status (e.g., 'overweight' or 'obese') in the electronic health records (EHR)[14]. Nutritional assessment which includes bodyweight and BCS assessment is also rarely performed by veterinary professionals when examined in several countries[15,16].

However, to date no studies have assessed how frequently such measures are recorded for cats in veterinary practices from the UK. Therefore, the aim of this study was to investigate how frequently veterinarians recorded the bodyweight, BCS and terms pertaining to weight status of cats in electronic patient records, as well as exploring variables which may affect the reporting of such

69 measures. A second aim was to determine variables associated with bodyweight in cats where this

70 had been recorded.

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Methods

Data collection

Utilising data stored within the practice management system (RoboVet), CVS PLC, a corporate group in the UK, EHR were searched by timeframe for entries based on the criteria of a specified consultation or vaccination professional fee being sold to feline patients. Data from two time periods were included, comprising the final quarter (1st October to 31st December) from 2019 and 2020. Data were extracted from each entry to confirm if the cat's weight had been recorded within the system's statistics table or whether the acronyms or phrases "kg", "BCS" or "Body Condition Score" were recorded in the clinical record (1 indicating present, 0 indicating absence). This excluded entries of "kg" where this text was associated with dispensing labels only. Each entry was exported to Excel for analysis.

Variables recorded

For each visit, the following variables were recorded: cat ID, practice ID, year (2019 vs. 2020), day type (weekday vs. weekend), consultation type (routine vs. non-routine; see supplementary table for definitions), time period (morning, afternoon, evening, out-of-hours [OOH]), age, sex (female vs. male), neuter status (sexually-intact vs. neutered), breed group (based on Governing Council of the Cat Fancy [GCCF] classification), whether weight was recorded (yes vs. no), whether a body condition score (BCS) was recorded (yes vs. no), weight (in kg), whether an overweight term was used in the free text (Table 1) and whether a weight loss term was used in the notes (Table 1). Overweight BCS was classed as >5/9 or >3/5, depending upon the system. Where BCS was recorded without a denominator (e.g., /5 or /9), cats were only classified as "overweight BCS" when the system used was obvious. In this respect, scores of 4 or 5 without a denominator could were not included because it was not clear whether they represented ideal weight (on the 9-point BCS system) or overweight (on the 5-point BCS system); conversely, scores of 6-9 were included because such scores implied that the 9-point system had been used.

Statistical analysis

Data were first entered into an electronic spreadsheet (Microsoft Excel® for Mac version 16.19), and checked for errors, for example, typographical errors with categorical variables and unrealistic values for ages and bodyweights. The final datasets are available as supplementary information (S1 Dataset) and summarised in Table 2. Statistical analyses were performed both with a computer software package (JMP version 16.0.0, SAS Institute Inc.) and an online open-access statistical language and environment (R, version 4.2.0, The R Foundation for Statistical Computing, http://www.R-project.org). The computer software package was used to calculate summary data for the 'complete dataset' (data after error checking) including proportions (percentages) for categorical data, mean ± standard deviation (SD) for continuous data that were normally distributed (determined by Shapiro-Wilk test and examination of Q-Q plots), or median and inter-quartile range (IQR) for continuous data that were not normally distributed. However, given that the dataset used for statistical analyses used only one visit per cat (see below), data on number of visits was reported as median (range), so that the full extent of the data range could be highlighted. Further, data on neuter status were not recorded or used in analyses given concerns over reliability. In this respect, neuter status must be manually changed within the EHR at the time of neutering, and this is not consistently done (ST and ME, personal observations), meaning that many cats recorded as sexually intact might in fact have been neutered.

The 'text explorer' function of the computer software package was also used to analyse free-form text in electronic patient records, to identify visit records which included terms associated with overweight status, weight loss and BCS scores (~~see above and~~ Table 1). This function enables a list of terms to be identified from free text along with their frequency of use. One observer (AJG) reviewed this list to identify the terms of relevance to be included in the analysis. Prior to selection, the context of use of each term was determined by reviewing random selections of free text where the term appeared. This ensured that the terms included in the analysis were relevant even when there were spelling errors. Some terms of potential relevance were not included because they were

sometimes used in alternative (irrelevant) contexts. For example, the word 'fat' was often used to describe adipose tissue rather than to infer the presence of obesity (e.g., subcutaneous fat, inflamed fat, the presence of fat during surgery). Likewise, the term 'thin' was commonly used as a descriptor for body parts, tissues or disease processes (e.g., thin haircoat, thin layer of tartar, thin gap). Finally, when identifying terms associated with weight loss, no distinction was made between cats where the weight loss was intentional (e.g., weight management in an overweight cat) and those where weight loss was related to illness.

The online statistical environment was used for mixed-effects linear modelling and mixed-effects logistic regression (using package lme 4)[17]. To ensure that models remained balanced, a subset of data was created (statistical dataset); first, only practices where there had been least 200 visits were selected. Thereafter, a single visit was selected for each cat seen, by taking the first available visit chronologically. The cats included in the statistical dataset were broadly similar to those in the main population (Tables 2 and 3). Linear mixed-effects models were created to examine associations between bodyweight and the variables described above (see: variables recorded); mixed-effects logistic regression was used to determine associations between the recording of either weight or BCS and the same variables. In all models, centre was included as a random effect, whilst all remaining variables were included as fixed effects. Initially, separate models were constructed with both the random effect and a single fixed effect. Thereafter, a further model was constructed, again containing the random effect and all fixed effects that were significant ($P<0.05$) in the initial models. Competing models were then tested in a backwards and forwards stepwise fashion with the best fit model chosen using the Bayesian Information Criterion (BIC); with this approach, the model was repeatedly refined with addition or removal of variables until the model with the smallest BIC was found. Models with interaction terms were also tested when these were thought to be clinically relevant. These included: possible interactions between year and GGCF breed, pedigree status, recording a weight loss term, recording an overweight term or recording an overweight BCS; possible interactions between day type and time period or consultation type; possible interactions

between consultation type and either age or time period; and possible interactions amongst recording an overweight BCS, using an overweight term using a weight loss term. Such interaction terms were retained in the model when overall fit was improved (as determined by BIC). Possible multicollinearity in all models was assessed using the generalised variance inflation factor (GVIF) and $GVIF^{(1/(2\times Df)}$, and was deemed to be acceptable when all values were <4 and <2 for GVIF and $GVIF^{(1/(2\times Df)}$, respectively. For mixed-effects linear regression models, residuals were checked (using scatterplots of residuals versus fitted values, histograms and Q-Q plots), whilst influential datapoints were identified using Cook's distance and removed if necessary (Cook's distance >0.1). The results of the linear mixed effects models are expressed as least-squares means and 95% confidence intervals (95%-CI), with pairwise comparisons amongst sub-groups made using the Tukey method. The results of mixed effects logistic regression models are reported as odds ratios (OR) with the associated 95%-CI. For all analyses, the level of statistical significance set at $P<0.05$, and two-sided analyses were used throughout.

Results

Final study population and subset for statistical analysis

The complete dataset comprised 240,115 visits from 136,052 cats at 486 different centres (Table 2). The median number of visits recorded at each centre was 397 (IQR: 189-735), the median number of visits per cat was 1 (range 1-16) and there were a similar number of visits in 2019 and 2020. Median age was 7.7 years (IQR 3.2-12.5 years; Table 3), there was a broadly equal distribution of male and female cats (male 50.7%, female 49.3%) and most cats were of mixed breeding (119,614; 87.9%), but several other breeds were also included (Table 3). The statistical dataset comprised 129,076 visits from 129,076 cats at 361 different veterinary centres, with the distribution of data being broadly similar to the complete dataset (Table 2), except that almost two thirds of visits were in 2019.

Weighing, body condition scoring and terminology

In the complete dataset, weight was recorded at most (228,480; 95.2%) visits, whilst BCS was recorded at less than a quarter (54,010; 22.5%; Table 4). In a minority of records, terms associated with weight loss (24,012; 10.0%) and overweight status (17,265; 7.2%) were used in the free text, whilst an overweight BCS score was formally recorded at 19,318 visits (8.0%), corresponding to approximately 1/3 of occasions where BCS was recorded (Table 4).

Variables associated with bodyweight

Tables 5 and 6 show the results from initial and final linear mixed-effects models, respectively, assessing associations between bodyweight and different variables. In the final model, the variables positively associated with bodyweight (in kg) were: consultation type (non-routine > routine, $P<0.001$),day type (weekend > weekday, $P<0.001$), time period (afternoon > evening, $P=0.046$), age ($P<0.001$), sex (male > female, $P<0.001$), GCCF group (Maine Coon and Norwegian Forest > mixed breed > Birman, Persian, Ragdoll, Russian, Siamese and other GCCF all; $P<0.001$), overweight term used ($P<0.001$) and overweight BCS recorded ($P<0.001$). The variables negatively associated with bodyweight were year (2020 < 2019, $P<0.001$) and use of a weight loss term ($P=0.003$), In addition, the final model also included a negative interaction term between consultation type and age,

whereby mean bodyweight was less in cats attending routine consultations in 2020 than in 2019 (P<0.001). There were additional interactions between year and either using an overweight term or recording an overweight BCS (P<0.001 for both); in both cases, the average weight of cats was greater in 2020 than in 2019, when either an overweight term was used or an overweight BCS was recorded (P<0.001 for both). Further, there were interactions between the use of a weight loss term and either the use of an overweight term or the recording an overweight BCS; in both cases, the average weight of cats was greater when a weight loss term was recorded with either an overweight term or an overweight BCS (P<0.001 for both). Finally, there was a negative interaction between the use of an overweight term and the recording of an overweight BCS (P<0.001).

Variables associated with veterinary professionals recording bodyweight

Tables 7 and 8 show the results from initial and final mixed-effects logistic regression models, respectively, assessing associations between the recording of bodyweight by veterinarians and different variables. In the final multiple logistic regression model, using either an overweight term (P<0.001) or weight loss term (P<0.001) were associated with increased odds of bodyweight being recorded, whilst being an out-of-hours consultation (P<0.001), being a non-routine consultation (P<0.001) or having BCS recorded (P<0.001) were associated with decreased odds.

Variables associated with veterinary professionals recording BCS

Tables 9 and 10 show the results from initial and final mixed-effects logistic regression models, respectively, assessing associations between the recording of BCS by veterinarians and different variables. In the final multiple logistic regression model, year (2020 > 2019, P<0.001), increasing age (P<0.001), using a weight loss term (P<0.001) and using an overweight term (P<0.001) were all associated with increased odds of BCS being recorded, whilst being a non-routine consultation (P<0.001) and having bodyweight recorded (P<0.001) were associated with decreased odds. There was also an interaction between year and consultation type, whereby routine consultations in 2020 were associated with a decreased odds of having BCS recorded (P<0.001). Finally, although being of

male sex was not itself associated with the odds of recording BCS (*P*=0.214), model fit was worse when this was removed from the model.

Discussion

In this study, we examined how frequently UK veterinary clinics recorded bodyweight and BCS, during two time periods and using EHRs from a large population of cats in the UK. Cats were regularly weighed in both routine and non-routine consultations (95.2% of visits), which was more frequently that that reported in one previous study in dogs (German and Morgan 2008), where bodyweight was recorded every seven visits. However, our findings were consistent with results from two surveys of veterinarians, whereby 95% and 85%, respectively of respondents reported using measuring bodyweight as part of a nutritional assessment;[15] that said, in one of these studies, only 38% of Belgian vets had separate scales for cats (Blees et al., 2022). In contrast to weight, body condition score was recorded in under a quarter of all consultations (22.5%), suggesting that, as in previous studies in companion animals,[13–16] this measure is infrequently assessed. The advantages of assessment of BCS include indirect assessment of body composition which reflects results of DEXA [9,11,20] and providing a semi-quantitative method of monitoring weight status without the need for scales [1]. In a previous study [15], veterinarians reported reasons for irregular use of BCS and muscle condition scoring in dogs and cats, with 27% reporting insufficient experience or lack of habit in performing the method, 23% reporting time constraints during consultation and 20% reporting use of such assessments only when related to clinical signs.

There was a negative association between recording bodyweight and BCS in the current study, suggesting that veterinarians are selective in the clinical measures that they choose to record during a consultation. This is, perhaps, further highlighted by the fact that both bodyweight and BCS were more likely to be recorded when either a weight loss term or an overweight term was used in the EMR. The odds of recording BCS was also positively associated with increasing age. Taken together, these findings suggest that bodyweight and BCS are more likely to be assessed if perceived to be clinically relevant, a finding similar to that in a previous study whereby nutritional assessment was more likely if patients had existing or suspected health complaints, dietary-related condition or evidence of malnutrition [16]. However, this suggestion is contradicted by the fact that both BCS and

bodyweight were less likely to be recorded in non-routine consultations in the current study. If bodyweight and BCS are mainly recorded in older or unwell patients, opportunities proactively to address weight-related problems (e.g., occult weight loss) at a time when interventions could be most effective.[21] Therefore, the authors would strongly recommend recording both these measures concurrently at all consultations because this increases available clinical information thereby aiding-making (e.g., during nutritional assessment and for medication dosing). In one study, survey respondents stated that they would value additional tools to assist nutritional assessment, such as videos explaining BCS and MCS [16]. Based on the findings of the current study, veterinary professionals may benefit from further education and emphasis on the benefits of measuring BCS and bodyweight concurrently in cats.

The odds of recording bodyweight were less for out-of-hours consultations, which might partly be associated with the fact that these consultations would overwhelmingly be non-routine, rather than routine when bodyweight recording more commonly occurred. It might also reflect the possible time pressures or fatigue in veterinary staff when working out-of-hours, not least after long days. In this respect, time pressures may build up during the day as fatigue increases; in human medicine, a decline in medical diligence is reported in the afternoon compared to the morning[22] and medication errors are more likely overnight and at weekends.[23]

In the current study, terms associated with overweight status appeared in only 7% of records, with such lack of documentation previously reported in studies of both dogs [14] and cats [2,25]. The reported prevalence of overweight status in UK cats ranges from 12% to 52% [26]; [27], whilst a greater prevalence has been reported in other countries, for example, 63% in New Zealand [28] and 41% in USA[2]. This suggests either under-recording of overweight status in the current study, or a lack of recognition of its impact on morbidity and mortality in cats, as previously seen [2,4,5]. The reasons for this lack of recording are not known, but might be due to time constraints or reluctance to hold discussions about obesity with owners for fear of causing offence [1,14]. Under-reporting in the current study is also suggested by the fact that, although overweight BCS was recorded in only 8%,

this represented approximately a third of all scores recorded. However, as mentioned above the accuracy of this result is not clear because, in approximately 10% of instances, the BCS denominator was not reported meaning that scores of 4 or 5 could either represent ideal weight, with the 9-point BCS, or overweight with the 5-point BCS. For the future, such confusion could be addressed if an automated field for BCS were available in veterinary EHRs.

Several variables were associated with bodyweight in the final multivariable mixed-effects model, many of which would be expected including breed, sex and age. However, there were also effects of day type and time period, whereby cats seen at weekends were heavier on average, whilst those seen during the evening or out-of-hours were lighter, on average. Such associations might reflect differences in types of appointment scheduled at different times (e.g., routine appointments more likely in the mornings and at weekends) or be related to possible effects of illness (e.g., sicker cats seen during the evenings and out-of-hours). There were also complex interactions between variables, such as the interaction between age and consultation type, whereby cats older cats seen as routine consultations were heavier than those seen at non-routine consultations. Other variables associated with bodyweight included use of a weight loss term, use of an overweight term and recording an overweight BCS, as well as interactions amongst these variables: cats were heavier on average when either an overweight term was used or an overweight BCS was recorded. Further, cats were lighter on average when a weight loss term was used, except when used in conjunction with either an overweight term or an overweight BCS. This suggests that weight loss terms were not only used to document weight loss due to illness, but also intended weight loss during weight management. Finally, and perhaps surprisingly, bodyweight was negatively associated with cats where both an overweight term and an overweight BCS was used concurrently. The reason for this interaction is not clear but, perhaps, might reflect the these are used interchangeably (i.e., either an overweight term or an overweight BCS recorded in the record); alternatively, overweight terms might have occasionally been used in a negative context (e.g., “not overweight” or “no longer overweight”) in conjunction with instances when an overweight BCS was not recorded.

The use of data from the final quarter of both 2019 and 2020 in the current study enabled us to examine possible effects of the COVID-19 pandemic on recording of bodyweight and BCS. Although there was no year effect on the recording of bodyweight, BCS was more often recorded in 2020 than in 2019, except during routine consultations when it was less commonly assessed. The reasons for these differences are not clear, but they might be related both to changes in working practices (e.g., BCS recorded less often during routine consultations) and population differences (e.g., overweight cats more often observed during non-routine consultations) during the COVID-19 pandemic. The results of the current study also suggest complex effects of the COVID-19 pandemic on bodyweight. For example, on average, cats were lighter in 2020 than in 2019, and there was a separate interaction between year and consultation type, suggesting this weight difference was most pronounced in cats weighed at routine consultations (in 2020 vs. 2019). These findings might reflect increased numbers of kittens being registered during the COVID-19 pandemic and requiring initial vaccination appointments. Despite the negative association between year and bodyweight overall, there were positive interactions between bodyweight and either the use of an overweight term or recording an overweight BCS; this suggests that overweight cats were heavier in 2020 than in 2019, perhaps, inferring that overweight cats were differentially prone to weight gain during the COVID-19 pandemic. Were this effect to be true, possible explanations would include altered owner husbandry (e.g., increased feeding of treats) or inability to undertake weight management during the COVID-19 pandemic. Alternatively, it might simply reflect the altered priorities of veterinarians during the COVID-19 pandemic, for example, only recording an overweight term or BCS in the most severely overweight cats. Given that this was an observational study, such a causal association cannot be confirmed, and further work would be required to assess the true impact of the COVID-19 pandemic on bodyweight and body condition of cats.

Limitations of the study include the method of identification of appropriate terms for the analysis, which was a manual process undertaken by one study author. Although many spelling errors were identified, other spelling errors might have been overlooked. It is also possible that some terms

were missed because they were used too infrequently to be highlighted by the free text search; for example, terms such as 'skinny' might have been expected but was not identified in this study. Finally, some relevant terms had to be excluded because they were used in other (non-weight-related) contexts, as already described for terms such as 'fat' or 'thin'.

A second limitation was the fact that neuter status was not included as a variable in our data analysis. The vast majority (~80%) of cats in the dataset are recorded as being neutered, but there are limitations with this because the information is not always accurate. In this respect, the EHR has to be manually updated when a cat is neutered and this does not always occur, making this variable unreliable (ST, ME; unpublished observations). In this respect, approximately 20% cats over 1 year of age are recorded as sexually intact in this study population, which is a greater proportion than would be typical of cats from these practices. Given concerns over the accuracy of this variable, we decided not to include it.

A third limitation is the fact that multiple veterinarians and practices were included, including a small number of referral practices, meaning that there would likely be many different protocols for recording bodyweight, BCS (including different scales) and recording weight-related terms. Further, weigh scales were not standardised and varied between veterinarians, within and between clinics. Finally, there were many different reasons for cats being seen at non-routine consultations, and these were not subdivided, meaning that differences in bodyweight and BCS recording for different diseases were not individually assessed. Arguably, this would require further studies examining cats diagnosed with specific disease conditions.

Conclusions

In the current study of EHRs UK veterinary practices from the UK, cats are frequently weighed and this was positively associated with using an overweight term or a weight loss term, but negatively associated with being either an out-of-hours or a non-routine consultation. Body condition score was less commonly recorded and was positively associated with age, using a weight loss term and

using an overweight term, but negatively associated with being a non-routine consultation. Although the fact that most cats are weighed during every consultation is encouraging, recording BCS is less common. In the authors' opinion, both bodyweight and BCS should be recorded at every consultation since this would increase available clinical information thereby aiding-making.

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Authors' note

The results of this study were presented, in part, as an abstract presentation at the 2022 ISFM World Feline Congress.

Conflicts of interest

AJG is an employee of the University of Liverpool, but his post is financially supported by Royal Canin. AJG has also received financial remuneration for providing educational material, speaking at conferences, and consultancy work from this company; all such remuneration has been for projects unrelated to the work reported in this manuscript. ST is an employee of CVS PLC. All other authors declare no conflict of interest with respect to this research, authorship or publication of this article.

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Ethical approval

This work did not involve the use of animals and, therefore, ethical approval was not specifically required for publication in JFMS. However, ethical approval was provided by CVS Ethical Review Committee (CVS-2021-007) and the Central University Research Ethics Committees, University of Liverpool (Ref 10074).

Informed consent

This work did not involve the use of animals (including cadavers) and therefore informed consent was not required. No animals or people are identifiable within this publication, and, therefore, additional informed consent for publication was not required.

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Tables and figures

Table 1. Terminology assessed in the free-text of electronic health records.

Category	Sub-category	Terms identified in electronic patient records
Overweight terms	Overweight	Poverweight, ovcerweight, overcondition, overconditioned, overconditionned, overeight, overweigh, overewight, oberweight, oervweight, oerweight, ofweight, ofwt, onweight, opverweight, opverwt, ov2erweight, ovberweight, overfeeds, overgiwght, overiweght, overiwehgt, overiweight, overiwght, overiwgth, overiwight, overniweght, overqeight, overw0eght, overweeight, overweght, overwegiht, overwegith, overweight, overweigth, overweigh, overweigt, overweihgt, overwght, overweiht, overweighrt, overweighted, overwehgt, overweieght, overweifght, overweifht, overweighr, overweightbut, overweightedness, overweightm, overweightmoderate, overweightr, overweioght, overweith, overwenight, overweright, overweught, overwgt, ovwerwheight, overwheihght, overwight, overwieght, overwiehgt, overwiegth, overwieight, overwierhgt, overwighted, overwigiht, overwirght, overwoight, overwt, overwweight, overwwight, oveweight, oveweigh, overwreight, ovewt, ovreweight, ovrweight, ovverweight, ovwerweight, ovwerweighted, ovweweight, oweight, owerweight, owverweight, owverweigth
	Obese or obesity	Obease, obeese, obeisity, obeisty, obeity, obes, obese, obesed, obeses, obestiy, obesety, obesitiy, obesity, obesoty, obesse, obesti, obestity, obestiy, obses, obsese, obesty
	Other	Chonk, chonkie, chub, chubbier, chubby, chubclub, chuncky, chunkier, chunky, fatter, heaviest, podgey, podgy, porky, portly, rotund, gained weight, needs to lose weight, put on weight, weight gain, wt gain, weighgain, weightup
Weight loss terms	---	Weight loss, wt loss, weighyloss, wightloss, wloss, weightoss, weightlosss, weightlos, weightloss, loosing weight, lost weight, losing weight, lost some weight, lose weight, lost a little weight, lost lot of weight, lost 200g, lost weight, lost a bit of weight, muscle wastage

Table 2. Summary data for cats included in the study

Variable		Complete dataset	Statistical dataset
Visits		240,115	129,076
Centres		486	361
Cats		136,052	129,076
Visits per centre		397 (IQR 189-735)	276 (IQR 193-420)
Cats per centre		231 (IQR 111-386)	276 (IQR 193-420)
Visits per cat		1 (range 1-16)	---
Year			
	2019	118,318 (49.3%)	80,997 (62.8%)
	2020	121,796 (50.7%)	48,079 (37.2%)
	Not recorded[1]	1	0
Day type			
	Weekday	218,722 (91.1%)	116,651 (90.4%)
	Weekend	21,392 (8.9%)	12,425 (9.6%)
	Not recorded[1]	1	0
Consultation type			
	Routine	138,081 (58.5%)	71,862 (56.9%)
	Non-routine	97,944 (41.5%)	54,489 (43.1%)
	Not recorded[1]	4098	2,725
Time period			
	Morning	101,803 (42.4%)	53,662 (41.6%)
	Afternoon	42,560 (17.7%)	23,112 (17.9%)
	Evening	94,334 (39.3%)	51,795 (40.1%)
	Out-of-hours	1,417 (0.6%)	507 (0.4%)
	Not recorded[1]	0	0

[1]Number with missing data; note that these data are not used in percentage calculations for categorical data.

Table 3. Summary data for cats included in the study

Variable		Complete dataset	Statistical dataset
Age (years)		7.7 (IQR 3.2-12.5)	7.7 (IQR 3.2-12.5)
	Not recorded[1]	669	493
Sex			
	Male	66,170 (50.7%)	64,653 (50.7%)
	Female	68,179 (49.3%)	62,859 (49.3%
	Not recorded[1]	1,703	1,564
Breed			
	Mixed breed	119,614 (87.9%)	113,526 (88.0%)
	British Shorthair	3,997 (2.9%)	3,824 (3.0%)
	Ragdoll	2,071 (1.5%)	1,973 (1.5%)
	Bengal	1,607 (1.2%)	1,515 (1.2%)
	Maine Coon	1,597 (1.2%)	1,520 2.2%)
	Siamese	1,297 (1.0%)	1,221 (0.9%)
	Persian	1,131 (0.8%)	1,063 (0.8%)
	Burmese	853 (0.6%)	775 (0.6%)
	Birman	505 (0.4%)	472 (0.4%)
	Norwegian Forest	332 (0.2%)	312 (0.2%)
	Russian	303 (0.2%)	281 (0.2%)
	Other GCCF	1,972 (1.4%)	1,809 (1.4%)
	Other unrecognised	817 (0.6%)	785 (0.6%)
	Not recorded	0	0
Weight (kg)		4.16 (IQR 3.30-4.99)	4.16 (IQR 3.30-4.99)
	Not recorded[1]	6,507	5,876

[1]Number with missing data; note that these data are not used in percentage calculations for categorical data. GCCF: Governing Council of Cat Fancy.

Table 4. Summary data for weight and body condition data recorded at visits

Variable		Complete dataset	Statistical dataset
Weight recorded			
	Yes	228,480 (95.2%)	123,220 (95.5%)
	No	11,634 (4.8%)	5,856 (4.5%)
BCS recorded			
	Yes	54,010 (22.5%)	29,638 (23.0%)
	No	186,104 (77.5%)	99,438 (77.0%)
Weight loss term used			
	Yes	24,012 (10.0%)	12,901 (10.0%)
	No	216,103 (90.0%)	116,166 (90.0%)
Overweight term used			
	Yes	17,265 (7.2%)	8,776 (6.8%)
	No	222,850 (92.8%)	120,300 (93.2%)
Overweight BCS recorded			
	Yes	19,318 (8.0%)	10,579 (8.2%)
	No	220,797 (92.0%)	118,497 (91.8%)

BCS: body condition score.

Table 5. Results of initial mixed-effects linear models examining univariable associations between various fixed effects and bodyweight

Variables		Results					
Random effects		Variance [1]		Standard deviation [1]			
Centre		0.024 (0.021-026)		0.154 (0.144-0.155)			
Residual		1.931 (1.769-1.949)		1.390 (1.330-1.396)			
Fixed effects		Estimate	Standard error	t value	LSM (95%-CI)[2]	*P*-value	
						Global	*Post-hoc*
Year		-0.284	0.008	-34.2		<0.001	---
	2019	ref			4.20 (4.18-4.22)	---	---
	2020				3.92 (3.90-3.94)	---	---
Consultation type		-0.097	0.008	-11.8		<0.001	
	Routine	ref			4.17 (4.15-4.19)	---	---
	Non-routine				4.07 (4.05-4.09)	---	---
Day type		0.110	0.014	8.057		<0.001	
	Weekday	ref			4.09 (4.07-4.11)	---	---
	Weekend				4.20 (4.17-4.23)	---	---
Time period						<0.001	
	Afternoon	ref			4.09 (4.06-4.11)	---	ref
	Morning	0.044	0.011	3.865	4.13 (4.11-4.15)	---	<0.001
	Evening	-0.017	0.011	-1.52	4.07 (4.05-4.09)	---	0.428
	Out-of-hours	-0.073	0.073	-0.989	4.01 (3.87-4.16)	---	0.756
Age		0.039	0.001	53.44		<0.001	---
Sex		0.839	0.008	109.9		<0.001	---
	Female	ref			3.68 (3.66-3.69)	---	---
	Male				4.51 (4.49-4.53)	---	---

Breed	-0.037	0.012	-3.041		0.002	---
Mixed				4.10 (4.08-4.12)	---	---
Pedigree				4.06 (4.04-4.09)	---	---
GCCF group					<0.001	
Mixed breed	ref			4.96 (4.91-5.02)	---	ref
British Shorthair	0.015	0.024	0.647	4.97 (4.90-5.04)	---	1.000
Ragdoll	-0.338	0.032	-10.430	4.69 (4.61-4.77)	---	<0.001
Bengal	0.046	0.037	0.126	5.02 (4.94-5.11)	---	0.863
Maine Coon	1.028	0.037	28.105	6.01 (5.92-6.09)	---	<0.001
Siamese	-0.228	0.041	-5.568	4.75 (4.66-4.84)	---	<0.001
Persian	-0.535	0.044	-12.213	4.50 (4.41-4.60)	---	<0.001
Burmese	-0.047	0.051	-0.918	4.85 (4.75-4.96)	---	0.450
Birman	-0.483	0.066	-7.318	4.54 (4.41-4.67)	---	<0.001
Norwegian Forest	0.413	0.082	5.059	5.30 (5.15-5.45)	---	<0.001
Russian	-0.341	0.085	-4.011	4.70 (4.54-4.86)	---	0.300
Other GCCF	-0.177	0.034	-5.19	4.78- (4.70-4.86)	---	<0.001
Other unrecognised	-0.208	0.051	-4.057	4.87 (4.76-4.98)	---	0.712
Weight loss term used	0.232	0.013	17.54		<0.001	
No	ref			4.07 (4.06-4.09)	---	---
Yes				4.31 (4.-4.33)	---	---
Overweight term used	1.173	0.015	75.94		<0.001	
No	ref			4.02 (4.00-4.03)	---	---
Yes				5.19 (5.16-5.22)	---	---
Overweight BCS recorded	1.407	0.014	97.25		<0.001	
No	ref			3.99 (3.97-4.01)	---	---
Yes				5.40 (5.37-5.43)	---	---

The results reported represent separate linear mixed models containing the same random effect (centre) and a single fixed effect tested (as listed in the table). [1] Random effects are reported as the median (range) variance and standard deviation across all models; [2] fixed effects from each model are reported as least squares means (LSMs) and 95% confidence intervals for the different comparisons. BCS: body condition score; GCCF: Governing Council of Cat Fancy.

Table 6. Results of the final multivariable mixed-effects linear model examining association between various fixed effects and bodyweight

Variables		Results					
Random effects		Variance [1]	Standard deviation [1]				
Centre		0.018	0.135				
Residual		1.479	1.216				
Fixed effects		*Estimate*	*Standard error*	*t value*	*LSM (95%-CI)* [2]	*P-value*	
						Global	*Post-hoc*
Year		-0.093	0.011	-8.201		<0.001	---
	2019	ref			5.10 (5.06-5.15)	---	---
	2020				4.91 (4.86-4.96)	---	---
Consultation type		0.045	0.009	4.846		<0.001	
	Routine	ref			4.92 (4.87-4.97)	---	---
	Non-routine				5.10 (5.05-5.14)	---	---
Year (2020) * Consultation type (routine)		-0.257	0.015	-16.871			
Day type		0.043	0.012	3.483		<0.001	
	Weekday	ref			4.99 (4.94-5.03)	---	---
	Weekend				5.03 (4.98-5.08)	---	---
Time period						<0.001	
	Afternoon	ref			5.04 (4.97-5.05)	---	
	Morning	0.022	0.010	2.180	5.06 (5.02-5.10)	---	0.135
	Evening	-0.027	0.010	-2.600	5.01 (4.97-5.05)	---	0.046
	Out-of-hours	-0.104	0.066	-1.584	4.93 (4.80-5.06)	---	0.376

Age	0.013	0.001	12.410		<0.001	---
Consultation type (routine) * Age	0.035	0.001	25.808		<0.001	
Sex	0.832	0.007	117.049		<0.001	---
Female	ref			4.59 (4.54-4.64)	---	---
Male				5.42 (5.38-5.47)	---	---
GCCF group					<0.001	
Mixed breed	ref			5.03 (4.99-5.07)	---	ref
British Shorthair	0.007	0.021	0.347	5.04 (4.98-5.03)	---	1.000
Ragdoll	-0.270	0.029	-9.267	4.76 (4.69-4.83)	---	<0.001
Bengal	0.056	0.033	1.702	5.08 (5.01-5.16)	---	0.863
Birman	-0.418	0.059	-7.105	4.61 (4.49-4.74)	---	<0.001
Burmese	-0.101	0.046	-2.219	4.93 (4.83-5.03)	---	0.450
Maine Coon	1.069	0.033	32.659	6.10 (6.02-6.18)	---	<0.001
Norwegian Forest	0.582	0.076	7.693	5.61 (5.46-5.77)	---	<0.001
Persian	-0.457	0.039	-11.703	4.57 (4.49-4.66)	---	<0.001
Russian	-0.259	0.076	-3.418	4.70 (4.54-4.86)	---	0.030
Siamese	-0.217	0.037	-5.907	4.81 (4.73-4.90)	---	<0.001
Other GCCF	-0.180	0.030	-5.901	4.85 (4.78-4.92)	---	<0.001
Other unrecognised	-0.078	0.046	-1.692	4.95 (4.85-5.05)	---	0.712
Weight loss term used	-0.039	0.013	-2.925		0.003	
No	ref			4.90 (4.85-4.95)	---	---
Yes				5.12 (5.06-5.18)	---	---
Overweight term used	0.945	0.020	47.938		<0.001	
No	ref			4.58 (4.53-4.63)	---	---
Yes				5.44 (5.38-5.50)	---	---
Overweight BCS recorded	1.165	0.019	61.385		<0.001	

	No	ref			4.47 (4.42-4.51)	---	---
	Yes				5.55 (5.50-5.61)	---	---
Year (2020)		0.124	0.030	4.108		<0.001	
* Overweight term used [3]							
Year (2020)		0.279	0.028	9.879		<0.001	
* Overweight BCS recorded [3]							
Overweight term used		-0.554	0.034	-16.062		<0.001	
* Overweight BCS recorded [3]							
Overweight term used		0.305	0.040	7.605		<0.001	
* weight loss term used [3]							
Overweight BCS recorded		0.221	0.035	6.376		<0.001	
* weight loss term used [3]							

The results reported represent the final best-fit multivariable linear mixed model containing the random effect (centre) and a combination different of all fixed effects (as listed in the table). [1] Random effects are reported as the variance and standard deviation of the final model; [2] fixed effects from each model are reported as least squares means (LSMs) and 95% confidence intervals for the different comparisons. [3] Interaction terms included in the final model. BCS: body condition score; GCCF: Governing Council of Cat Fancy.

Table 7. Results of the initial univariable mixed-effects logistic regression models examining association between various fixed effects and veterinary professionals recording bodyweight

Variables		Results		
Random effects		*Variance* [1]	*Standard deviation* [1]	
Centre		1.113 (1.005-1.166)	1.055 (1.003-1.080)	
Fixed Effects		*Odds ratio*	*95% confidence interval*	*P-value*
Year				
	2019	ref	---	---
	2020	1.027	0.968 to 1.090	0.370
Consultation type				
	Routine	ref	---	---
	Non-routine	0.871	0.822 to 0.924	<0.001
Day type				
	Weekday	ref	---	---
	Weekend	1.043	0.949 to 1.146	0.384
Time period				
	Afternoon	ref	---	---
	Morning	1.099	1.013 to 1.193	0.023
	Evening	0.971	0.896 to 1.053	0.482
	Out-of-hours	0.279	0.214 to 0.363	<0.001
Age (years)		0.998	0.992 to 1.003	0.349
Sex				
	Female	ref	---	---
	Male	1.056	0.998 to 1.112	0.061
Breed				
	Mixed	ref	---	---
	Pedigree	0.957	0.879 to 1.041	0.306
GCCF group				
	Mixed breed	ref	---	---
	British shorthair	1.003	0.851 to 1.182	0.972
	Ragdoll	0.881	0.709 to 1.094	0.252
	Bengal	0.956	0.742 to 1.231	0.725
	Maine Coon	1.364	1.015 to 1.835	0.040
	Siamese	1.052	0.782 to 1.416	0.737
	Persian	1.027	0.747 to 1.410	0.871
	Burmese	1.037	0.719 to 1.496	0.845
	Birman	0.880	0.572 to 1.353	0.561
	Norwegian Forest	0.898	0.543 to 1.483	0.674

Russian	1.314	0.692 to 2.496	0.404
Other GCCF	0.730	0.589 to 0.904	0.004
Other unrecognised	0.756	0.547 to 1.046	0.091
Body condition score recorded	0.217	0.203 to 0.231	<0.001
Weight loss term used	1.319	1.189 to 1.462	<0.001
Overweight term used	1.241	1.097 to 1.405	<0.001
Overweight BCS recorded	0.535	0.492 to 0.581	<0.001

The results reported represent separate mixed effects logistic regression models containing the same random effect (centre) and a single fixed effect tested (as listed in the table). [1] Random effects are reported as the median (range) variance and standard deviation across all models fixed effects from each model are reported as odds ratios (OR), 95% confidence intervals and the respective *P* value. BCS: body condition score; GCCF: Governing Council of Cat Fancy.

Table 8. Results of final multivariable mixed-effects logistic regression model examining association between various fixed effects and veterinary professionals recording bodyweight.

Variables	Results		
Random effects	*Variance* [1]	*Standard deviation* [1]	
Centre	1.044	1.022	
Fixed effects	*Odds ratio*	*95% confidence interval*	*P-value*
Consultation type			
Routine	ref	---	---
Non-routine	0.698	0.655 to 0.743	<0.001
Time period			
Afternoon	ref	---	---
Morning	1.088	0.998 to 1.186	0.054
Evening	0.959	0.880 to 1.045	0.338
Out-of-hours	0.225	0.171 to 0.295	<0.001
Body condition score recorded	0.183	0.171 to 0.196	<0.001
Weight loss term used	1.769	1.588 to 1.972	<0.001
Overweight term used	1.468	1.291 to 1.670	<0.001

The results reported represent the final best-fit multivariable mixed-effects logistic regression model containing the random effect (centre) and a combination different of all fixed effects (as listed in the table). [1] Random effects are reported as the variance and standard deviation of the final model; [2] fixed effects from each model are reported as odds ratios (OR), 95% confidence intervals and the respective *P* value. BCS: body condition score; GCCF: Governing Council of Cat Fancy.

Table 9. Results of the initial univariable mixed-effects logistic regression models examining association between various fixed effects and veterinary professionals recording body condition score.

Variables		Results		
Random effects		*Variance* [1]	*Standard deviation* [1]	
Centre		1.527 (1.526-1.545)	1.236 (1.235-1.243)	
Fixed effects		*Odds ratio*	*95% confidence interval*	*P-value*
Year				
	2019	ref	---	
	2020	1.003	0.974 to 1.034	0.822
Consultation type				
	Routine	ref	---	
	Non-routine	0.511	0.495 to 0.526	<0.001
Day type				
	Weekday	ref	---	
	Weekend	0.970	0.925 to 1.018	0.215
Time period				
	Afternoon	ref		
	Morning	1.070	1.027 to 1.114	0.001
	Evening	0.970	0.931 to 1.011	0.149
	Out-of-hours	0.627	0.481 to 0.816	<0.001
Age (years)		1.009	1.007 to 1.012	<0.001
Sex				
	Female	ref		
	Male	0.951	0.925 to 0.979	<0.001
Breed				
	Mixed	ref	---	
	Pedigree	0.935	0.895 to 0.977	0.003
GCCF group				
	Mixed breed	ref		
	British Shorthair	1.041	0.959 to 1.130	0.336
	Ragdoll	0.9213	0.818 to 1.038	0.178
	Bengal	0.990	0.870 to 1.127	0.880
	Maine Coon	0.905	0.793 to 1.033	0.140
	Siamese	0.823	0.707 to 0.959	0.012
	Persian	0.829	0.706 to 0.972	0.021
	Burmese	0.938	0.783 to 1.124	0.488
	Birman	0.872	0.692 to 1.099	0.245

Norwegian Forest	1.013	0.760 to 1.352	0.928
Russian	0.893	0.658 to 1.211	0.465
Other GCCF	0.862	0.762 to 0.976	0.019
Other unrecognised	0.938	0.780 to 1.128	0.498
Weight recorded	0.217	0.204 to 0.232	<0.001
Weight loss term used	2.234	2.141 to 2.332	<0.001
Overweight term used	2.098	1.993 to 2.209	<0.001

The results reported represent separate mixed effects logistic regression models containing the same random effect (centre) and a single fixed effect tested (as listed in the table). [1] Random effects are reported as the median (range) variance and standard deviation across all models fixed effects from each model are reported as odds ratios (OR), 95% confidence intervals and the respective *P* value. BCS: body condition score; GCCF: Governing Council of Cat Fancy.

Table 10. Results of final multivariable mixed-effects logistic regression model examining association between various fixed effects and veterinary professionals recording body condition score.

Variables		Results		
Random effects		*Variance* [1]	*Standard deviation* [1]	
Centre		1.572	1.254	
Fixed effects		*Odds ratio*	*95% confidence interval*	*P-value*
Year				
	2019	ref	---	
	2020	1.304	1.240 to 1.372	<0.001
Consultation type				
	Routine	ref	---	
	Non-routine	0.409	0.393 to 0.426	<0.001
Year (2020) * consultation type (routine) [3]		0.737	0.691 to 0.787	<0.001
Age (years)		1.010	1.007 to 1.013	<0.001
Sex				
	Female	ref	---	
	Male	0.981	0.952 to 1.011	0.214
Weight recorded				
	No	ref	---	
	Yes	0.186	0.173 to 0.199	<0.001
Weight loss term used				
	No	ref	---	
	Yes	2.488	2.378 to 2.603	<0.001
Overweight term used				
	No	ref	---	
	Yes	1.906	1.806 to 2.011	<0.001

The results reported represent the final best-fit multivariable mixed-effects logistic regression model containing the random effect (centre) and a combination different of all fixed effects (as listed in the table). [1] Random effects are reported as the variance and standard deviation of the final model; [2] fixed effects from each model are reported as odds ratios (OR), 95% confidence intervals and the respective *P* value. [3] Interaction term included in the final model. BCS: body condition score; GCCF: Governing Council of Cat Fancy.