The Relationship Between Body Weight, Body Condition, and Survival in Cats with Heart Failure

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Background: Obese people with heart failure have improved survival compared with their normal or underweight counterparts. The purpose of this study was to determine if there is a relationship between body weight or body condition and survival in cats with heart failure.

Hypothsis: Body weight and body condition score (BCS) are predictors of survival in cats with heart failure.

Animals: One-hundred and one cats with heart failure (International Small Animal Cardiac Health Council Classes II, IIIa, or IIIb) evaluated between March 2007 and June 2009.

Methods: Data regarding initial body weight and BCS, subsequent changes in body weight, and treatment were collected from records and compared with survival times.

Results: Median initial body weight was 5.1 kg (range, 2.2–9.5 kg). Median BCS was 5 (range, 3–9). Of the 68 cats that were discharged from the hospital, median body weight change was 0.0 kg (range, –2.6 to +2.3 kg). Survival time for all 101 cats was 93 days (0–811 days). Survival could be predicted using a model combining initial body weight (P = .02), body weight squared (P = .02), and survival to discharge (P < .001) with a resulting global P value for this model of P < .0001.

Conclusions and Clinical Importance: Cats with the lowest and highest body weights had reduced survival times compared with those with body weights in the intermediate ranges, suggesting a U-shaped relationship between body weight and survival. Additional research into the effects of body composition could help to determine optimal management of cats with heart failure.

Key words: Cachexia; Feline; Heart disease; Nutrition; Obesity.

Hypertrophic cardiomyopathy (HCM) and other forms of cardiomyopathy are common diseases in cats. Medical treatment, including nutrition, has improved the care of cats with cardiac disease. Nutrition can play an important role in the optimal treatment for heart failure in cats. Preventing dietary excesses (eg, sodium, potassium) and preventing nutrient deficiencies (eg, taurine, B vitamins) are critical to the optimal management of cats with cardiac disease. Supplementation of certain nutrients above and beyond their nutritional requirements, such as omega-3 fatty acids or antioxidants, may have additional benefits in dogs with cardiac disease. However, one of the most important aspects of optimal care for animals with heart failure is maintaining optimal weight and body condition. As in dogs and people, cats can lose body weight and lean body mass (ie, cardiac cachexia) which may negatively affect immune function, strength, and mortality. Cardiac cachexia is a multifactorial problem that results from decreased food intake, increased energy requirements, and an increased production of inflammatory cytokines.

Although muscle loss and total weight loss can occur in cats with heart failure, some cats with cardiac disease also commonly are overweight (over ideal body weight) or obese (>20% over ideal body weight). Publications since 2000 have documented a prevalence of overweight and obesity in the general feline population between 25 and 52%, although some studies have reported even higher rates.

The documented deleterious effects of weight loss in heart failure and the role of obesity as a risk factor for cardiac disease in people makes it logical to strive for an ideal body weight in heart failure patients. However, in both people and dogs with heart failure, weight gain and obesity have been shown to be associated with longer survival. The direct relationship between weight or body mass index (BMI) and survival time has been called the “obesity paradox.” In people with heart failure, higher BMI is independently associated with lower risk of all cause mortality and death because of worsening heart failure, although there has been some variation in results depending upon the disease studied and other methodological differences. Most of these studies have evaluated chronic heart failure, but higher BMI also was associated with lower in-hospital mortality in people presented with acute decompensated heart failure. A recent meta-analysis of over 28,000 patients with heart failure concluded that obesity and overweight were associated with lower all-cause and cardiovascular mortality and that underweight patients had a higher risk of death.

Currently, the mechanism of protection associated with obesity in heart failure is not known. Possible

Abbreviations:

ARVC arrhythmogenic right ventricular cardiomyopathy
BCS body condition score
DCM dilated cardiomyopathy
HCM hypertrophic cardiomyopathy
ISACHC International Small Animal Cardiac Health Council
RCM restrictive cardiomyopathy
UCM unclassified cardiomyopathy
mechanisms include protective neuroendocrine factors produced by adipose tissue, presentation earlier in the course of disease caused by an increased impact of heart failure symptoms because of obesity, and potentially protective effects of medications used to treat concurrent diseases (eg, hypertension, diabetes). However, the benefit of obesity in heart failure is likely due more to a lack of cachexia, rather than to the obesity per se, given the adverse effects associated with cachexia. When people (or cats) gain weight, they not only gain adipose tissue but also gain lean body mass (the weight gained is comprised of approximately 75% adipose and 25% lean tissue). Therefore, obese people not only have more adipose tissue compared with lean people but they also have more lean body mass, and this extra lean body mass may provide a greater reserve during the catabolic state of congestive heart failure (CHF).35, 40

Dogs with heart failure were shown to have a similar association between body weight and survival.36 Dogs that gained weight during the course of their disease had a longer survival time than those that lost or maintained weight.36 There was also a trend for a positive association between higher body condition score (BCS) and survival time. Information on the association between body weight and body condition in cats has not been published. Such information would be useful both for establishing treatment goals and to enhance client communications. Therefore, the purpose of this study was to evaluate the relationship between body weight and body condition in cats with heart failure. We hypothesized that body weight and body condition are associated with survival time in cats with heart failure and that overweight or obese cats would have longer survival times than normal or underweight cats.

Materials and Methods

Case Selection

Eligible cases were identified from a computer database search of cats with cardiomyopathy and heart failure evaluated by the Cardiology Service at the Foster Hospital for Small Animals at Tufts Cummings School of Veterinary Medicine (TCSVM) between March 2007 and June 2009. Cats that had a first-time diagnosis of CHF (International Small Animal Cardiac Health Council [ISACHC] class II, IIIa, or IIIb) at the TCSVM during this time period were eligible. ISACHC class was assigned at the time of initial evaluation by the attending cardiologist or for 6 cats that did not have an echocardiogram performed by a cardiologist at the time of the initial diagnosis, ISACHC class was assigned retrospectively after review of the medical record. Each of these 6 cats was assigned to the ISACHC class IIIb. Cats that were diagnosed with CHF at <1.0 year of age were excluded, because growth would interfere with the evaluation of body weight. Hyperthyroid cats and cats with congenital or valvular causes of CHF were excluded. Cats whose medical records lacked either a body weight or BCS during the initial visit also were excluded.

Study Design

The medical record for the initial presentation of each eligible cat was reviewed, and the following information was gathered for the cat’s initial visit by a standardized data collection form: signalment, BCS (on a 1–9 scale where 1 = emaciated, 5 = ideal, and 9 = obese),41 body weight, underlying disease (ie, HCM, dilated cardiomyopathy [DCM], restrictive cardiomyopathy [RCM], unclassified cardiomyopathy [UCM], or arrhythmogenic right ventricular cardiomyopathy [ARVC]), laboratory results, ISACHC class, and echocardiographic measurements. Presenting clinical signs as well as any fluid accumulation (identified by radiography or ultrasonography) were noted. If ascites or pleural effusion was noted at the time of a body weight measurement, that body weight was not used and the next body weight measurement after abdominocentesis or thoracentesis, respectively, was performed (from the same visit) was used or, if the volume of fluid removed by centesis was noted, it was subtracted from the precentesis weight. If none of this information was available for these cases, that body weight was not included. Medications, dietary supplements, and diet used during the course of the disease also were recorded. Information also was collected from the medical record regarding change in body weight over time (from the time of initial diagnosis of CHF until the last available body weight), survival time, and cause of death or euthanasia. If the date of death was not available from the medical record, referring veterinarians or owners were contacted for this information.

Data Analysis

Data were examined graphically. Data that were normally distributed are presented as mean ± SD, whereas skewed data are presented as median and range. Data that were not normally distributed were logarithmically transformed before analysis. Categorical variables were compared among groups by the χ2-test (or Fisher’s exact test, where appropriate). Continuous variables were compared between 2 groups by independent t-tests and among 3 groups by ANOVA. Kaplan-Meier curves and log-rank tests were used to compare survival time among cats with baseline BCS categories, as well as with body weight categories. Body condition categories were defined as underweight (BCS = 1–4), normal weight (BCS = 5), or overweight (BCS = 6–9), based on initial BCS. Weight changes were categorized as weight loss (loss of >0.05 kg; to account for scale variation), weight gain (gain of >0.05 kg), or no change (weight within 0.05 kg of initial weight). Survival times were calculated for all cats and for those that were discharged from the hospital. Cats that were still alive at the time of data analysis and cats lost to follow-up were censored for the purposes of survival analysis, with the last known date alive used for cats lost to follow-up. The association between survival and weight or BCS also was analyzed using Cox proportional hazards models. Statistical analysis was performed by 2 commercial statistical software packages.42, 43 P values <.05 were considered statistically significant.

Results

One hundred and one cats with heart failure attributable to cardiomyopathy were diagnosed with an initial episode of ISACHC class II, IIIa, or IIIb heart failure between March 2007 and June 2009. Cats were classified in ISACHC class II (n = 31), class IIIa (n = 12), and class IIIb (n = 58) at the time of their initial visit for heart failure at TCSVM. The median age of the cats was 10.0 years (range, 2.0–18.7 years). Seventy male cats (all cases treated) and 31 female cats (29 spayed) were included in the study. Most cats (n = 84) were domestic short- or long-haired cats but several purebred cats also were included: Siamese (n = 7), Maine Coon (n = 4), Persian (n = 4), Himalayan (n = 1), and Oicat (n = 1). HCM was the most common underlying cardiac disease (n = 74) but other diseases included UCM (n = 14), RCM (n = 7), DCM (n = 5), and ARVC (n = 1). At the
time of initial diagnosis of heart failure, the primary location of fluid accumulation was assessed to be pleural effusion (n = 61), pulmonary edema (n = 37), and pericardial effusion (n = 2). The medical records of 2 cats with pleural effusion also indicated the presence of ascites. At the time of initial diagnosis of heart failure, median weight was 5.1 kg (range, 2.2–9.5 kg). An initial BCS was available for 92 of 101 cats (91%). Median BCS was 5 (range, 3–9), with 32 cats in the predefined underweight category (BCS = 1–4), 26 cats in the normal weight category (BCS = 5), and 34 cats in the overweight category (BCS = 6–9). Forty-five cats (45%) were noted to have anorexia at the time of the initial visit. Body weight (P = .44) and BCS (0.33) were not different among cats in different ISACHC classes but anorexia was more likely in cats with class IIb compared with II or IIIa (P = .02).

Thirty-three cats died (n = 2) or were euthanized (n = 31) in the hospital at the time of the initial visit. Medications administered over the course of the cats’ disease were variable. For cats discharged after their initial diagnosis of heart failure (n = 68), medications included (all were provided orally except low molecular weight heparin, which was administered subcutaneously): furosemide (n = 65; median dose, 1.4 mg/kg/day; range, 0.4–6.9 mg/kg/day), angiotensin converting enzyme inhibitors (n = 50), clopidogrel (n = 34), pimobendan (n = 13), low molecular weight heparin (n = 14), β-blocker (n = 6), aspirin (n = 6), amiodipine (n = 2), diltiazem (n = 1), and spironolactone/hydrochlorothiazide (n = 1). Most cats were receiving more than 1 medication. Five cats received dietary supplements: Omega-3 fatty acids (n = 4) and taurine (n = 1). Six cats were consuming diets designed for feline cardiac disease. Fifty-seven cats (56%) had concurrent diseases with chronic kidney disease (n = 10), neoplasia (n = 6), diabetes mellitus (n = 6), and feline lower urinary tract disease (n = 4) being most frequent.

Of the 68 cats that were discharged from the hospital after their initial visit, a 2nd body weight was available for 64 cats (94%). Median body weight change was 0.0 kg (range, −2.6 kg to +2.3 kg). Body weight change was not different among cats with different initial ISACHC classes (P = .12) or cats with HCM versus other forms of cardiomyopathy (P = .55). Twenty-two cats lost weight over the course of their disease (range, −0.2 to −3.2 kg), whereas 22 cats gained weight (range, 0.1 to 2.3 kg) and 20 cats had a change in body weight of <0.05 kg. All 22 cats that lost weight lost ≥5% of their initial body weight, 1 of the criteria for cardiac cachexia from a recently developed definition for people.16

The duration of time between the 1st and 2nd weight measurements ranged from 3 to 763 days (median, 91 days). Thirty-four percent of cats that were discharged from the hospital had weight loss >5% of their initial body weight.

Thirty-two cats were still alive at the time of analysis and 7 cats were lost to follow up. For cats with follow-up information that did not survive (including both those that died or were euthanized at the time of the initial visit and those that died or were euthanized at a later date), 12 died and 50 were euthanized. The most common causes of death were worsening heart failure (n = 33), arterial thromboembolism (n = 11), noncardiac causes (n = 9), and sudden death (n = 6). The cause of death could not be determined for 3 cats. Survival time for all 101 cats was 93 days (0–811 days) and for cats that were discharged from the hospital and lived longer than 24 h, median survival was 201 days (range, 13–811 days). Initial examination of the data showed an effect of discharge (Table 1) and a nonlinear relationship between survival and body weight (based on Martingale residual plots).42 Consequently, a quadratic term of body weight along with survival to discharge was added and significantly improved the model fit (χ2 = 4.6, df = 1, P-value = .032; likelihood ratio test). In this group of 101 cats, survival could be predicted using a Cox proportional hazards model combining initial body weight (P = .03; hazards ratio = 0.36), body weight squared (P = .04; hazards ratio = 1.09), and survival to discharge (P < .0001; hazards ratio = 0.06) with a global P value for this model of P < .0001. The final model included proportional hazards and could be explained with the following: h(t|X) = h(t) exp(X1×(−2.81) + X2×(−1.04) + X2²×0.09) where t is the time, X1 is discharged from the hospital (0 or 1), and X2 is weight. There were no significant associations between survival and initial presenting sign (ie, CHF, arterial thromboembolism [ATE], syncope), ISACHC class, medications, age, sex, serum biochemical variables, BCS, or change in body weight.

Discussion

In this population of cats with heart failure, survival was significantly associated with body weight. In people, there is a positive association between overweight or obesity and survival once heart failure is present.22–35,37,38 Although most studies of human patients have shown a protective effect at all levels of obesity, severe obesity may not have the same benefits. A study of patients who underwent ventricular assist device placement for advanced heart failure had similar findings to other studies in terms of the detrimental effects of being underweight; in this case, an increased risk for 30-day mortality for people who were underweight.43 However, this study also found that people with severe obesity (ie, a BMI > 35 kg/m²) had an odds ratio of 5.8 for 30-day mortality compared with people with a BMI of 25–29 kg/m².43 Another recent study of chronic heart failure also showed a

<table>
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<th>Parameter</th>
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<th>High CI</th>
<th>P Value</th>
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<td>0.82</td>
<td>1.35</td>
<td>.69</td>
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Low CI, 5% lower confidence interval; high CI, 5% upper confidence interval; BCS, body condition score.

Results of the Cox proportional hazards analysis.

Table 1. Effects of variables on survival.
similar relationship between BMI and survival with people having the lowest and highest BMIs having the worst survival. These results suggest a “U-” or “J-shaped” curve defining the relationship between obesity and survival in heart failure in humans that was not shown in previous studies of human patients. The results of the current study are consistent with these 2 recent studies in humans38,43 showing that cats with the lowest and highest body weights had the shortest survival times. This result differs from a study of dogs with heart failure in which a difference was not identified for varying degrees of obesity36 and from some studies of humans that have shown improved survival at all levels of obesity.22-34,37 Additional studies are needed to clarify the role of severe obesity on survival in all species with heart failure.

Although body weight and BCS are highly correlated in cats, the current study was not able to demonstrate a statistically significant association between BCS and survival although the pattern was similar to that for body weight. In addition, the hazards ratios for body weight and BCS were in the same direction (<1 when all cats were analyzed and >1 when only cats that were discharged were analyzed; Table 1). This similar pattern between the 2 measurements but lack of significance for BCS may be a result of the relatively small sample size and using an ordinal variable (ie, BCS which has only 9 possible scores) compared with the continuous variable of body weight. It also may be related to using BCS, which is a subjective measure of obesity that was assessed by multiple clinicians and students in the current study. Although there are guidelines to determine the BCS and these have been validated against quantitative measures of body composition, there is some interobserver variation among individuals assigning the score. Future studies should have a single investigator assigning BCS for all cats in a prospective manner. This approach may help to further elucidate the relationships among these factors.

In the meta-analysis of studies of the obesity paradox in humans, most patients had ischemic heart disease, raising the possibility that the obesity paradox is specific to this form of heart disease. However, the fact that there also is a relationship between body weight and survival in dogs and cats with spontaneous heart failure suggests that this phenomenon is not specific to a certain form of heart disease. Also, a recent study of 1,160 people with heart failure because of various underlying forms of cardiac disease showed that the obesity paradox held, regardless of heart failure etiology.37

In a study of similar design, dogs that gained weight had significantly longer survival times compared with those that lost weight or whose weight did not change.36 The results of the current study differ in that we were not able to demonstrate an association between change in body weight and survival. This outcome may be related to the relatively small sample size or to the fact that there may not have been enough time for cats to demonstrate a change in body weight during the course of their illness (the duration of time between the initial and follow-up weight was 3–763 days [median = 91 days]). This result also may be related to differences between dogs and cats. In the similar study,36 46% of dogs lost weight compared with 34% of cats in the current study. Cachexia and weight loss are anecdotally thought to be bigger problems in dogs than in cats and, although the overall percentage of animals with weight loss was lower in cats compared with dogs, weight loss was a problem in a subpopulation of cats. Of cats that were discharged after their initial visit for heart failure, the median weight change ranged from −2.6 to +2.3 kg or a weight loss of up to 30% of cats’ body weight. This underscores the importance of monitoring body weight and muscle loss in cats with heart failure to detect weight loss early and to intervene accordingly with medication adjustments and dietary modifications.

There are a number of important limitations to the current study. The retrospective design of the study may make it impossible to collect all of the desired information for each cat at the same time point. An attempt was made to use body weights that did not include large volumes of fluid accumulation (eg, ascites). However, it was not always possible to obtain a body weight after removal of smaller volumes of fluid (eg, pulmonary edema, pleural effusion). Therefore, overestimation of body weight could have occurred at both the time of initial diagnosis and subsequent visits. Also, body composition only was assessed by BCS which assesses the degree of adiposity, and lean body mass was not assessed in this study.

Assessment of lean body mass by cachexia or muscle score4 or using more accurate measures of lean body mass (eg, total body potassium) would provide valuable information. It also is not possible to determine if any of the cats lost weight purposely based on instructions of the veterinarian because they were overweight or obese. However, this is unlikely to have contributed to weight loss in the majority of animals exhibiting weight loss in this study, given the difficulty with achieving weight loss in overweight cats and other species. The overall sample size also limits this study. Most studies of the obesity paradox in humans include >300 patients (including a meta-analysis of >28,000). Additional research with a larger group of cats may provide additional information regarding the relationship between body weight or body composition and survival in cats with heart failure. The role of concurrent diseases that also can cause anorexia and weight loss (eg, chronic kidney disease, diabetes mellitus, cancer) also needs to be considered. In the current study, 57 cats had concurrent diseases, although they were determined to be the cause of death in only 9 cats. Nonetheless, the relative roles of these diseases versus heart failure in weight loss and survival is an important one that was not specifically addressed in this study but should be further evaluated. Finally, the option for euthanasia hampers studies of survival time in veterinary medicine. Although most cats in the current study were euthanized for worsening heart failure or arterial thromboembolism, owners may have elected this option at different points in the process. Although factors influencing the euthanasia decision for cat owners have not been specifically studied, various factors, such as the prognosis given by the clinician, quality of life, recurrent clinical signs, and anorexia influence owners’ decisions to euthanize their dogs with heart failure.45 Despite the
limitations of the study, results are consistent with those in people and dogs and support the importance of body composition in heart failure. Additional research into the effects of body composition could help to determine the optimal management of cats with heart failure.

Footnotes

1 Systat 11.0, SPSS, Chicago, IL
2 SAS 9.2, The SAS Institute, Cary, NC

Acknowledgments

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References