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Body Condition of Feral Cats and the Effect of Neutering

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Considerable debate exists regarding the most appropriate methods for controlling feral cat populations, both from humane and logistical points of view. The physical condition of feral cats has not been reported, and it is not known if these cats benefit from neutering. This study investigates the body condition of feral cats by measuring body weight (BW), body condition score (BCS; Burkholder, 2000; Laflamme, Kealy, & Schmidt, 1994), and falciform fat pad. The study includes lateral abdominal radiographs taken at the time of neutering of 105 adult feral cats for measurement of falciform fat pad depth and area. At that time we also assessed BW and BCS. One year later we assessed the effects of neutering on body condition by evaluating a subsample of 14 cats. At the time of surgery, the cats were lean but not emaciated (BW 3.1 ± 0.9 kg; BCS 4 ± 1; based on a 1 to 9 scale ranging from 1 [*emaciated*] to 9 [*grossly obese*]). Falciform fat pad depth and area averaged 7.1 mm and 197.4 mm^2, respectively, indicating a small amount of fat. Fourteen cats, reevaluated 1 year after neutering, increased 260% + 90% in falciform fat pad depth, 420% ± 390% in fat pad area, 40% ± 4% in BW, and 1 level in BCS ranking (1 to 9 scale; all differences $p <$ .001). Similar to confined socialized cats, feral cats gained significant weight and body fat after neutering.

It is well established that cats gain weight after neutering. Many experimental studies have examined this phenomenon (Allen, Pfeiffer, Jones, Esslemont, &

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Wiseman, 2000; Butterwick, Wills, Sloth, & Markwell, 1994; Duch, Chow, Homar, & Lewis, 1978; Robertson, 1999; Root, Johnston, & Olson, 1996; Root-Kustritz, 1999; Russel, Sabin, Holt, Bradley, & Harper, 2000). Stubbs, Bloomberg, Scruggs, Schille, & Lane (1996) compared cats neutered at 7 weeks or 7 months of age with intact cats and found that 1 year later both groups of neutered cats gained more weight than did the intact cats. These researchers found no difference in activity levels between neutered and intact cats. Fettman, Stanton, Banks, & Hamar (1997) observed similar results with male and female cats neutered at 18 to 24 months of age. When these cats were compared with intact controls 3 months after surgery, the neutered cats gained approximately two to three times more weight than did the controls and also had a higher percentage of body fat. Flynn, Hardie, and Armstrong (1996) reported that an increase in food consumption caused the weight gain they observed in neutered female cats. The neutered cats ate everything offered, whereas the intact cats appeared to self-regulate intake, resulting in a significant difference in caloric intake. There was no difference in activity level between neutered cats and intact cats. Nguyen, Duncan, and Martin (1999) compared neutered male and female cats with intact cats and females with tubal ligations. Only the neutered animals gained weight.

There are several methods to quantify body condition in live animals. Body weight is one method, but it does not differentiate between a lean large cat and an obese small one. Body condition scoring (BCS; Burkholder, 2000; Laflamme, Kealy, & Schmidt, 1994) is a method to rank a cat's condition visually. It can be reliable in the hands of an experienced person; being subjective, however, it is difficult to compare rankings made by different people. A few studies have utilized dual energy x-ray absorptiometry (DEXA) to measure fat and lean body mass (Butterwick & Markwell, 1996; Munday, Booles, Anderson, Poore, & Earle, 1994; Munday, Earle, & Anderson, 1994). This can be accurate, but the necessary equipment is not readily available.

Body mass index (BMI) is another way to estimate body condition. It is a calculation based on the weight, length, and height of a standing animal and has been used in combination with visual assessment and body weight (Nelson, Himsel, Feldman, & Bottoms, 1990). One difficulty with this method is maintaining the cat in a consistent standing position during height and length measurements. It cannot be performed on anesthetized animals. Hawthorne and Butterwick (2000) reported that rib cage circumference and length of lower hind limb (patella to calcaneal tuber) together correlate well with DEXA for estimating body fat. This can be performed in conscious cats, although it does require the cat to stand for accurate rib cage circumference measurements.

Lateral abdominal radiographic measurement of the falciform fat pad can be used to estimate body fat (Stubbs et al., 1996). This method, which correlates well with changes in body weight and subjective assessment of body condition, was

used to document increased fat accumulation in cats following neutering. However, measurement of falciform fat pad has not been validated by more objective measures of body composition such as DEXA or calorimetry. This method requires positioning the cat in lateral recumbency using gentle restraint or sedation. As it allows measurement of anesthetized or sedated animals, this method is ideal for feral cats.

Most of the studies reported to date evaluated cats confined to indoor facilities. Some lived in cages and were let out at times during each day for exercise; some lived in communal rooms; all were kept indoors. Scarlett and Donogue (1994) measured body condition of pet cats with some outdoor access and saw no difference in condition when compared with cats without outdoor access. The authors knew of no published reports on the effect of neutering on body condition of free roaming feral cats.

Feral cats are cats who are not owned and are wary of most human contact. They may once have been owned cats or stray (friendly toward humans) cats that have reverted to a more wild state. These cats must be trapped and anesthetized for safe handling. Trap-neuter-return is one method of population control for feral cats (Slater, 2001). It is a procedure in which caretakers trap the cats, bring them to a veterinarian for neutering, and then return the cats back into their environment. Other methods of feral cat control include trapping for euthanasia, trapping for relocation, and numerous methods of ending the lives of cats without trapping them. Trap-neuter-return is one method shown to have the support of many colony caretakers (Centonze & Levy, 2002; Natoli, Ferrari, Bolletti, & Pontier, 1999; Zasloff & Hart, 1998). It is controversial because reports vary as to its effectiveness for controlling cat populations and whether the welfare of feral cats is served by neutering followed by return to the environment instead of euthanasia.

Body condition is one method of judging the overall health and welfare of feral cats. The baseline body condition of unneutered, free roaming, feral cats has not been reported. Nor has the effect of neutering on these cats' body condition been studied. It is not known if they gain weight as do confined cats.

The objectives of this study were (a) to determine the body condition of sexually intact adult feral cats and (b) to evaluate the effect of neutering on feral cats by measuring body weight, BCS, and falciform fat pad.

METHODS

Animals

The study population consisted of adult intact feral cats in Alachua County, Florida, and contiguous counties. Over a 1-year period, 105 male (n = 61) and female (n = 44) feral adult cats were enrolled in this study. The cats had been

brought by their caretakers to a free spay/neuter clinic for feral cats. At this high volume clinic, cats pass from one treatment station to another to be anesthetized, prepared for surgery, sterilized, vaccinated, and recovered. The tip of the left ear is trimmed to identify sterilized cats in the field following release. Cats were selected for participation in the study if they were judged fully mature and were still sufficiently anesthetized for radiography. The cats were judged fully grown by the presence of adult canine teeth and radiographic detection of fusion of the distal femoral ephiphysis, which occurs after 1 year of age. As many cats as possible were radiographed without disrupting the efficiency of the clinic.

Falciform Fat Pad Measurement

Body fat estimates were made as described by Stubbs et al. (1996). Immediately following sterilization surgery, a right lateral radiograph[1] was taken while the cats were still anesthetized. Using computed radiography, the depth (mm) of the falciform fat pad was measured by dropping a perpendicular line at the level from the center of the 12th thoracic vertebra (T12) to the ventral body wall and measuring the distance between the caudoventral angle of the liver and the ventral body wall (see Figure 1). The area (mm^2) of the fat pad was defined as the area outlined by the line used for the depth measurement, the ventral border of the liver, the diaphragm, and the ventral body wall (Figure 1).

Weight and BCS

Cats were weighed to the nearest 0.1 kg and scored for body condition (BCS; 1 to 9 scale; Laflamme et al., 1994) by the same two investigators (coauthors Karen C. Scott and Shawn P. Gorman) throughout the study. The body condition score is divided into 9 levels ranging from 1 (*emaciated*) to 5 (*ideal*) to 9 (*grossly obese*).

Repeat Examination

Approximately 1 year after surgery, the caretakers of the cats were contacted both by letter and telephone requesting that they attempt to retrap the cats to perform follow-up measurements. Depending on the number of cats to be retrapped in each colony, one or more traps were prepared each night for up to a week. If

[1]Radiographic images were made and measured with a Fuji Computed Radiography system (FujiFilm Medical Systems, USA, Inc., Elmsford, NY).

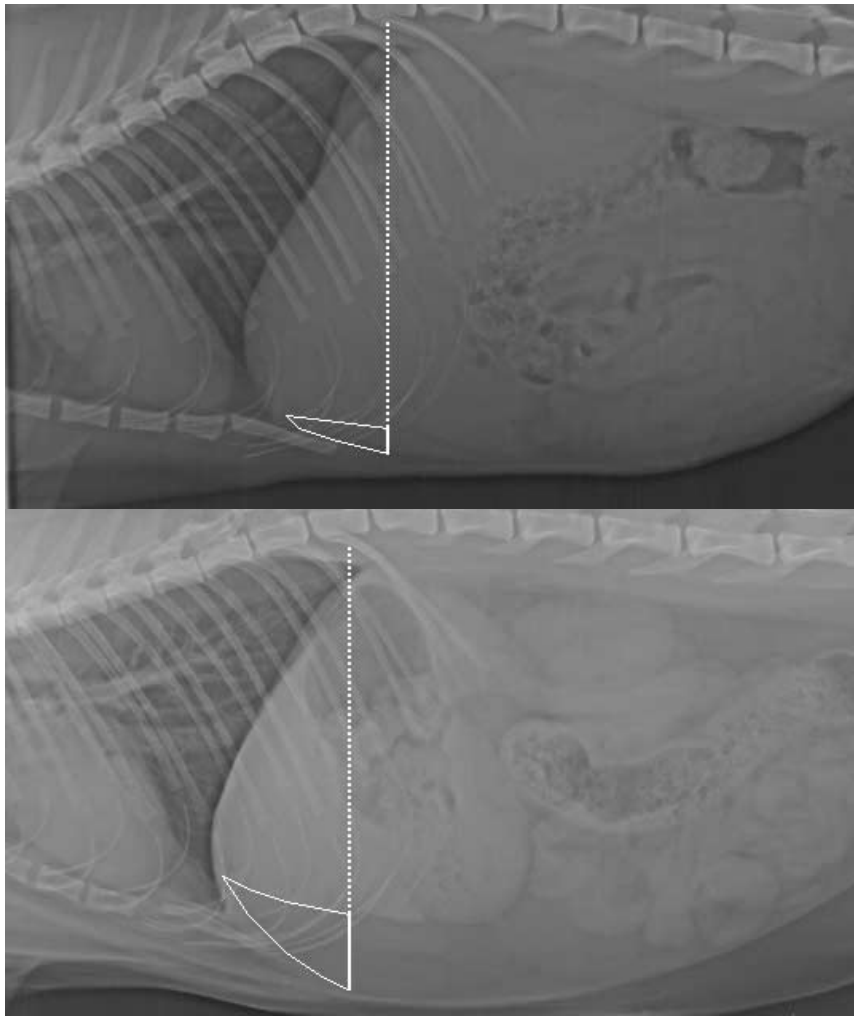

FIGURE 1 Lateral abdominal radiograph of a cat. The solid perpendicular line is a line from the center of T12 to the ventral abdominal wall. The dashed line is the depth of the falciform fat pad; the other solid lines measure the area for the falciform fat pad. Top picture represents a cat at the time of sterilization. Bottom picture represents the same cat 1 year later.

the desired cat could not be trapped in that time frame, no further attempt was made. These caretakers were experienced at trapping cats and had the advice of other experienced trappers.

To avoid possible seasonal influences on body condition, the follow-up examination occurred approximately 1 year (range 11 to 13 months) after neutering. During the follow-up examination, caretakers completed a written questionnaire about each cat's behavior compared with that prior to surgery. Each body condition test was repeated. Some cats would allow a technician wearing lead lined gloves to hold them still enough to obtain radiographs. Most would not and required light sedation.

Statistical Analyses

Falciform fat pad depth and area data were compared using a Mann–Whitney *U* test, as the data were not uniformly distributed. Body weight and BCS were compared using a paired *t* test. Because the data were not normally distributed, nonparametric analysis of variance was used to compare seasonal data. Differences were considered statistically significant when $p < .05$.

RESULTS

A total of 105 cats were enrolled in the study and radiographed at the time of sterilization surgery. Of these, 63 cats also were weighed and scored for body condition. Fifteen were weighed but not scored, and 31 were neither weighed nor scored. The weight and BCS variables were added part way through the study; thus, these data were not collected from the first 31 cats.

Approximately 50% of the caretakers of the original 105 cats agreed to attempt to retrap cats for reevaluation 1 year after neutering for a total of 31 cats. Trapping was successful for 14 of these 31 cats, a 45% capture success rate (13% capture rate of the original 105 cats). Reevaluation could not be completed on the remaining cats for a variety of reasons including relocation of the caretaker (5 cats), adoption (4 cats), disappearance (3 cats), inability to retrap (17 cats), inability to recognize a particular cat in a large colony (4 cats), and caretakers choosing not to participate (58 cats).

The BCS data of the 105 cats at the time of sterilization surgery are summarized in Table 1 and Figure 2. There was a modest but significant seasonal variation in falciform fat pad measurements, body weight, and BCS. The cats had a higher body condition in summer and autumn than in winter and spring. This finding was anticipated; therefore, cats were reevaluated 1 year after surgery to prevent seasonal variation from confounding the measurements for individual cats. Based on

TABLE 1
Body Weight and BCS at the Time of Surgery for Cats Enrolled in the Study, Summarized by Season of Data Collection

	Body Weight			*BCS*		
Season	*Mdn*	*Range*	n^a	*Mdn*	*Range*	n^a
Winter[b]	1.9		1	4		1
Spring[c]	2.7_a	2.2 – 3.6	4	4_a	4 – 5	5
Summer[d]	3.2_a	1.6 – 4.8	15	5_b	5 – 5	3
Autumn[e]	2.8_a	1.25 – 3.2	54	4_a	3 – 7	54

Note. BCS is based on a 9-point scale ranging from 1 (*emaciated*) to 5 (*ideal*) to 9 (*grossly obese*). Values in a column that do not share subscripts are significantly different at $p < .05$. Winter median range of values were not included in analyses due to $n = 1$. BCS = body condition score.

[a]n = number of observations. [b]Winter = December to February. [b]Spring = March to May. [c]Summer = June to August. [d]Autumn = September to November.

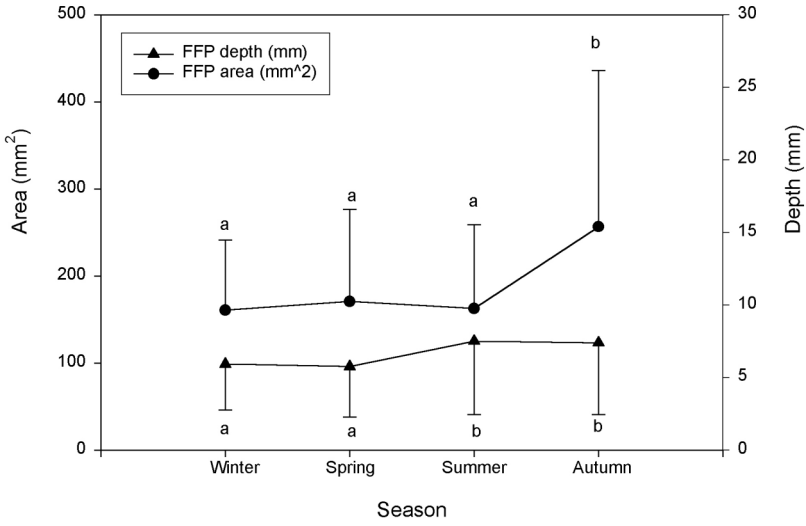

FIGURE 2 Falciform fat pad (FFP) depth (mm) and area (mm^2) in 105 cats at the time of sterilization, averaged by season. Seasons with different letters are significantly ($p < .05$) different.

the BCS, 54% of the cats were less than ideal weight (BCS = 4, $n = 28$; BCS = 3, $n = 5$), whereas 8% were more than ideal condition (BCS = 6, $n = 4$; BCS = 7, $n = 1$) at the time of sterilization.

Cats increased in mean body weight by 40% and scored 1 BCS point higher (see Table 2) 1 year after sterilization. All but one cat with complete data gained weight. At the time of reexamination, 14% of the recaptured cats were under-

TABLE 2
BCS and Body Weight at the Time of Surgery, at Follow-Up, and Percentage Change

Variable	*Mdn*	*Range*
Time of sterilization[a]		
Body weight (kg)	3.1	2.2 to 3.6
BCS	4	4 to 6
1-year follow-up[b]		
Body weight (kg)	3.8	2.7 to 6.6
BCS	6	4 to 7
% change[a]		
Body weight	+40	0 to +90
BCS	+20	0 to +50

Note. BCS is based on a scale ranging from 1 (*emaciated*) to 5 (*ideal*) to 9 (*grossly obese*). BCS = body condition score.
[a]$n = 9$. [b]$n = 14$.

weight (BCS = 4, $n = 2$), and 71% were over ideal weight (BCS = 6, $n = 6$; BCS = 7, $n = 4$; Table 2).

The falciform fat pad depth and area of the recaptured cats increased by 260% and 420%, respectively (Table 3), over the course of the study.

All the caretakers judged their cats friendlier, less aggressive, less inclined to roam, heavier, and experiencing improved health and coat condition compared with before neutering (see Table 4).

DISCUSSION

This is the first time the body condition of feral cats has been reported. Overall, the cats in this study were lean but not emaciated prior to neutering. In the subset of cats reevaluated 1 year after neutering, cats gained weight, had higher body condition scores, and had an increase in falciform fat pad. This particular population of cats was feral—all unowned. All cats lived entirely outdoors and had ample opportunity for exercise.

Alhough the cats in this study lived outdoors and could not be observed at all times, the caretakers reported a decreased tendency to roam following neutering. This may account for some of the increased weight, BCS, and fat pad size observed after surgery. This is in contrast to the observations of Flynn et al. (1996) and Stubbs et al. (1996), who observed no difference in activity level between intact and neutered research cats housed indoors. The original 105 cats represented a variety of ages. The reevaluation data 1 year after neutering showed a significant increase for all the variables measured. In some instances, the cats may have gained weight because of growth and maturation. We attempted to control for this by se-

lecting cats that were judged fully adult at the time of sterilization. Caretakers believed neutering was associated with behavior changes that included increased friendliness and decreased roaming and fighting. However, because the survey was completed only for cats who were retrapped, it is possible they represented a portion of cats that became most sociable and not the overall population. Ideally, a group of intact cats would have been included as controls. There was an ethical dilemma about capturing intact cats without sterilizing them and releasing them to roam and breed for another year. As shown in this study, it is difficult to retrap cats a year later. Thus, a majority of cats in a control group would be expected to avoid retrapping and remain intact and breeding at the end of the study. For this reason, no control group was included in this study.

TABLE 3
Falciform Fat Pad Depth and Area of Cats at the Time of Surgery, at 1-Year Follow-Up, and Percentage Change

Variable	*Mdn*	*Range*
Time of sterilization		
Depth (mm)	7.1	2.1 to 18.1
Area (mm^2)	197.4	53.0 to 619.0
1-year follow-up		
Depth (mm)	16.4	3.1 to 28.7
Area (mm^2)	470.9	105.4 to 916.0
% change		
Depth (mm)	+260	–24 to +573
Area (mm^2)	+420	–32 to +996

Note. $n = 14$.

TABLE 4
Categories Used by Caretakers to Compare Cats at Follow-Up With 1 Year Previous

Category	*Mdn Ranking*
Rank the cat's friendliness to humans	4
Rank cat's friendliness to other cats	4
Rank cat's aggression to other cats	2
Rank incidence of cat fights	2
Rank cat's tendency to roam	2
Rank cat's weight (visual appearance)	4
Rank incidence of spraying	2
Rank cat's coat condition	4
Rank cat's health	4

Note. $N = 14$. All caretakers completed all categories at time of follow-up. Ranking based on a 5-point scale ranging from 1 (*large decrease*), 2 (*small decrease*), 3 (*no change*), 4 (*small increase*), to 5 (*large increase*).

This study illustrates some of the difficulties in conducting longitudinal research on free-roaming animals. A majority of the cats originally radiographed were unavailable for follow-up a year later because of noncooperation by the caretakers, trapping failure, adoption, and disappearance. The retrap rate for those cats for whom trapping was attempted was 45%. Although this is a high rate for recapture success of wild animals, it is possible that the cats retrapped were not representative of the entire population of cats in the study. The results would be skewed only if the friendliest and fattest cats were retrapped.

These results indicate that feral cats, like their tame counterparts, experience enhanced fat accumulation following neutering. Fifty-four percent of the original cats were thin or underweight at the start of the study compared with 14% of the recaptured cats when reevaluated 1 year later. At the initial examination, 8% of the cats were overweight, whereas 71% were over ideal body weight 1 year later. Possible reasons for fat accumulation following neutering include decreased metabolic rate, decreased activity, and increased food intake.

In conclusion, we found that adult feral cats were generally lean but not emaciated at the time of neutering. One year later, cats were significantly fatter than they were at the time of neutering. Thus, in addition to halting reproduction, neutering may have other effects that, combined, improve the welfare of feral and free roaming cats.

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