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Risk of obesity in the neutered cat

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Abstract

Surgical neutering is one of the most common procedures performed on pets in the USA among other countries. There are known effects of neutering on the physiology and behavior of the cat that predispose to obesity, which is the most significant sequela from a nutritional perspective. Increased food intake is the most likely factor influencing weight gain in the neutered cat. Proactively addressing these changes with nutritional management strategies can help prevent weight gain and associated negative consequences.

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Importance of feline obesity and risk of neutering

Epidemiological data have demonstrated that neutering is a risk factor for obesity in cats, especially in males.^{1–4} Obesity is a common and serious problem in domestic cats. Studies have reported that some populations have a prevalence of overweight and obese cats of up to 63%.^{2,4–6} Overweight cats are more likely to suffer from many problems, including diabetes mellitus, constipation, orthopedic disease, altered hemostasis, urinary tract disease, hepatic lipidosis and skin disease.^{5,7,8} As the majority of feline veterinary patients have a known risk factor (neuter status) for a disease that is likely to result in potentially significant morbidity (obesity), strategies aimed at prevention and intervention are indicated.

Impact of neutering on food intake, body weight and energy expenditure

The relationships among food intake, body weight and body condition score (BCS), and energy expenditure after neutering are complex. However, it seems clear that when cats are fed ad libitum after neutering, weight gain is likely to occur,^{9–12} and free availability of food results in greater body weight and body fat percentage after neutering of male,¹³ as well as female cats,¹⁴ compared with restricted access. This effect is even seen in feral cats participating in trap–neuter–return programs.¹⁵ In addition, greater weight gain and body fat accumulation are seen after neutering when energy-dense diets are used.^{16,17} Many studies have investigated whether an increase in food intake, a decrease in energy expenditure, or both, are responsible for the weight gain commonly seen after neutering.

Compared with cats left intact, one study showed that neutered cats gained more body weight (30.2% vs 11.8% for males and 40% vs 16.1% for females) when assessed at 1 and 3 months postsurgery.⁹ When food intake was measured at baseline and at 3 months, the authors reported a significant increase only for neutered and not intact males and females, with neutered males having higher food intakes than neutered females.⁹ They also reported that fasting but not resting metabolic rate, calculated on a metabolic body weight basis (kcal/kg total body weight^{0.75}/day), decreased at 3 months after neutering in females but not males, despite a smaller mean gain in the females at that time point. The study was unable to determine whether energy expenditure on a lean body mass (LBM) basis was altered by neutering or by sex, and whether reduced energy expenditure drove the gain in body mass, or if the increase in body mass was driven by food intake.

Another study investigated energy balance in male cats during the immediate postsurgical period, and found that food intake increased almost immediately for neutered cats compared with intact cats, becoming significantly higher at just 3 days after neutering, while

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body weight increases did not become significantly higher until 7 weeks after neutering (exact values for these time points were not provided).¹¹ The gains in body weight plateaued at approximately 28% and were primarily due to increases in fat mass; however, it is interesting to note that energy expenditure on an LBM basis was not different before and after neutering, and there was also no difference in energy expenditure between neutered and intact cats in that study.¹¹ These findings agreed with a previous study that also reported no change in energy expenditure on an LBM basis due to neutering,¹⁷ and were also confirmed by more recent data demonstrating that postneutering weight gain in adult male cats is the result of increased food intake and not a change in energy expenditure.¹⁸

In contrast, another study showed an increase in heat production in male and female cats neutered at 7 weeks or 7 months compared with those kept intact; however, the calculations used absolute body weight, and body composition, weight and BCS of the cats were not reported.¹⁹ Assuming that the neutered cats were heavier throughout the study, as well as at the endpoint, as reported by this author in lecture proceedings,²⁰ if ideal body mass or LBM had been used to calculate the heat coefficients, the differences between the intact and neutered cats would have been smaller and may not have been significant.

The role of sex, and potential differential effects of neutering on females vs males, may also be significant.^{9,21} One study showed that calorie intake to maintain body weight in neutered females was significantly decreased by 16% from 4 to 16 weeks after surgery, while there was no significant reduction for neutered males up to 16 weeks after surgery.²¹ Sex differences in hormonal responses (leptin, insulin, free thyroxine) to neutering were also noted.²¹ Another study showed that significantly fewer calories were necessary to maintain body weight in ovariohysterectomized vs intact queens (exact values not provided).²² These findings agree with other data which showed that a restriction in food intake of >30% was necessary to maintain body weight in neutered queens; voluntary activity of the cats was also markedly decreased (60% and 33% of baseline measurements for the light and dark periods, respectively).¹⁴ More work is needed to explore these differences and may help explain varied findings in studies of energy expenditure of neutered cats.

It should be noted that most studies vary in when energy expenditure was measured after neutering (from 7 days to almost 2 years), which may bias the findings when significant body weight and fat mass gains have occurred in the interim. In addition, the methodology used to measure energy expenditure is not standardized. Further, some studies rely on estimated energy intake or degree of restriction to maintain body weight as an indirect measure of energy expenditure. When directly measured in the immediate postneutering period, and

normalized for body composition, energy expenditure does not change in adult male cats.^{11,18}

While most evidence supports that energy expenditure (as determined by indirect calorimetry and adjusted for lean mass) does not change as a result of neutering regardless of body weight change, it has been shown that energy restriction per se results in a decrease in lean mass-adjusted energy expenditure.²³ Further, one study showed that neutered female kittens allowed free access to food increased their intake compared with intact littermates by 17% at 10 weeks postsurgery, which then decreased until there were no differences between groups by 18 weeks postneutering.¹² Regardless, the neutered cats continued to accumulate body fat (mean proportion more than doubled from 12.7% before neutering to 30.2% at 1 year of age) and gain body weight; by 1 year of age neutered kittens were 24% heavier compared with intact littermates, with mean BCS increasing from 4.9 before neutering to 6.1 at 1 year of age compared with 5.1 and 5.2, respectively, for the intact group.¹² It has also been demonstrated that body weight gain can be avoided after neutering provided that food intake is actively limited, although it seems clear that some cats need fairly severe restriction of up to 50% to maintain preneutering body weight.^{10,22} Thus, it appears that the initial effect of increased food intake, when allowed, followed by resultant increases in body weight and fat mass, is probably responsible for the obesity seen in neutered cats.¹¹ This underscores the role of food intake and feeding management in pet cats in the weeks following neutering.

Mechanisms for increased food intake

One of the consequences of neutering is a change in the hormonal milieu, including impacts on cholecystokinin response,²⁴ increases in concentrations of prolactin, insulin-like growth factor-1 and leptin,²⁵ and decreases in concentrations of sex hormones such as testosterone and estrogens. Decreases in sex hormones are unsurprising; however, it is noteworthy that significant reductions in estradiol are seen in male cats after neutering, with reduction of plasma concentrations to approximately half the presurgical concentrations.¹³ Previous work has implicated this as a potential major factor influencing the increase in food intake seen with neutering. For example, it has been demonstrated that administration of low-dose estradiol (0.5 µg per cat) to overweight, neutered, male and female cats significantly reduced food intake.²⁶ In addition, low-dose exogenous estrogen can prevent the increase in food intake associated with neutering, as well as reduce the degree of accompanying weight gain and increase in fat mass.²⁷ Further, plasma concentrations of estradiol were not affected by food restriction vs free access, nor with the degree of adiposity, and exogenous injections of estradiol restored

presurgical plasma concentrations and resulted in reduced food intake.¹³ These findings support the role of gonadal estrogens in both sexes. It remains to be seen whether this therapy might be clinically useful for the management of cats after neutering, and whether long-term treatment would be needed. As the general agreement is that food intake is the key factor underlying weight gain after neutering, the current focus remains on feeding management and owner education.

Management of neutered kittens

Cats are commonly neutered at a young age, during the growth period. Kittens require a specific balance of nutrients to support normal development, so it is important to feed a food designed for growth throughout this life stage (typically, adult size is achieved by approximately 10 months of age^{12,28}). Owing to the timing of neutering, this presents a challenge for balancing the nutritional requirements of a growing kitten with the need to control food intake and avoid excessive weight gain. As there does not appear to be a difference in obesity risk dependent on age of neuter,^{19,29} it might be prudent to delay neutering procedures until after the period of the most rapid growth is passed when possible; however, in many circumstances earlier neutering is preferred (or mandated) to address overpopulation issues. In any case, portion-controlled feeding is recommended, and regular monitoring of body weight and BCS is necessary to enable adequate and timely adjustment of the amounts fed. Although BCS systems have not been specifically validated for use with growing animals, tools to estimate body composition such as dual-energy X-ray absorptiometry and the deuterium oxide method are not typically available clinically. As such, most nutritionists recommend and apply BCS values as a tool to estimate ideal condition in kittens.

Although commercially available diets formulated for growth tend to be more energy dense than those formulated for adult maintenance, there is still a wide range of options with varying energy densities in the kitten growth category. An informal and limited survey of over-the-counter products was conducted by the author by collecting values from manufacturer websites and product guides, which revealed a range of energy density values for dry kitten foods of 3288–4420 kcal/kg on an as-fed basis, and for canned kitten foods of 847–1343 kcal/kg on an as-fed basis. If food intake cannot be adequately controlled, and/or if the necessary volume restrictions are too severe, a growth diet with lower energy density should be used. This recommendation assumes that volume intake is consistent; however, the drive for increased food intake that occurs secondarily to neutering may overcome the reduction in energy density. Therefore, in some cases, the increased amount of food eaten may negate the effect of a lower energy density diet. One study showed that dry feline diets with fiber added to lower the

energy density were consumed in increased amounts to achieve static calorie intake, although the increased fiber resulted in decreased energy digestibility.³⁰ Based on data showing that added moisture resulted in reduced food intake and body weight in cats fed over a 3 week period,³¹ using a canned diet may be an effective way to limit food intake due to caloric dilution with moisture, yet still meet the needs of a growing kitten. In addition, a diet with 37% moisture resulted in weight regain of 5.7% over 3 weeks in cats fed ad libitum after a 6 week period of postrestriction, while a diet with 12% moisture resulted in significantly higher weight regain of 6.9%.³² However, another study found no difference in weight gain after neutering in cats fed dry or canned diets.¹⁰ Longer-term and larger studies are needed to confirm the effect of higher moisture intake on prevention of weight gain. Overall, the effects of diet type on risk of obesity are unclear given the variable findings reported to date. Regardless, more active restrictions on food consumption are probably needed in many cases.

Given the marked reduction in voluntary activity in neutered queens,¹⁴ it is possible that actively encouraging increased activity may also help partly offset the effect of neutering such that less severe restrictions of food intake are needed. It has been shown that increased feeding frequency and increased dietary moisture result in increased voluntary activity, so these changes should be considered.^{32,33} The use of food puzzles and similar toys, as well as bowls that slow intake, may have some utility;^{34,35} research is needed to determine the value of such tools. The difficulties in accomplishing weight loss in cats in addition to the risk of the cat regaining the weight help emphasize that any factors that help to prevent obesity are preferable to trying to reverse it.

Energy requirements for growth and maintenance

For adult compared with immature and growing cats undergoing neutering, energy restriction to prevent increased food intake is less complex, although many owners do not already monitor or control their cat's intake, in which case this may require the institution of a new household routine. For some cats, disallowing the voluntary increase in food intake after neutering may be adequate for prevention of inappropriate weight gain, but, for others, reduction in the amount fed is likely necessary. If known, the energy intake should be reduced by at least 11%, and may need to be restricted by over 30%, based on the degree of the increases reported for adult cats in several studies.^{11,13,14,18,22} Although not ideal, owing to the individual variation in energy requirements, if the prior intake cannot be determined, reliance on equations to estimate these needs is necessary.

Many studies of the reported daily energy maintenance requirements of cats have been conducted, with a very wide range of values determined and primarily

given on an absolute body weight basis (31–100 kcal/kg body weight).³⁶ Many factors likely explain the variation; the National Research Council provides different equations for lean vs overweight adult cats which both use metabolic body weight;³⁶ however, there is no differentiation for neuter status:

- Lean cats: $100 \text{ kcal} \times \text{kg body weight}^{0.67}$
- Overweight cats: $130 \text{ kcal} \times \text{kg body weight}^{0.4}$

For kittens after weaning, the equation provided is more complex and requires estimation of predicted adult body weight; this was based on pooled data from many published studies:

- $(100 \text{ kcal} \times \text{kg body weight}^{0.67}) \times 6.7 \times [e^{(-0.189p)} - 0.66]$

Where p = actual body weight/expected mature body weight and e = base of natural log (~2.718)

Many clinical nutritionists use a simplified equation based on a growth factor applied to the resting energy requirement (RER) at the current weight:³⁷

- $2.5 \times \text{RER}$

Where $\text{RER} = 70 \times \text{kg body weight}^{0.75}$

Regardless, any equation used is a starting point, and recommendations for individuals necessitate reassessment and adjustments as needed to maintain an ideal BCS during growth and beyond.

Owner education

Underestimation of the cat's overweight condition or a general unawareness of body condition is common among cat owners and may contribute to the development of obesity;² in fact, one study identified owner underestimation of cat BCS as a main variable influencing obesity in cats.⁶ Pet owners should be counseled on appropriate body condition for their individual pet,³⁸ and encouraged to perform body condition scoring at home on a regular basis (every 2 weeks during the growth period³⁴).

Free feeding is common for cats, and is a convenience factor that owners sometimes attribute to their preference of pet cats over dogs. Free feeding is often practiced regardless of body condition,³⁹ with 80% of pet owners using this method of feeding.⁴⁰ This is not generally recommended; however, studies have not identified a link between feeding practices and the prevalence of obesity.^{6,41,42} It is clear that some cats successfully regulate their food intake to maintain an ideal body weight, while others tend to overeat and become overweight or obese. For many cases, consideration of the amount fed, as well as the energy density of the diet, is important, and an individualized approach to the determination of the necessary degree of restriction for a subset of cats is

warranted. Monitoring of the pet's BCS and body weight, accompanied by any necessary adjustment in the amount and type of food fed, is a critical component in providing recommendations that meet the needs of individual pets. This process starts with a veterinary assessment and is maintained by both the owner and the veterinary team.

Conclusions

Neutering represents a common and routine procedure for pet cats, but it increases the risk of obesity and related diseases. Prevention is preferable to reversal given the challenges of weight loss plans in cats, and the potential benefits of maintenance of a lean body condition throughout the lifespan. Ultimately, evidence supports avoidance of ad libitum feeding, consideration for energy density, provision of a life stage-appropriate diet and regular monitoring of the BCS of neutered cats. Determination of energy needs should be based on prior intake if known; however, the degree of restriction necessary to avoid weight gain is variable and underscores the importance of monitoring and adjustment.

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