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Maintenance energy requirement determination of cats after spaying

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Abstract

Neutering is often associated with obesity in companion animals. However, the maintenance energy requirement (MER) for these animals has not been clearly defined. The present study investigated the MER for spayed cats whose body weights (BW) began to increase shortly after ovariohysterectomy. A total of twenty-two shorthair adult female cats were fed complete and balanced diets in amounts to maintain their BW and body condition score (BCS) before the present study. All cats were spayed and the diet was fed for 11 weeks using the same MER as previously. During these weeks, all cats gained weight. Beginning with week 12, a weight-loss regimen was initiated until each cat achieved a BCS of 5 out of 9. After each cat obtained a BCS of 5, an appropriate amount of diet was fed to maintain its BW for at least 4 weeks to determine a modified MER. Daily food consumption, weekly BW and BCS were monitored. Blood was collected before and after weight loss for plasma biochemistry profiles. BW and BCS increased by 16 % and one point ($P<0.01$), respectively, during the first 11 weeks after surgery, although food consumption was constant both pre- and post-surgery. The mean MER after obtaining a BCS of 5 was 313·6 (SEM 23·6) kJ/BW$^{0.67}$, which is 25 % lower than the current National Research Council recommendation and lower than the cat's requirement before surgery ($P<0.05$). In conclusion, spaying significantly increased BW when using MER values for intact cats. Thus, 313·6 × ideal BW$^{0.67}$ kJ is proposed for the MER of spayed adult cats.

Key words: **cats: energy requirements: spaying: obesity**

Neutering of pet animals is popular and recommended. In the USA, 80 % of domesticated cats are reportedly neutered[1]. Nonetheless, neutering is one of the key factors for obesity development[2]. Obesity is closely linked with numerous medical conditions such as diabetes mellitus, dyslipidaemia, osteoarthritis and musculoskeletal disorders[2]. Although the rationale behind the relationship between neutering and obesity is subject to debate, several studies have reported that the problem is due to alteration of food intake and decreased energy expenditure after neutering in cats[3–5]. Therefore, controlling energy intake after neutering is important.

The National Research Council (NRC) publication recommends a maintenance energy requirement (MER) for cats based on a 9-point body condition score (BCS) as follows: 419 × (body weight; BW)$^{0.67}$ kJ or 293 × (BW) kJ for a BCS of ≤5 and 544 × (BW)$^{0.40}$ kJ for a BCS of >5[6]. By contrast, the MER for spayed cats has not been clearly defined, although weight gain of spayed cats is widely recognised. Therefore, the objective of the present study was to determine the MER for spayed adult cats whose BW began to increase shortly after surgery.

Experimental methods

Animals

The present study was approved by the Texas A&M University Animal Care and Use Committee (College Station, TX, USA). A total of twenty-two shorthair adult female cats were used. They were 2 years old and had an average BW of 3·3 (SEM 0·1) kg and a BCS of 5·5 (SEM 0·1). All cats were housed individually at the Laboratory Animal Research Resources facility, Texas A&M University, according to the American Physiological Society Guidelines for Animal Research and guidelines set forth by Texas A&M University Care and Use Committee. Each cage for cats was 2·5 m long, 2·0 m high and 1·2 m wide. Before the present study, physical examinations, complete blood counts and serum biochemistry profiles were performed on all cats to verify their normal clinical status.

Abbreviations: AF, allometric factor; BCS, body condition score; BW, body weight; MER, maintenance energy requirement; NRC, National Research Council.

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Diet and study design

The cats were fed three complete and balanced dry-extruded diets (diets A, B and C) containing similar nutrient compositions and ingredients but varying in fatty acid type in an amount to maintain their BW and BCS 300 d before the present study. These extruded diets were given because those cats were used in a separate project before the present study. The diets contained 8·0 (SEM 0·3) % moisture, 32·2 (SEM 0·2) % protein, 17·4 (SEM 0·5) % fat, 1·8 (SEM 0·1) % crude fibre and 6·7 (SEM 0·2) % ash. Diet A contained high linoleic acid (35·6 g/100 g fat); diet B contained high γ-linolenic acid (2·3/100 g fat) and diet C was adequate in linoleic acid (11·4 g/100 g fat). Energy density of the diets, calculated after digestibility determinations, was similar at 18·1, 18·5 and 18·1 MJ/kg for diets A, B and C, respectively. To begin the present study, all cats were spayed. The cats that were fed diet A (*n* 8) and diet B (*n* 6) were changed to diet C with a 5 d gradual transition period in order to adjust diet C. The cats that were fed diet C (*n* 6) were continuously fed without any transition periods. All of the cats were then fed diet C (*n* 22) once daily for 11 weeks using the same MER before the study (weight-change monitoring period). During these 11 weeks, all cats gained weight. Beginning on week 12, a weight loss regimen was initiated until each cat achieved a BCS of 5 out of 9. Cats were fed approximately $272 \times BW^{0.67}$ kJ to achieve a 1–2 % BW loss/week during this period. After each cat obtained a BCS of 5, it was then fed an appropriate amount of diet to maintain its BW for at least 4 weeks. BW and BCS were monitored weekly and bi-weekly, respectively, before and during weight loss. Because BCS system is a subjective measure, one individual (Y. M.) was responsible for determining the BCS throughout the study. Food consumption was recorded daily and used to determine an allometric factor (AF) calculated by dividing energy (kJ) consumed by metabolic BW ($BW^{0.67}$) based on the BW of cats at a BCS of 5. Blood samples were collected via saphenous venepuncture at the time of surgery and after weight loss for plasma biochemistry profiles.

Statistical analyses

Statistical analyses (SPSS 16.0 for Windows; SPSS Inc., Chicago, IL, USA) were performed on all data both before the study and during weight gain. Weekly BW and AF were analysed by repeated-measures ANOVA using a general linear model, with BW or AF as a between-subject factor and week as a within-subject factor. Weekly BCS data were analysed by a Friedman test followed by the Wilcoxon signed-rank test with Bonferroni adjustment. A paired *t* test was used for analysing the AF between pre- and post-surgery. Differences were considered significant at $P < 0.05$.

Results

All blood chemistries were within normal limits before and during the study. Before spaying, cats consumed all foods that were offered (diet A, 441·6 (SEM 12·2) kJ/$BW^{0.67}$; diet B 422·2 (SEM 31·9) kJ/$BW^{0.67}$; diet C, 405·0 (SEM 13·8) kJ/$BW^{0.67}$) and did not change their BW or BCS except two cats in diet B, which voluntarily controlled their food intake (301·4 (SEM 37·4) kJ/$BW^{0.67}$) to maintain their BW. During 11 weeks post-surgery, the cats incrementally increased their BW by 16 % (3·9 (SEM 0·1) kg at week 11) and BCS by nearly one point from BCS of 5·5 to 6·4 (SEM 0·1) at week 11 ($P < 0.01$; Fig. 1). It should be noted that the AF was constant ($P = 0.16$) both before surgery (414·0 (SEM 11·7) kJ/$BW^{0.67}$) and thereafter

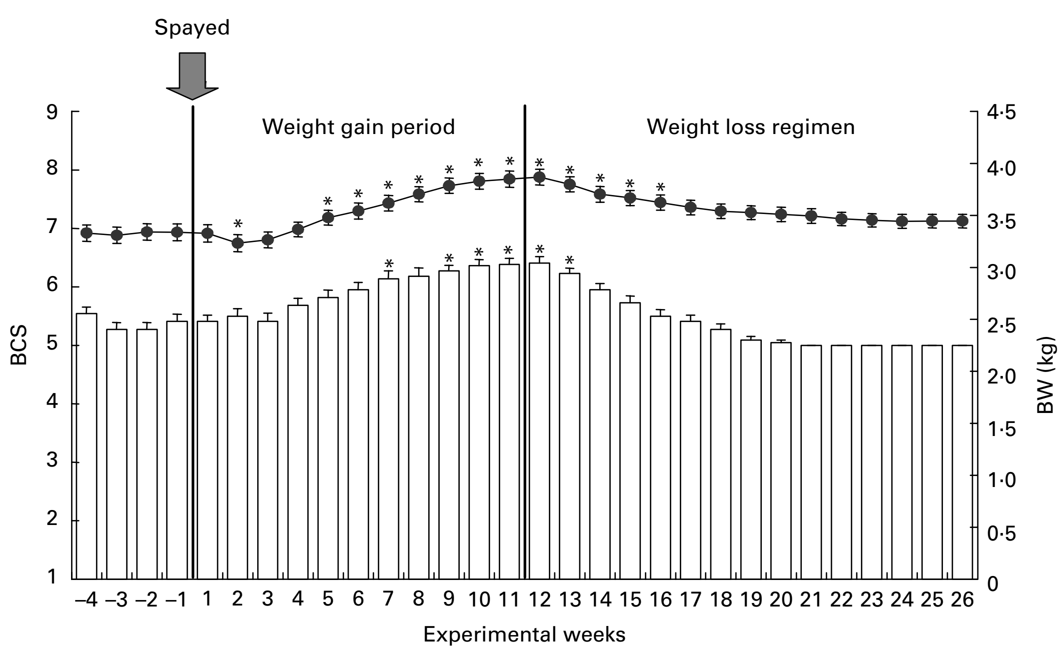

Fig. 1. Changes in body weight (BW; —●—) and body condition score (BCS; □) during the present study. Values are means, with their standard errors represented by vertical bars (*n* 22). * Mean values were significantly different from week 1 ($P < 0.05$).

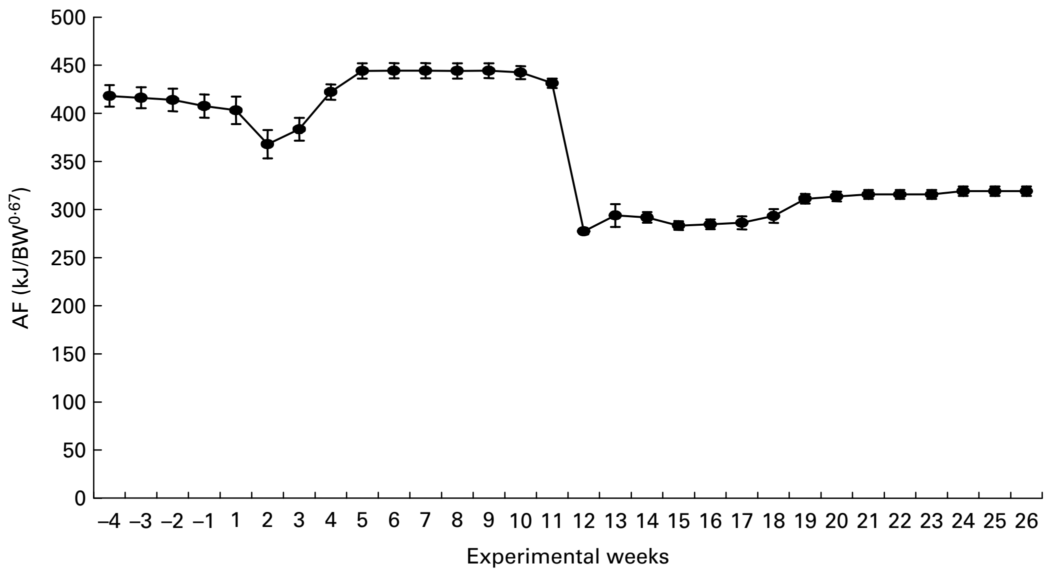

Fig. 2. Changes in allometric factor (AF) during the present study. Values are means, with their standard errors represented by vertical bars (*n* 22). The mean AF before spaying and during the weight-change monitoring period (i.e. weeks 1–11) was 414·0 (SEM 11·7) and 424·9 (SEM 10·0) kJ/BW$^{0·67}$, respectively.

(424·9 (SEM 10·0) kJ/BW$^{0·67}$) during which time all cats significantly gained weight (Fig. 2). The two cats that self-regulated their food intake before spaying changed their feeding behaviour and consumed the entire amount of food that was offered post-surgically. This change in food intake increased the AF by 7·1 % during the weight-change monitoring period (weeks 1–11) compared with before spaying (Fig. 2). During the weight-loss regimen, cats lost 1·9 (SEM 0·1) kg BW/week, which required 4·7 (SEM 0·4) weeks to decrease their BCS from 6·4 to 5 (Fig. 1). After the weight-loss regimen, the AF needed to maintain the BW of each cat at a BCS of 5 was 313·6 (SEM 23·6) kJ/BW$^{0·67}$. This AF was lower than that for cats before surgery using a paired *t* test ($P<0·05$).

Discussion

The objective of the present study was to investigate the MER for spayed cats whose BW began to increase shortly after ovariohysterectomy surgery. As expected, all cats gained weight after surgery with consistently similar food intakes between the pre- and post-surgery periods with the exception of two cats. It is uncertain what factors were involved in this increased food intake for these two cats. Kanchuk *et al.*[4] reported that neutering increased food intake in male cats. Although the present study differed in the use of female cats, the spaying may have affected the increase in food intake. Another potential cause was that the diets of these two cats were changed from diet B to C pre- and post-surgery. If these two cats preferred diet C more than diet B, then their food intake would have increased due to the differences in palatability.

Flynn *et al.*[7] found that the MER for spayed adult cats was 175·8 kJ/BW energy while sexually intact adult cats needed 251·2 kJ/BW energy to maintain their BW during a 17–26-week post-surgery period. A similar decrease in MER in spayed adult cats has been reported by Martin *et al.*[5]. They compared energy expenditure between sexually intact and spayed adult cats, 19·5 (SEM 0·3) months old, using a doubly labelled water method. While sexually intact cats expended 238·6 kJ/BW energy per d, energy expenditure of spayed cats was only 213·5 kJ/BW[5]. In the present study, we found that $313·6 \times BW^{0·67}$ kJ energy was sufficient to maintain the cats' BW after spaying. When using the cats' initial BW before surgery (3·3 (SEM 0·1) kg), the animals required only 697·9 kJ amount of energy per d (e.g. $kJ = 313·6 \times 3·3^{0·67}$ kg) to maintain this BW after spaying. In order to compare this amount of energy with the aforementioned relevant studies, this amount of energy was divided by BW. The resulting amount was 211·5 kJ/BW (e.g. kcal/kg = 697·9 kJ/3·3 kg), which is similar to the study by Martin *et al.*[5].

In summary, spaying of cats increased BW if the amount of energy offered daily before surgery was not decreased. The NRC has recommended that a cat with a BCS of 5 out of 9 requires an amount of metabolic energy given by the equation $MER = 419 \times BW^{0·67}$ kJ to maintain their BW. The present study found that 25 % less energy than the NRC recommendation for adult cats is needed to maintain BW after spaying. Weight gain and obesity are often the result of spaying and perhaps decreased activity in cats and are associated with several metabolic dysfunctions. Therefore, adult female cats needed $313·6 \times BW^{0·67}$ kJ energy to maintain an ideal BW (i.e. BCS of 5 out of 9) after spaying.

Acknowledgements

Y. M. and J. E. B. designed the research; Y. M., A. J. C. and K. E. B. conducted the research; Y. M. analysed the data; Y. M. and J. E. B. wrote the paper; and J. E. B. had the primary responsibility for the final content. There is no conflict of interest.

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