
The Challenge of Providing Feeding Recommendations for Puppies after Neutering

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Abstract

Surgical sterilization has been associated with weight gain¹ and decreased maintenance energy requirement in female dogs.² The importance of maintaining lean body condition for long-term health and longevity is well-established.³ Adjusting feeding recommendations after this procedure is prudent. However, it is equally imperative to ensure appropriate intake of nutrients during the critical growth phase. Several factors including the age of the puppy, breed or anticipated mature size, body condition, activity level, and the specific diet formulation must be considered when asked, “How much should I feed my puppy?” The answer requires individual patient and diet assessment, client education and continued monitoring.

Introduction

The Humane Society of the United States estimates that 83% of owned dogs in the United States are spayed or castrated.⁴ Surgical sterilization of dogs may be performed for several reasons including potential medical or behavioral benefits for the individual, prevention of heritable conditions in future generations, and to combat pet overpopulation.^{5,6} This procedure is often performed before dogs have reached adulthood. Knowing that ovariectomy can lead to significant weight gain in bitches¹ and decrease the dog’s daily energy requirement,² veterinarians often recommend decreasing caloric intake to prevent weight gain. This is important since maintaining lean body condition throughout the course of a pet’s life is associated with increased longevity and delayed onset of signs of chronic disease.³ Furthermore, excess caloric intake in large- or giant-breed puppies has been shown to contribute to the development of skeletal disease.^{7,8} For these breeds the goal is to avoid rapid growth and to provide optimal intake of nutrients, such as calcium and phosphorus, for the developing skeletal system. All growing puppies have higher requirements for nutrients compared to adult dogs. Energy requirements for young puppies greatly exceed that of adult dogs but decrease with increasing age as well as following sterilization. Further complicating the issue is the wide range of individual energy requirements among puppies of various ages and breeds, and the variability of nutrient content and energy density among the plethora of products marketed for growing dogs. This discussion will explore some of the patient and diet variables and provide

Glossary of Abbreviations

AAFCO: Association of American Feed Control Officials

BCS: Body Condition Score

NRC: National Research Council

WSAVA: World Small Animal Veterinary Association

some recommendations to consider when asked the apparently simple question, “What and how much should I feed my puppy now that she’s been spayed?”

Ensuring Appropriate Energy Intake

When a commercial pet food is formulated to provide complete and balanced

nutrition for growth, it is assumed that a puppy consuming the appropriate amount of that formulation to meet its energy need, is also consuming the appropriate amount and ratio of all essential nutrients. It is recommended that the veterinarian begin with a nutritional assessment of the individual puppy starting with a complete diet history to determine factors such as the current caloric intake, source of calories and feeding management. Several resources provide a more in-depth discussion on nutritional assessment.^{9,10}

When assessing intake, it is imperative to inquire about all food sources including snacks, table foods, supplements, dental chews, edible toys, etc. During this life stage, the puppy is likely receiving food rewards as part of a training program. It is important to determine the type and amount of treats used in training since many pet owners do not consider the calories consumed outside the food bowl when thinking about how much their pet is eating. Although food rewards are important during training, one must ensure that these treats do not lead to excessive caloric intake or unbalance the overall nutrient intake. Client education regarding appropriate “snacking” should start with the first puppy visit.

The question “How much to feed?” is best answered with the response “Feed to a lean body condition.” A 14-year study in Labrador Retrievers (Purina Life Span Study) showed that dogs fed to a lean body condition (mean body condition 4.6 on a 9-point body condition score system¹¹) had a lower frequency of hip dysplasia,¹² lower prevalence and severity of osteoarthritis,¹³ delayed onset of chronic disease, and an increased median life span³ when compared to a control group consisting of paired littermates with a mean body condition score (BCS) of 6.7/9. Teaching clients the importance of maintaining a lean body weight and how to body condition score their dog is recommended. This should be reinforced at every veterinary visit. Since overfeeding large- and giant-breed puppies has been shown to contribute to the development of skeletal disease,^{7,8,12} owners should be told that maximal growth is not optimal growth for these puppies.

Knowing the importance of maintaining a lean body condition throughout life, the pet owner may ask, “Well, how much food should I give?” This seems like a reasonable and simple question; however, there are food and patient variables to consider. Owners do not always measure food, so providing standard measuring cups (since most pet owners in the United States feed based on volume measures) and discussing the importance of knowing how much the pet is consuming should occur during routine puppy visits. Diets marketed for puppies do not all have the same caloric content, and there can be significant variation when comparing kilocalories per cup among products. To provide one example, there is a 1.4-fold difference in kcal/cup between two puppy formulations within the same brand, so simply instructing a client to feed 1 cup of “Brand X puppy food” without stating the specific formulation could in this example result in over- or underfeeding by approximately 140 calories per day.

Although it is important to provide pet owners with feeding guidelines regarding the amount to feed, you also should recognize the limitations of any specific “feed X calories per day” recommendation. As stated in the National Research Council’s (NRC) 2006 Nutrient Requirements of Dogs and Cats, “At present, the energy requirements of an individual dog cannot be more than an educated guess and can easily miss the true requirement by 50 percent.”¹⁴ Even within the rather homogeneous population mentioned in the Purina Life Span study (48 dogs of the same age and breed from seven litters divided equally into two groups), the investigators detected a 20% variation in metabolizable energy requirement.¹⁵ Adding differences among breeds, ages, genders, and lifestyles can dramatically influence deviations in energy needs.

Equations used to determine energy needs can only serve as guidelines. Dobenecker et al. also reported a range of 0.72-2.34 times the maintenance energy requirement when comparing energy requirements of two different breeds of puppy from weaning until 28 weeks of age.¹⁶ An initial feeding recommendation based on knowledge of current intake and body condition provides just a starting point. The owner should be taught how to monitor body condition at home, and the veterinarian should frequently re-evaluate the growing puppy’s BCS over time so feeding guidelines can be modified to that individual’s needs.

Understanding the derivation of canine growth energy requirements, the variables that influence caloric requirements, and the limitations of any method for calculating energy needs are necessary when providing recommendations. Energy requirements for growing puppies take into account the puppy’s maintenance energy requirement plus the growth energy requirement (i.e., energy required for tissue accretion). Arnold and Elvehjem predicted that growing puppies require about twice the amount of energy per unit of body weight as an adult dog of the same breed.¹⁷ However, growth does not occur in a linear fashion as the puppy progresses chronologically from weaning to adulthood; it varies with growth stage and breed size.¹⁸ The typical post-weaning growth pattern follows a sigmoid curve in which growth begins

exponentially followed by a gradual decline until weight reaches a plateau.¹⁹ Therefore, energy requirements change as the puppy progresses from weaning to adulthood.

Canine studies have constructed growth curves by plotting body weight against age for various breeds.²⁰⁻²² The amount of tissue accretion and, therefore, body weight gain during growth for a large- or giant-breed dog far exceeds that of a toy breed. In other words, the scale of difference among larger and smaller breeds increases throughout growth such that a sevenfold weight difference noted between neonates of the smallest and largest breeds evaluated in one study increased to a 35-fold difference by adulthood.²³ With regard to age, in the initial post-weaning period when growth velocity is highest (i.e., the slope of the growth curve is steepest), energy needs per metabolic body weight will be greatest.

During these first weeks when growth velocity is high and body size is relatively small, it is estimated that approximately 50% of total energy intake may be used for growth and the remaining 50% for maintenance.²⁴ At the inflection point of the growth curve, daily weight gain is maximal and then begins to decline with time as the growth rate begins to decline.^{18,19} Thus, as the puppy ages, the proportion of energy needed for growth declines and the proportion of energy used for maintenance increases. The NRC Nutrient Requirements of Dogs and Cats accounts for this by proposing an arbitrary decrease to 1.6 times maintenance when 50% of adult body weight is reached and to 1.2 times maintenance at 80% of body weight to compensate for the decline in energy required from weaning to adulthood,¹⁴ though not all studies have demonstrated a decrease in the energy requirement during growth on a metabolic body weight basis.¹⁶ Of course, the age at which an individual puppy achieves 50% of mature body weight is dependent on anticipated mature body weight with smaller breeds maturing at a younger age compared to large- and giant-breed dogs.

A study by Hawthorne et al. demonstrated a toy breed (Papillon) achieved 50% of its adult body weight at a mean age of 11.1 weeks, while a giant breed (English Mastiff) achieved 50% of its adult body weight at a mean age of 22.9 weeks.²² In the same study, toy, small and medium breeds approached adult weight at ~9-10 months of age, while large and giant breeds approached adult weight at ~11-15 months of age. This study noted additional breed-specific growth pattern differences in dogs of similar size. The NRC’s 2006 recommendations provide an equation proposed by Blanchard et al. for calculating canine energy requirement during the growth continuum by factoring the percentage of realized growth [body weight at time of evaluation (kg)/expected mature body weight (kg)] at a given time point.^{18,25} The equation (shown in Table 1) is best-suited for use with computer programs.

Other variables including body composition (e.g., lean body mass), temperament/activity level, coat type, and environmental temperature could affect energy requirements.^{14,22,26} There is currently insufficient data to determine whether known breed

Table 1. Daily Metabolizable Energy Requirements for Growth of Puppies after Weaning²⁵

ME (kcal) = Maintenance amount x 3.2 x [e^(-0.87p) - 0.1]
 ME (kcal) = 130 x BW_a^{0.75} x 3.2 x [e^(-0.87p) - 0.1]
 Where:
 P = BW_a/BW_m
 BW_a = Actual body weight at the time of evaluation (kg)
 BW_b = Expected mature body weight (kg)
 e = Base of natural log ≈ 2.718

differences affecting adult maintenance energy requirements should be considered during growth.¹⁴ However, the NRC's 2006 recommendations note that inactive puppies may have a 10-20% lower energy requirement and active puppies or puppies of certain breeds, such as Great Dane, may have higher energy requirements. Rather than relying solely on energy requirement calculations, the NRC recommends that individual large- and giant-breed puppies be fed to achieve certain body weight guidelines at specific ages during the growth phase (Table 2) since controlled growth is essential for proper skeletal development of these puppies.^{7,14}

One might postulate that gender, including neuter status, could affect growth patterns and subsequent energy requirements. For example, Allard studied small, medium and large breeds and noted that males sustained a longer growth term compared to females of the same breed.²⁰ There have been limited studies evaluating the effect of neutering on voluntary food intake, body weight, body composition, and maintenance energy requirements following ovariectomy. Houpt et al. reported ovariohysterectomized bitches gained more weight (1.3 kg +/- 0.3 kg) compared to sham operated controls (0.3 +/- 0.1 kg; P<0.05) by the 90th postoperative day when food was offered *ad libitum*.¹ Total food intake was significantly higher at certain measured time points in the eight ovariohysterectomized bitches compared to sham controls over a 15-week study period. Food intake per kilogram of body weight tended to be greater in the ovariohysterectomized bitches and was significant at one measured time point. The authors attributed the weight gain to decreased activity without decreased food intake, but activity was not measured in this study.

Another study of adult female dogs observed for 55 weeks showed no change in body weight among the ovariectomized

bitches, ovariectomized bitches with ovarian autotransplants and the sham control dogs when fed a fixed amount of food and exercised regularly.²⁷ In 2004, Jeusette et al. reported a 30% decrease in daily energy requirement in four 2-year old adult female Beagles after ovariectomy.² These dogs were at ideal body condition at the time of sterilization with feeding amounts adjusted weekly to maintain optimal body weight for the first 26 weeks after surgery. The 30% decrease in daily energy required to maintain optimal weight is comparable to observations reported in cats.^{28,29} The study was not designed to determine whether this observation is due to a decrease in basal metabolic rate or a decrease in activity. These same dogs were then offered high-energy food for 16 weeks at twice the amount determined to maintain optimal weight to assess the effect of *ad libitum* feeding. There was no intact female control group. *Ad libitum* feeding induced overconsumption that was most marked during week one though the increased energy consumption was significant each of the four weeks when compared to the previous controlled consumption. Dogs gained weight during this period with a 22% increase of body weight resulting in all dogs becoming overweight or obese. The authors concluded that "restriction of energy intake seems necessary in dogs after ovariectomy."³⁰

Although the above studies looked at the effect of neutering older dogs, there is limited data looking specifically at the effect of energy and nutrient requirements in dogs neutered at an early (prepubertal) age. A 15-month study saw no difference in rate of growth, food intake, weight gain, or back-fat depth when comparing male and female dogs neutered at 7 weeks of age, 7 months of age or sexually intact.³¹ However, growth plate closure was delayed in all neutered dogs compared to intact dogs with the greatest delay in dogs neutered at the youngest age. Whether this has any implication for optimal nutrient intake of micronutrients, such as calcium or phosphorus, or growth rate is unknown. In two cohort studies, owners of dogs that underwent prepubertal gonadectomy were no more likely to report their pet was overweight than owners of dogs that underwent traditional-age (i.e., near anticipated age of sexual maturity) gonadectomy.^{32,33} In fact, one of the studies³³ reported that dogs undergoing prepubertal desexing (<5.5 months of age) were less likely to become overweight later in life compared to dogs desexed >5.5 months of age. However, results of owner surveys regarding the reporting

Table 2. Recommendations for Growth of Large- and Giant-Breed Dogs¹⁴

Age (months)	Medium Breeds (mature weight 20 kg)		Large Breeds (mature weight 35 kg)		Giant Breeds (mature weight 60 kg)	
	BW (kg)	% mature BW	BW (kg)	% mature BW	BW (kg)	% mature BW
1	1.8	9	2.5	7	3.6	6
2	4.4	22	7.0	20	8.4	14
3	7.4	37	12.3	35	15.6	26
4	10.4	52	16.8	48	22.8	38
6	14.0	70	22.8	65	36.0	60
12	19.0	95	30.8	88	48.0	80

of a pet's body condition must be interpreted with caution since other studies have observed that pet owners underestimate their own pet's body condition score.^{34,35}

A recent retrospective cohort study set out to determine whether gonadectomy or age of gonadectomy was associated with the risk of dogs becoming subsequently obese.³⁶ The study evaluated electronic medical records data from 1,930 desexed and 1,669 sexually intact dogs followed over a minimum 10-year period. The relative risk of becoming overweight was assessed between desexed and intact dogs according to their age at gonadectomy [early (<6 months of age), standard (6-12 months of age), and late (1-5 years of age)]. The study was limited by the lack of a standardized body condition scoring system for most of the study period.

Gonadectomized dogs had a greater risk of being diagnosed as overweight compared to intact dogs, but this difference was only significant during the first two years after surgical sterilization. No difference in risk of being overweight was detected with respect to age at time of gonadectomy. From a practical clinical perspective, this study supports the recommendation for client education regarding food intake and close monitoring of body weight and body condition score after neutering.

Although the evidence is strong to support the recommendation that dogs should be kept lean during their entire lifetime, specific recommendations regarding exactly how much to feed an individual requires an understanding of all variables that impact energy requirements and an appreciation that the "one size fits all" recommendation means feeding the amount necessary to ensure a lean body condition. Teaching clients to properly body condition score and objectively assess their own pet is recommended. This is especially important at the time of neutering since traditional surgical sterilization (around 4-6 months of age) coincides with when a puppy's growth and daily maintenance energy needs subsequently are leveling off. More data are needed specifically regarding the impact of energy requirements in puppies neutered at a much earlier age.

Ensuring Appropriate Nutrient Intake

Feeding to maintain a lean body condition means the caloric intake must match the individual's energy requirement. As discussed above, this can vary significantly between individuals. Two puppies of similar body weight and body condition, age, breed, and gender may have different energy requirements. For example, in young adult dogs, Kienzle and Rainbird found that Newfoundlands had a lower and Great Danes had a higher energy intake than dogs of other breeds.²⁶ However, all puppies have an increased need for nutrients during the growth phase. The challenge is to ensure that the individual consumes the necessary amount of all essential nutrients when fed the appropriate amount of food to meet energy needs. In other words, the essential nutrients must be balanced to the caloric density of the diet, and the caloric density of the diet must be balanced to the needs of the

puppy such that when a puppy consumes the proper amount of food to meet his energy needs, he has concurrently met his macronutrient and micronutrient requirements as well.

One can consider that for a puppy with a very low energy requirement, the diet must have a relatively higher nutrient-to-calorie ratio to ensure that the puppy consumes the recommended amount of each essential nutrient at a lower-than-average caloric intake. This scenario would argue against selecting a product that has been formulated close to the minimum nutrient recommendations. Therefore, knowledge of the nutrient profile of the specific food that the pet is consuming is required to make this assessment. For adult dogs with an unusually low energy intake, the NRC's 2006 recommendations use the dog's metabolic body weight to determine the recommended allowance for each specific nutrient.²⁵ This same recommendation is not stated for puppies, but rather, guidelines exist for calculating the amount of nutrients to feed based on a puppy's calculated energy requirement multiplied by the recommended allowance for that nutrient.

There are additional guidelines for the calcium recommendation of weaned puppies up to 14 weeks of age with an anticipated mature body weight >25 kg.²⁵ Calcium requirements for growing puppies require special consideration since both inadequate calcium intake³⁷⁻⁴⁰ and excessive calcium intake, particularly without a concurrent increase in dietary phosphorus,^{7,37,41-43} are associated with adverse health effects including skeletal malformations and stunted growth. In addition, certain breeds appear more intolerant to a wider range of dietary calcium content than others.^{43,44} This reaffirms the importance of an individual nutritional assessment in the exam room to recognize a breed that may be more susceptible to developmental orthopedic disease if energy, calcium and phosphorus intake are not considered.

Let's suppose we are asked to provide a dietary recommendation for a 12-week-old spayed female Newfoundland puppy in lean body condition that weighs 15.4 kg. Per the NRC's 2006 recommendations, a puppy of this expected mature size under 14 weeks should consume not less than 15.4 kg (BW) x 0.54 grams calcium/kg(BW) = 8.32 grams of calcium per day. Also per NRC, her estimated daily energy requirement would be 2108 calories per day. However, if we assume a Newfoundland puppy would have a similar breed-specific lower maintenance component to her energy requirement (105 x kg BW^{0.75}),^{25,26} her daily energy requirement may be closer to 1703 Kcal/day. If we further assume that the 30% decrease in daily energy requirement required to maintain optimal weight that Jeusette reported in the study evaluating 2-year-old Beagles² may also apply to this prepubertal ovariohysterectomized dog, perhaps her daily energy intake could be even lower (1192 Kcal/day). Therefore, in this hypothetical extreme of the range of individual energy requirements, this dog would need to be fed a diet that provided 6.97 g calcium/Mcal (=697mg/100Kcal) in order to consume 8.32 grams/day. This amount of 6.97 g calcium/Mcal is well above the Association of American Feed Control Officials' (AAFCO) minimum for

growth and reproduction (2.9 g/Mcal) and approaching the AAFCO maximum (7.1 g/Mcal).⁴⁵ The veterinarian would need to determine if this dog would be at risk if less than 0.54 g/kg body weight was provided since a commercial puppy diet most likely would not provide this calcium intake when fed to provide 1192 Kcal/day. If the nutritionist determined this puppy needed more calcium than the current diet provided, options could include recommending a diet with a higher ratio of calcium to energy or careful supplementation for a defined period of time.

In addition, for a dog with very low metabolic energy expenditure, owner consultation regarding snacks is imperative. The owner may need to use complete and balanced food rewards for training, such as a piece of kibble, since the individual may not have the luxury to consume “treats” that are not concurrently delivering essential nutrients.

At the other end of the spectrum is the puppy with a higher-than-average energy requirement, such as a Great Dane puppy. In this scenario avoiding excess nutrient intake may become a consideration when energy intake is high. Therefore, the same nutrient-dense diet selected in the above example could potentially lead to excessive nutrient intake. A diet with a lower nutrient-to-calorie ratio fed to meet the energy requirement for proper growth rate and maintenance of lean body condition without leading to overconsumption of a nutrient of concern, such as calcium, would be an appropriate recommendation.

Providing a Recommendation

The veterinarian providing consultation for growing puppies must first complete a nutritional assessment of individual patient factors including breed, age, neuter status, body weight, body condition score, current caloric intake, source of calories, etc., and owner factors including feeding philosophies, level of knowledge regarding canine pediatric nutrition, and personal needs and desires before providing a recommendation regarding what to feed and how much to feed. “How much to feed?” is answered by feeding to a lean body condition.

Some general guidelines, such as knowing most dogs have achieved 50% of mature weight around 4 months of age, help provide general recommendations. At this age, energy need expressed as kcal/kg is decreasing such that for many puppies the amount of food (i.e., absolute caloric intake per day) is unlikely to increase significantly in the coming months. Furthermore, 4 to 6 months of age coincides with the traditional age for surgical sterilization. This time period is critical for nutrition consultation and client education. If the puppy is neutered at this age, the amount of food likely will have to be decreased. This is not intuitive to most pet owners who more likely will assume the puppy will need to be fed more food in the coming months. Currently, one of the best tools is client education for all puppy owners that includes teaching body condition scoring, appropriate growth rate for the breed, importance of maintain-

ing lean body condition throughout life, measuring food intake, and understanding appropriate selection and amount of snacks.

Development of standardized breed-specific growth charts may in the future assist veterinarians and pet owners in determining if a specific puppy is growing at the appropriate rate. Since recommendations are often, at best, an educated guess and should only be considered as a starting guideline, frequent reassessment with necessary modifications to the nutrition plan is warranted. It is not uncommon in some practices for the puppy to be evaluated at 6 months of age (time of neutering) and, if no health problems occur, not to be evaluated again until the next vaccinations are due after 1 year of age. A veterinary practice might consider implementing veterinarian or veterinary technician wellness nutrition recheck appointments so that the puppy can be evaluated and the owner can continue to be educated regarding proper nutrition.

“What food to feed?” can only be answered after the nutritional assessment. Owners can be directed to reputable resources such as the World Small Animal Veterinary Association (WSAVA) Global Nutrition Committee’s recommendations on selecting pet foods (<http://www.wsava.org/sites/default/files/Recommendations%20on%20Selecting%20Pet%20Foods.pdf>) to provide general guidelines for assessing a pet food. However, the recommendation still needs to be tailored to the individual as demonstrated in the Newfoundland puppy example. Since no standard large-breed puppy nutrient profile guidelines exist, one cannot rely solely on the product name to know the caloric content or nutrient profile for a given “large-breed puppy formula.” Depending on the caloric density and nutrient profile, certain large-breed puppy formulations may meet that puppy’s needs and others may not. An all-life stage product may, in fact, meet one puppy’s needs better than a product marketed as a large-breed puppy diet.

Some veterinarians may recommend switching a growing large-breed puppy to an adult food in an attempt to lower energy intake. This is probably based on the assumption that an adult diet will be lower in calories than the puppy diet. This assumption may not be correct because of the range in caloric density of both adult and growth formulations, e.g., some “adult” foods can contain more calories than some puppy foods. Further, the puppy may still consume as much or more energy when fed an adult formulation if portions are not controlled. In addition, the adult diet may not meet the specific nutrient requirements for growth. Given the variables of both calories and nutrient/calorie ratio, the veterinarian must evaluate the nutrient profile of the recommended diet before determining that a specific food will meet that puppy’s needs. For a puppy with a relatively low-energy requirement, products formulated to near-minimum requirements should be avoided as they will need a greater “safety margin.”

Providing snacks or treats is one way owners interact and bond with their puppy. General guidelines such as ensuring snacks do not comprise >10% of daily caloric intake are useful. However, this recommendation also should be tailored to the

individual. The owner may seek recommendations for treats used for training. One option may be to use kibbles of cat food as training treats for puppies due to their small size with few calories per piece, yet they provide essential nutrients. Food items designed to keep the puppy occupied, such as certain edible chew toys, may contribute more calories than the owner realizes. Alternative feeding methods, such as interactive feeding toys, offer a potential solution.

Summary

The apparently simple question “What and how much should I feed my puppy now that he is neutered?” may in fact raise some challenges and involve a bit more thought when providing a specific recommendation. The goal is to provide the optimal intake of required nutrients to help the puppy achieve his growth potential at an appropriate rate and ensure maintenance of a lean body condition. A complete nutrition assessment to evaluate patient, owner and food variables in conjunction with client education that includes specific recommendations regarding the type and amount of diet and close monitoring are the most useful tools we currently have to make dietary recommendations for the neutered patient.

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