

## Feeding Large-Breed Puppies

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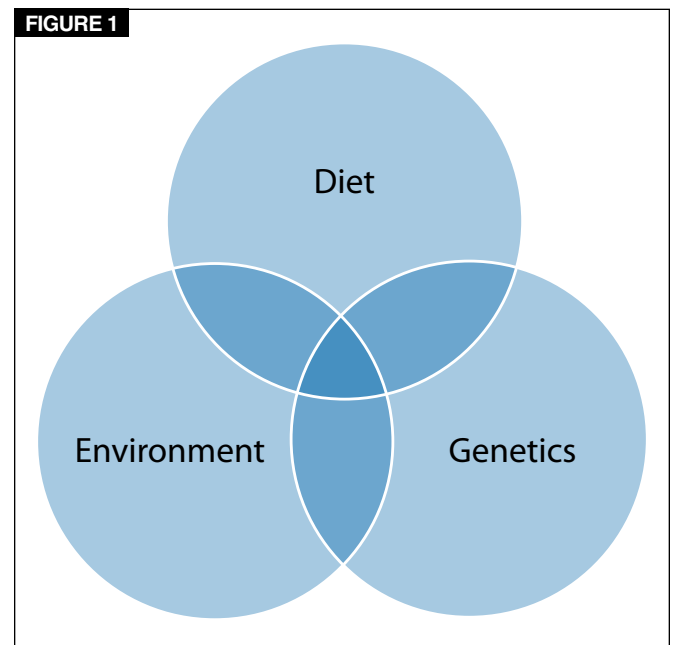
**Abstract:** Growth is a physiologically demanding process that requires adequate amounts of energy as well as optimal intake of essential nutrients. Key nutritional factors, including energy and calcium, have been identified as important during growth. Large-breed puppies have a genetic tendency toward fast growth rates that can stress developing skeletal structures and result in malformations if left unchecked. Overnutrition in large-breed puppies leads to not only heavier body weight but also faster bone growth with abnormal bone remodeling. The end result is a larger but less dense skeletal structure supporting a load that is heavier than ideal. Controlling the growth rate and providing nutrients in amounts adjusted for energy intake can help decrease the risks of skeletal abnormalities caused by rapid growth in large-breed puppies.

Veterinarians are regularly asked about diet selection for puppies. Owners often receive advice from breeders or friends or read the Internet for tips on how to feed their puppy; however, the soundness of these recommendations is variable, and some are unsafe. Several orthopedic diseases of dogs can be precipitated by improper feeding practices during growth. Rickets and other developmental diseases can be devastating and have lifelong effects. However, less dramatic disorders of orthopedic development secondary to dietary causes may be more common. Large-breed puppies are predisposed to these problems due to their genetic potential for excessively rapid growth. Additionally, excessive body weight can stress the immature, developing skeleton. If energy intake is not controlled, or if the mineral balance of the diet is not within a safe range, developmental orthopedic disease (DOD) can result. Although genetics, exercise, trauma, and other factors can affect the skeletal development of puppies (FIGURE 1), the diet is one factor that every owner can control.

### Key Nutritional Factors

Many nutrients have been studied to determine which dietary components cause DOD, which includes hypertrophic osteodystrophy, osteochondrosis dissecans, and cervical spondylomyelopathy (“wobbler” syndrome). A significant amount of data has been published to describe the connection between improper nutrition and a variety of skeletal abnormalities in Great Danes. One of the first stud-

ies used experimental diets that varied in protein concentration, energy density, and mineral concentrations, and it was unclear which factor or combination thereof contributed to the abnormalities observed, including osteochondrosis with lameness and deformity.<sup>1</sup> The same group of researchers went on to investigate the individual dietary compo-



**The etiology of developmental skeletal disease is often multifactorial. Genetics, environment, and diet are all important components of proper growth.**

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nents and demonstrated that dietary protein concentration had no effect on skeletal development.<sup>2</sup> Despite these data, high dietary protein concentrations continue to be incriminated by some owners, breeders, and veterinarians as a contributing factor in DOD. In contrast to protein, excessive calories and inappropriate amounts of calcium have both been shown to negatively influence skeletal development in large-breed puppies.

## Energy

Many people believe that a round puppy is a happy, healthy puppy. However, consumption of excessive energy is undesirable in dogs of any age. Fast growth and excessive body weight can predispose large-breed puppies to DOD, including osteochondrosis.<sup>3</sup> Fast bone growth increases rates of remodeling, resulting in structural defects such as decreased density; affected bones are, in turn, unable to accommodate increased body weight. Compared with puppies of smaller breeds, large-breed puppies have decreased bone density, so they are more vulnerable to stress from excess weight loads.<sup>3</sup> Adult size is principally influenced by genetics; however, the time to reach adult size should be controlled by proper nutrition, especially for at-risk breeds.

While research has demonstrated that rapid growth results from ad libitum feeding of energy-dense diets and that excessive body weight has an adverse effect on skeletal development,<sup>1,3</sup> studies have not been done to determine optimal energy densities of growth diets. The energy density of a diet on a weight basis is a function of the fat, fiber,

and moisture concentrations and should be balanced with the practical feeding of a volume that will satisfy both the owner and the puppy. Any food has the potential to cause problems with skeletal development if overfed; however, maximal growth in puppies commonly occurs with feeding a highly palatable, high-energy density growth diet. Owners should be educated that maximal growth is not optimal growth and that encouraging slower growth with proper feeding practices will not result in a smaller adult body size.

Feeding on a free-choice basis or feeding too much on a meal basis can result in overeating regardless of energy density. A body condition score (BCS) is a tool that can easily be adopted and used by veterinarians.<sup>4</sup> Assessing and recording body weight and BCS for every pet at every visit is useful for tracking trends and identifying problems. Owners should also be taught to use the BCS to evaluate their pets because healthy puppies undergo veterinary examination only intermittently during the growth period, and educating owners about the risks of improper feeding methods helps them to successfully manage their growing puppy.

Energy requirements for puppies are approximately three times the resting energy requirement (RER; [70 × body weight in kg]<sup>0.75</sup>) until 4 months of age, then two times the RER for the remainder of the growing period.<sup>5</sup> However, there is no equation to guarantee an optimal rate of growth for an individual puppy, and the equations should be used as a starting point and adjusted as needed to maintain a lean body condition. Breed and individual differences, environmental factors such as climate, and activity level all affect the amount of food required. Providing a properly measured amount of food throughout growth allows a slow growth rate without adversely affecting final adult size. The goal is to keep growing puppies at a BCS of 4 on a 9-point scale and to maintain this leanness throughout life to promote health and longevity.<sup>6</sup> The owner should assess the puppy's body condition regularly, and the amount of food being offered should be adjusted accordingly.

## Calcium and Other Nutrients

In addition to excessive energy intake, inappropriate amounts of calcium have also been shown to increase the risk of DOD.<sup>7</sup> Many breeders and dog fanciers advocate calcium supplementation for growing pups; however, excess calcium is potentially very detrimental to the development of a healthy skeleton. Calcium supplements should not be recommended for healthy puppies eating commercially available complete and balanced diets. Unlike adult dogs, puppies appear to have inefficient mechanisms for regulating how much dietary calcium is absorbed from the intestinal tract, which can result in excessive absorption and retention of calcium, especially when the dietary calcium

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concentration is high.<sup>8,9</sup> Excessive calcium can result in skeletal malformation<sup>10</sup> and can cause deficiencies in other nutrients, especially zinc.<sup>11</sup>

Feeding a diet with too little calcium is equally problematic. Nutritional secondary hyperparathyroidism develops much more quickly and with more serious consequences in puppies compared with adult dogs. In this condition, parathyroid hormone concentrations increase, subsequently increasing calcium release from the skeleton and potentially resulting in soft, malformed bones and pathologic fractures. Many home-prepared diets, even those that include bone, do not provide appropriate concentrations of calcium and other essential nutrients.<sup>12,13</sup> Many vitamins and minerals, including phosphorus, vitamin D, vitamin A, copper, zinc, and manganese, are also important for proper skeletal formation, and deficiency or excess of one or more of these nutrients has been associated with abnormal orthopedic development during growth in dogs. Dietary phosphorus concentrations, in particular, must be considered in relation to calcium concentrations. The ratio of calcium to phosphorus should be approximately 1:1 to 1.5; however, absolute amounts of each nutrient appear to be more important than the ratio per se.<sup>8</sup> Clinical experience supports this, as developmental problems with extreme ratios in the presence of adequate dietary concentrations of calcium and phosphorus have not been reported.

### Diet Selection

Research investigating the optimal dietary calcium concentration for growing puppies has typically compared dogs of extreme sizes (miniature poodles and Great Danes); however, it is generally accepted that the findings also apply to other breeds and sizes of dogs. Generally, three ranges of calcium intake have been investigated: low (0.3% to 0.5% dry matter [DM]), medium (1.1% to 1.2% DM), and high (>3% DM). Few data report the results of feeding calcium concentrations between these ranges. One study showed poor growth rates in puppies of various breeds and sizes that were fed diets providing calcium at  $\leq 0.9\%$  DM or  $\geq 2.3\%$  DM.<sup>14</sup> Both large and small breeds appear to grow safely when consuming diets that provide 1.0% to 1.5% DM calcium (or approximately 3 g calcium per 1000 kcal). For canine growth diets, the Association of American Feed Control Officials (AAFCO) has established a minimum of 1% DM calcium (with a maximum of 2.5% DM for both growth and maintenance),<sup>15</sup> while the National Research Council (NRC) provides a recommended allowance for growing puppies of 1.2% DM calcium (with a maximum of 1.8% DM for growth), with no distinction for breed size or growth rate.<sup>16</sup>

Many nonveterinary sources—and some veterinarians—advise owners of large-breed puppies to feed commercially available adult dog foods. The goal of this practice is presumably to prevent excessive growth rates by providing a

#### KEY POINTS

- Adult foods are often inadequate for large-breed puppies. Choose a diet formulated for large-breed growth instead.
- Avoid supplementation with vitamin and mineral products.
- Keep growing puppies lean to reduce the risk of abnormal skeletal development.

less energy-dense food with less dietary calcium. However, this advice is much too vague to be widely and safely interpreted. The broad category of adult canine maintenance foods encompasses hundreds to thousands of diets with an extremely wide range of nutrient profiles, caloric densities, and mineral contents. In fact, some foods marketed for adult maintenance have been formulated to be adequate for growth, while others have not. In many instances, maintenance diets provide more calcium per calorie and/or have more calories per cup than growth diets designed for large-breed puppies, and some greatly exceed the NRC's safe upper limit for calcium intake for puppies.<sup>16</sup>

The total amount of calcium consumed depends on the energy density of the diet and the energy requirement of the puppy, and nutrient requirements are established based on assumptions of dietary energy density. Variations in energy density can result in either suboptimal or supraoptimal intake of total calcium; for example, diets that have high calcium concentrations relative to energy or that have a high energy density result in a greater overall calcium intake. In most cases, growth diets formulated for puppies of all sizes as well as those for large breeds provide calcium concentrations in the safe range; however, those formulated specifically for large breeds are less energy dense and therefore are less likely to be overfed. A diet specifically formulated for growth that has passed standardized feeding tests is preferred; the guidelines for these tests are established by AAFCO.<sup>15</sup> The growth diet should be fed until growth plate closure has occurred, which likely varies with both genotype and phenotype because it is influenced by the rate of growth, the presence of joint dysplasia, and hormones (and therefore neuter status).<sup>17,18</sup> It is not detrimental to keep a healthy, lean puppy on growth formula until full adult size is achieved. When such a diet is fed, vitamin and mineral supplements are unnecessary and potentially harmful.

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