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Nutritional Considerations in the Pediatric Dog:

Dietary and Developmental Relationships

A.J. Reynolds, DVM, PhD, DACVN

Approximately 30% of puppy mortality occurs during the first 14 days of life.[1] Many of these deaths result from inadequate nutrition or the inability of the gastrointestinal tract (GIT) to adequately digest and absorb nutrients.[2] The nutritional state experienced during prenatal and postnatal development and growth can have a major influence on longevity and the incidence of diseases later in life.[3,4] Thus, understanding how, why, and when the GIT changes during development may help owners and veterinarians provide diets that best meet the needs and digestive abilities of growing puppies and kittens during each stage of development.

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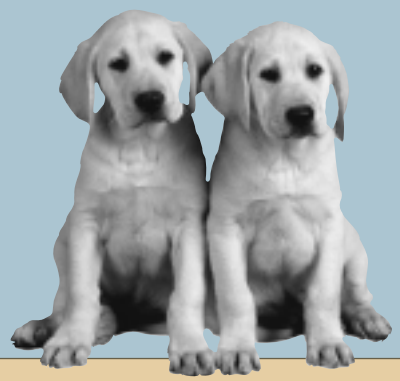

The Effect of Breed Size on Nutritional Considerations for Growing Puppies

Dogs are a unique species in that the adult body size of different breeds can range by nearly 100-fold. These differences in body size and associated metabolic differences have a pronounced effect on appropriate dietary formulation for these animals. In addition to different energy needs, the require-ments for certain key nutrients appear to differ between large and small breeds. This is especially true for growing puppies.

Effect of breed size on energy requirements

Small breed adult dogs can have maintenance energy needs per unit body weight that approximate two- to three-fold the needs of large or giant breed dogs. Multiply this by the incremental requirements for growth, and it is clear that puppies of small breeds have extreme energy requirements. Large and giant breed dogs, on the other hand, generally need fewer calories per unit body weight. Excess calorie intake in growing puppies can lead to obesity. In addition, overconsumption of calories in large and giant breed puppies can promote too rapid growth. Rapid growth in several species, including dogs, rats and humans, appears to increase the incidence of skeletal abnormalities.[4] Restricting food intake slows the rate of growth, which can be beneficial

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Nutritional Considerations in the Pediatric Dog

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Prenatal and Neonatal Development

The signals that regulate the differentiation and development of the fetal GIT are not well understood. It is likely that factors exist in the amniotic fluid that may play a role in this process. Gut peptides are found in the fetal human GIT within the first trimester and in the amniotic fluid by the second trimester.[5] In porcine and ovine feti, GIT development was impaired when the swallowing of amniotic fluid was prevented.[6,7] Compared to controls, these animals showed a decrease in the weight of their small intestine, pancreas and liver and a generalized thinning of the gut wall throughout the length of the GIT.[6,7] Other factors, including cortisol, insulin and numerous other hormones, present in both the fetal and maternal circulation also may have significant effects on GIT development. Although there have been very few studies examining the prenatal development of the GIT in dogs and cats, some brush border enzymatic activity and nutrient transport activity is developed by the time of parturition.[8]

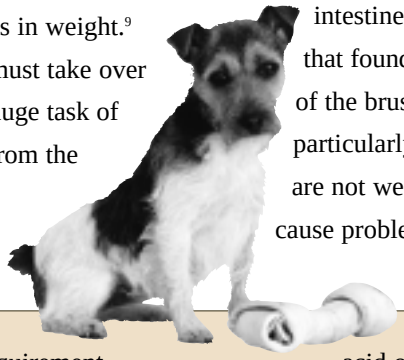
Birth to Weaning

At birth, the GIT undergoes perhaps the most drastic change in function of any organ system except the lungs. During the first 24 hours, the canine small intestine nearly doubles in weight.[9] At this time, the GIT must take over from the placenta the huge task of transferring nutrients from the outside world to the neonatal circulation. Since neonatal puppies and kittens have very small energy and glucose reserves, failure to make this accommodation becomes a serious if not fatal problem in a matter of hours.

The nutritional state experienced during prenatal and postnatal development and growth can have a major influence on longevity and the incidence of diseases later in life.

The normal neonatal GIT is fully capable of digestion and absorption of its primary substrate, mother's milk. Many of the brush border enzymes found in the mature GIT are present to facilitate the final stages of digestion and thus absorption. The activity of these enzymes increases markedly just before parturition and so premature animals may experience digestive difficulties.[2]

The neonatal GIT is not well suited for ingesta other than milk. Newborn puppies lack certain pancreatic enzymes and the muscularis layer of their small intestine is about 50% thinner than that found in adult dogs.[2,10] Some of the brush border enzymes, particularly the alphaglycosidases, are not well developed and this can cause problems if sugars such as



The Effect of Breed Size on Nutritional Considerations for Growing Puppies

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in puppies susceptible to these problems.[3] Thus, meeting a puppy's energy needs for normal growth is essential, but excessive intake should be avoided.

Effect of breed size on protein requirements

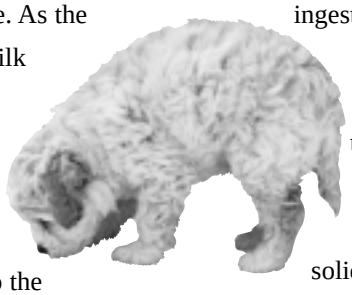
Most studies suggest that if approximately 17% to 22% of calories consumed are provided as good quality protein, the diet should meet the minimal protein requirement for growing puppies of all breeds.[7] However, results from recent studies evaluating Great Dane and Miniature Poodle puppies suggest that more protein may be needed if factors other than growth are considered. These pups were fed an identical diet with 21% dietary protein (energy basis).[5] While growth was normal for both groups, reduced packed cell volume, serum albumin and urea nitrogen in the Great Dane puppies suggested that the diet was sub-optimal in protein content for these large breed puppies. In addition, other investigators evaluating the requirement for the essential amino acid, methionine, identified that Labrador puppies require approximately 50% more of this amino acid on an energy basis, compared to Beagle puppies.[1] Purina research also suggests that a protein level of approximately 25% of the energy is more appropriate for large breed puppies.

Excessive intake of dietary protein has been suggested as a contributing factor to skeletal developmental problems, such as osteochondrosis, in large breed dogs. This hypothesis was tested by feeding Great Dane puppies diets with either 15%, 23% or 32% dietary protein (13%, 21% or 29% of energy).[6] While the low protein diet reduced growth, no detrimental effects from the higher protein diets were observed.

sucrose or maltose are used in homemade milk replacers.

While the neonatal GIT may have difficulty handling foods other than milk, it is highly specialized for milk digestion and absorption. Not surprisingly, the changes which occur in the developing GIT are well matched to changes in the composition and volume of the milk with which it is presented. The first milk, colostrum, is rich in protein, immunoglobulins, hormones and other factors which promote hypertrophy and hyperplasia of the neonatal GIT. Puppies fed milk replacer instead of colostrum experience a much smaller increase in intestinal mass during the first 24 hours of life.[2]

The ability to internalize large molecules such as proteins persists up to two weeks after birth in many species.[11] In puppies, this may help compensate for inadequate activities of pancreatic proteases[2] which are secreted in only small amounts during the first one to two weeks of life.[10] Neonatal puppies also secrete very little pancreatic lipase but this is compensated for by secretion of gastric lipase. As the concentration of fat in milk increases over time, the secretion of pancreatic lipase also increases.[10]



Weaning and Beyond

From the second week to the seventh week of life, there is a multi-fold decrease in milk intake as a percent of body weight. Similarly there is a three-fold increase in solid food intake as a percent of body weight from the third week to the seventh week.[2] By three weeks of age, the puppy's GIT will have undergone considerable changes. The thickness of the gut wall will have nearly doubled primarily due to hypertrophy of the tunica muscularis. This will facilitate the passage of solid ingesta along the lumen of the gut.[2] The pancreas will have developed adequate capacity to produce digestive enzymes as well as antibacterial factors.[10] The introduction of solid food provides both a source and a substrate for bacterial growth and these factors take over from those found in milk to help establish normal GI microflora.

Commercial foods balanced for the needs of growing puppies should be introduced beginning at about three weeks of age.

In later life, the ability to change digestive function varies among species in accordance with natural variation in the diet.[2] The cat, which is an obligate predator, is less able to vary its pancreatic and GIT enzyme activity than is the more omnivorous dog.[2,10,12] Dogs also possess a tremendous capacity to adapt their GIT function over an enormous range of energy requirements. For most dogs, the largest demand on the GIT for processing nutrients occurs during growth. A weaned puppy may require

Effect of breed size on calcium requirements

A deficiency of calcium in growing puppies can lead to osteoporosis or osteodystrophy and spontaneous fractures. Excess calcium also can contribute to skeletal malformations, as well as depressed growth and secondary deficiencies of nutrients such as zinc. Breed differences in calcium metabolism were illustrated by observations on Miniature Poodle and Great Dane puppies fed similar diets with varying calcium content.[5] The smaller puppies were able to tolerate calcium as low as 0.33% and as high as 3.3% with only very minimal changes. The Great Danes, however, developed significant pathological lesions when fed either 3.3% calcium (osteochondrosis and stunted growth), or 0.59% calcium (osteoporosis and pathologic fractures). The latter occurred despite using a highly available source of calcium.[2] Thus, large breed puppies are more susceptible to both excesses and deficiencies of calcium, compared to small breed dogs. A dietary calcium level averaging between 1.0% and 1.5% of the diet, depending on energy concentration, is safe and appropriate for puppies of all sizes, while extremes should be avoided.

Meeting a puppy's energy needs for normal growth is essential, but excessive intake should be avoided.

Effect of calorie content of the diet

For puppies, as for dogs or cats of any age, it is important to recommend or feed diets with an energy density appropriate to the individual. Most nutritionally complete and balanced diets are formulated such that as an animal meets its energy needs, its needs for other nutrients are also satisfied. If a diet that is too high in caloric density is fed, it will be necessary to restrict the amount fed to avoid obesity or excessive growth rate. This results in less food being consumed, thus a restriction in other essential nutrients. On the

two to three times the energy per unit body weight of a sedentary adult dog.[13] If that puppy is a bitch that later whelps a large litter, her energy requirement may return to that same three times maintenance she experienced as a puppy.[13] If she is a sled dog running 100 miles a day in subzero conditions, her GIT will need to process foods to meet her energy needs which may reach an incredible eight times maintenance.[14]

Feeding the Neonatal Puppy

All of these developmental changes are important to consider when feeding young puppies. Puppies should increase their bodyweight about 10% each day during the early neonatal period. If puppies require nutritional intervention before three weeks of age, their GIT is not yet capable of handling solid food. Pups of this age should be fed milk replacers which mimic canine mother's milk in nutrient concentration (78% water, 8% protein, 10% fat, 1.2 - 1.4 Kcal/gm) and digestibility.[15] The ingredients should ideally be milk-based (i.e., casein or whey) for the protein source, lactose for the carbohydrate, and milk fat or at the least emulsified fats for the lipid source. If tube feeding is necessary, puppies should receive about 20 - 26 Kcal/100gm body weight, divided into several feedings.[15] Commercial foods balanced for the needs of growing puppies should be introduced beginning at about three weeks of age. Dry foods should be mixed with warm water and provided in shallow bowls several times each day. During this period, puppies should continue to gain weight daily and this can be used as a measure of adequate energy intake. Puppies that lose or merely maintain their body weight are not receiving enough calories and may require supplementation with milk replacer or a more energy dense solid food.

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REFERENCES

1. Poffenbarger EM, Olson PN, Ralston SL, Chandler Ml. Canine Neonatolgy Part II : Disorders of the Neonate. *Compd Cont Edu Pract Vet* 1991; 13:25-37.
2. Buddington RK Paulsen DB. Development of the canine and feline gastrointestinal tract. In Recent Advances in Canine and Feline Nutrition Vol II. GA Reinhart and DP Carey eds. Orange Frazier Press Wilmington 1998. Pp195-213.
3. Langley-Evans SC, Phillips GJ, Jackson AA. Fetal exposure to low protein maternal diet alters the suceptibility of young adult rats to sulfur dioxide-induced lung injury. *J. Nutr.* 1997; 127: 202-209.
4. Newberne PM. Animal models for investigation of latent effects of malnutrition. *Am J Dis Child* 1975;129:574-577.
5. Lucas A, Bloom SR, Green AA. Gastrointestinal peptides and the adaptation to extrauterine nutrition. *Can J Physiol Pharmacol* 1985;63:527-537.
6. Avila CG; Harding R. The development of the gastrointestinal system in fetal sheep in the absence of ingested fluid. *J Pediatr Gastroenterol Nutr* 1991 Jan;12(1):96-104
7. Mulvihill SJ; Stone MM; Fonkalsrud EW; Debas Trophic effect of amniotic fluid on fetal gastrointestinal development. *J Surg Res* 1986 Apr;40(4):291-6
8. Buddington RK, Nutrition and ontogenetic development of the intestine. Can J Physiol *Parmacol* 1980; 72:251-259.
9. Heird WC, Schwarz SM, Hansen IH. Colostrum induced enteric mucosal growth in beagle puppies. *Pediatric Res* 1984; 18:512-15.
10. Elnif J. Buddington RK. Adaptation and development of the exocrine pancreas in cats and dogs. In Recent Advances in Canine and Feline Nutrition Vol II. GA Reinhart and DP Carey eds. Orange Frazier Press Wilmington 1998. Pp 217-29.
11. Clarke RM, Hary RN. Structural changes in the small intestine associated with the uptake of polyvinyl pyrrolidone by the young ferret, rat, guinea-pig, cat, and chicken. *J. Physiol* 1970; 209:669-87.
12. Ballesta MC, Manas M, Mataix FJ, Martinez-Victoria E, Seiquer I. Longer term adaptation of pancreatic response by dogs to dietary fats of different degress of saturation: olive and sunflower oil. *Brit. J. Nutr.* 1990; 64:487-496.
13. National Research Council Subcommittee on Dog Nutrition. Nutrient Requirements of Dogs. 1985. National Academy Press. Washington DC. pp 2-9.
14. Hinchcliff KW, Reinhart GA, Burr JR, Schrier CJ, and Swenson RA. Metabolizable energy intake and sustained energy expenditure of Alaskan sled dogs during heavy exertion in the cold. *Am. J. Vet.* Res. 1997 Dec; 58(12)
15. Lawler DF, Chandler ML. Indications and techniques for tube feeding puppies. *Canine Pract* 1992;17:13-16.

other hand, feeding a diet that is too low in caloric density for the individual can result in inadequate calorie consumption due to restrictive stomach capacity or to greater intake of dry matter resulting in unnecessarily large stool volume.

Many veterinarians recommend feeding an adult dog food to growing large breed puppies on the assumption that adult foods are lower in calories. However, before recommending or feeding any particular food, it is important to know the specific calorie density of that product. Several puppy foods that have been marketed for years have calorie contents less than those of some of the newer foods recommended for large breed puppies, just as many adult foods have a higher calorie content than some puppy foods. Information on the calorie content of pet foods can be obtained from label or product information

A protein level of approximately 25% of the energy is more appropriate for large breed puppies.

or by calling the manufacturer. Alternately, the relative calorie content can be estimated from the percent fat in the product with higher fat products generally containing more calories.

REFERENCES

1. Blaza SE, Burger IH, Holme DW, Kendall PT. Sulfur-containing Amino Acid Requirements of Growing Dogs. *J Nutr* 1982;112:2033.
2. Hazewinkel HAW, van den Brom WE, van't Klooster AT, Voorhout G, van Wees A. Calcium Metabolism in Great Dane Dogs Fed Diets with Various Calcium and Phosphorus Levels. *J Nutr* 1991 121:S99.
3. Kealy RD, Olsson SE, Monti KL, et al. Effects of Limited Food Consumption on the Incidence of Hip Dysplasia in Growing Dogs. *J Am Vet Med Assoc* 1992;201:857.
4. Lavelle RB. The Effects of the Overfeeding of a Balanced Complete Commercial Diet to a Group of Growing Great Danes. in Burger IH, Rivers JPW. Nutrition of the Dog and Cat. Cambridge University Press, Cambridge. 1989. pp 303.0.
5. Nap RC. Nutritional Influences on Growth and Skeletal Development in the Dog. PhD Thesis. Utrecht University. 1993.
6. Nap RC, Hazewinkel HAW, Voorhout G, van den Brom WE, Goedegebuure SA, van't Klooster AT. Growth and Skeletal Development in Great Dane Pups Fed Different Levels of Protein Intake. *J Nutr* 1991;121:S107.
7. Schaeffer MC, Rogers QR, Morris JG. Protein in the Nutrition of Dogs and Cats. in Burger IH, Rivers JPW. Nutrition of the Dog and Cat. Cambridge University Press, Cambridge. 1989. pp 159.

Commercial vs. Traditional Food in Canine Health

A study was conducted in a dog population fed with commercial overseas manufactured food and traditional homemade food to find out which was more efficacious in preventing diseases. The study was carried out for a period of one year and included three groups of dogs. Group I animals were maintained on traditional home made feed stuffs without meat, Group II with meat and Group III on commercial feed. A total of 1,229 dogs of different breeds were used. Occurrence of diseases of digestive system, urinary system, skin disorders and metabolic diseases were recorded. From the study on digestive disorders, it was observed that the percentage incidence of parasitic enteritis, bacterial enteritis, non specific anorexia, indigestion and ascites was 5.82 %, 3.98%, 3.68%, 2.76% and 0.61% in dogs receiving commercial food as against Group I and II animals fed on home made food which was 8.86%, 5.77%, 4.94%, 4.53% and 1.44% and 9.33%, 6.93%, 4.54%, 4.30% and 1.19%, respectively. Similarly results on percentage incidence of dermatological disorders such as pyoderma, dermatomycoses, atopic dermatitis, hormonal disorders, dry coat, pruritus, dandruff, infestation with ticks, fleas and sarcoptic and demodectic mite in Group III was 2.45%, 2.14%, 1.53%, 0.92%, 1.53%, 1.84%, 1.84%, 3.06%, 2.14%, 1.22% and .61% as against 3.71%, 3.71%, 3.09%, 1.85%, 3.09%, 2.47%, 1.64%, 4.12%, 3.29%, 2.26%, and 1.03% and 3.58%, 3.58%, 3.11%, 1.67%, 3.34%, 3.11%, 2.15%, 4.30%, 4.06%, 2.15% and 0.95% in groups II and III. The percentage incidence of renal diseases in Group III was 14.72% as compared to Group I (17.73%) and Group II (21.05%). Results of occurrence of metabolic diseases indicated that the percentage of rickets and zinc responsive dermatosis in Group III was 0.92% and 0.61% which was much less as compared to 4.74% and 2.47% and 6.45% and 2.15% in Group I and Group II. The mortality pattern of pups till weaning indicated that the percentage survival of pups in Group III was higher (94.44%) as compared to Group I (86.75%) and Group II (87.92%). The results of overall incidence of disease in dogs indicated that percentage occurrence of disease in Group III was less as compared to Group I and II. This is probably due to the fact that commercial food is balanced and meets the requirements of the animal and the same nutrients, though available in homemade food, are not available in right proportion and form.

S. Abdul Rahaman and S. Yathiraj. Veterinary College, University of Agricultural Sciences, Hebbal, Bangalore, India, Proc. 1999 Purina Nutrition Forum, St. Louis, Mo.

Research Abstracts

The Effect of Dietary Fat and Calorie Content on the Growth of Puppies

Puppies compensated for reduced fat and calorie content of feed by consuming more.

Excessive calorie intake and growth rate have been linked to obesity and developmental skeletal problems in growing puppies. The growing availability of superpremium diets formulated with more fat and more calories than found in "typical" puppy foods have been thought to contribute to this problem. The objective of this study was to compare the effect of feeding diets that differed in fat and calorie content on calorie intake and growth in medium to large breed puppies.

Methods: Twenty-six puppies (12 Pointers, 14 English Setters) were blocked for breed, sex and body weight, and assigned to treatment groups at six weeks of age.

One group was fed a high calorie, high fat (HCHF) extruded puppy food and the other a medium fat/medium calorie (MFMC) extruded puppy food. Both groups were fed *ad libitum* for a 10-week period. Food intake was measured daily. Body weights and lengths were measured at the beginning and end of the test period.

Results: Over 10 weeks, the puppies fed the MFMC diet consumed more feed, gained more weight and gained more length than those fed the HFHC. The English Setter puppies ate more of the MFMC diet compensating for the lower caloric density, such that the two English Setter groups did not differ significantly in weight or length gain. The Pointer puppies also ate significantly more of the MFMC diet, overcompensating for the lower caloric density. The Pointer puppies on the MFMC diet gained significantly more weight and length than those fed HFHC.

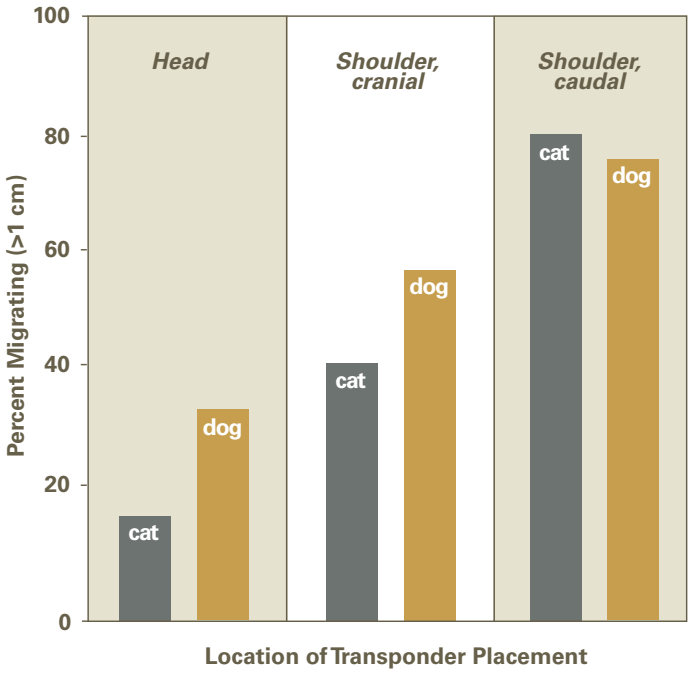
Conclusion: The results demonstrate that fat content and calorie density alone cannot be used to effectively manage puppy growth.

Owens SF, Ralston Purina Company, Proc. 1999 Purina Nutrition Forum, St. Louis, Mo.

Identify Your Patients

Microchips (transponders) have all but replaced tattooing as a means of providing permanent identification for pet dogs and cats. One concern with their use is the tendency for transponders to migrate. A recent 16-week study evaluated the effect of placement sites on migration. They found that transponders implanted on the head near the base of the ear were less likely to migrate than those placed intrascapularly. The authors suggest that adequate training in the correct placement of transponders will help reduce complications, including migration

(Source: Jansen JA, van der Waerden JPCM, Gwalter RH, van Rooy SAB. Biological and migrational characteristics of transponders implanted into Beagle dogs. Vet Rec 1999;145:329-333.)



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