CPD article

Puppy nutrition: weaning and beyond

In 2019 and 2020, and especially during the COVID-19 pandemic, the number of households owning dogs increased considerably, and many of these pets were new puppies acquired during the lockdowns in the UK. With such a rise in puppy ownership, it has never been more important to ensure that these puppies receive adequate nutrition throughout their weaning and growth periods, and beyond. In this article, the nutritional considerations of growing puppies will be discussed, along with current pet food trends and how to ensure puppies are receiving a complete and balanced diet.

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From 2019–2020, 3.2 million households acquired a new 'pandemic pet' (Pet Food Manufacturers Association, 2015a). Many of these pets were new puppies, acquired during the lockdowns in the UK. With such a rise in puppy ownership, it is as important as ever to ensure that these puppies receive adequate nutrition throughout their weaning and growth periods, and beyond. It is also important that all members of the veterinary team are confident and knowledgeable about nutrition, so they are able to properly educate owners on feeding during these important life stages and give a consistent message. In this article, the nutritional considerations of growing puppies will be discussed, along with current pet food trends and how to ensure puppies are receiving a complete and balanced diet.

Weaning considerations

Weaning is an important life stage for puppies. It is a high-risk time for them (Grellet et al, 2012) and must be managed carefully. At 4 weeks of age, the dam's milk no longer provides all the nutrients that puppies need (Fontaine, 2012). At this point they will need to begin the transition to solid food, and choosing the right diet is important. Asking several questions about a particular diet may help to determine whether that diet is appropriate for the pet, for example, is it safe? Is it nutritious? Is it right for the individual pet? It is prudent to select a diet described as complete and balanced for the life stage in question.

Growing puppies require a variety of different nutrients in particular quantities and proportions in their diet. It is important to select a commercially prepared diet that is complete and balanced, as this will provide all the required nutrients in appropriate quantities, including fats, proteins, carbohydrates, minerals and vitamins.

There are multiple studies looking at the inclusion of various nutrients in weaning diets and their effect on puppies at this life stage. One study has shown that fructan supplementation may support the immune response to bacterial challenges (Apanavicius et al, 2007). There is also evidence to show that diets supplemented with nucleotides appear to improve biological markers of immune responses in puppies (Romano et al, 2007). Many other nutrients are also very important for puppy development, both during and after weaning. Docosahexaenoic acid has been identified as an important component in neurocognitive development in young puppies (Zicker et al, 2012). It should be noted that diets formulated to be complete and balanced for any life stage should not be supplemented, as they already contain the nutrients in the appropriate quantities and proportions required, and incorrect supplementation may unbalance them.

Practical considerations for weaning include feeding puppies in a quiet area, to avoid potential food aversions associated with their environment, for example loud noises (Lawler, 2008). In addition, feeding the same weaning diet consistently is important, as diet changes may be associated with digestive upsets. Feeding the puppy the same complete and balanced growth diet as the dam may also be helpful, provided it is a diet appropriate for weaning puppies. It is also beneficial to offer different textures at different stages of the weaning process, starting with softer food during early weaning and moving to dry kibbles in late weaning, as the puppies start to be able to manage more challenging textures. Using a kibble diet that can be rehydrated for a softer texture may be helpful. There are also anecdotal reports that puppies may eat more in the presence of other puppies. Anecdotal evidence also supports feeding puppies from their own individual bowl rather than from one large communal bowl where practical, to ensure that food intake can be monitored for each puppy and to reduce the risk of the puppy developing resource guarding behaviours. This is also helpful to ensure that the stronger puppies do not push

Figure 1. Nutrition should be discussed at every opportunity during growth to ensure that the puppy is receiving adequate nutrition. Photo of the author's dog at a puppy check appointment.

other puppies out of the way to access food. Regular monitoring of each puppy should be performed, including weighing and assessing body condition to assess the growth rate of the puppy, and to confirm that the diet being fed is still suitable.

Nutritional requirements of puppies after weaning

A complete and balanced diet is essential for the growing puppy, both to ensure optimal health and to avoid pathologies associated with over or under supplementation of many key nutrients. It is well documented that unbalanced nutrition in growing dogs can result in severe consequences, including fractures (Tal et al, 2018), osteopenia (Hall et al, 2020), myelopathies (Taylor et al, 2009) and seizures (Hutchinson et al, 2012). It is also important to understand that nutrients can interact with one another, and unbalanced levels of one nutrient can exacerbate the effects of other unbalanced nutrients. One review concluded that excess calcium in growing puppies is much more dangerous when a concurrent low phosphorus supply is present, causing them to be more at risk of developmental orthopaedic diseases (Dobenecker, 2011). While adult dogs have been shown to tolerate higher levels of dietary calcium (Stockman et al, 2017), growing dogs fed a high calcium diet will absorb much of their dietary calcium in the gut passively (Tryfonidou et al, 2002), so dietary calcium must be carefully controlled.

Large and giant breed dogs are more prone to developmental skeletal diseases associated with inappropriate calcium and phosphorus levels (Dobenecker, 2011), and there is a narrow margin of safety for calcium and phosphorus intake in large breed dogs, outside of which the development of skeletal abnormalities is a real risk (Shoenmakers et al, 2000). The European Pet Food Industry Federation (FEDIAF) (2020) guidelines for minimum and maximum calcium levels are summarised in *Table 1*. Recommended minimum levels of phosphorus for early growth (<14 weeks) are 0.90g/100g dry matter, and for late growth (>14 weeks) 0.70g/100g dry matter. The minimum calcium:phosphorus ratio is 1:1. The maximum ratio for early growth is 1.6:1. For the late growth phase for puppies with an expected adult bodyweight of <15kg it is 1.8:1, and for those with an expected adult bodyweight of >15kg it is 1.6 until 6 months, at which point the ratio can be increased to 1.8:1. By selecting a diet that follows the FEDIAF guidelines, these minimum and maximum levels should be adhered to.

Different sizes of dogs grow and mature at different rates, and there may also be variations in growth patterns between breeds of similar sizes (Hawthorne et al, 2004; Harvey, 2021). This emphasises the need for regular individualised assessments of puppies to ensure that they are growing well and maintaining a healthy weight. This is especially important given the wide variation in maintenance energy requirements of puppies (Dobenecker et al, 2013). Therefore, it is important to choose a diet formulated for the expected adult size of the puppy and to choose a diet formulated for large or small dogs as appropriate. Many food companies offer diets formulated for smaller dogs which are higher in energy and protein, and those formulated for larger dogs are lower in energy but balanced with the required protein levels for growth (Greco, 2014).

In terms of feeding frequency, the Pet Food Manufacturers Association (2015c) have practical guidelines, indicating that puppies should be fed four times a day up until they are aged 4 months, then moving to three meals a day up until 6 months. At 6 months, feeding frequency can be reduced to twice a day, which should be continued for the rest of the dog's life.

Table 1. Recommended levels of calcium (adapted from The European Pet Food Industry Federation, 2020)

	Recommended calcium levels (g/100g dry matter)	
Age and size of puppy	Minimum	Maximum
Puppies <14 weeks old	1	1.6
Puppies >14 weeks old with an expected adult body weight of <15kg	0.8	1.8
Puppies >14 weeks old with an expected adult body weight of >15kg, until 6 months old	1	1.8
Puppies >6 months old with an expected adult body weight of >15kg	0.8	1.8

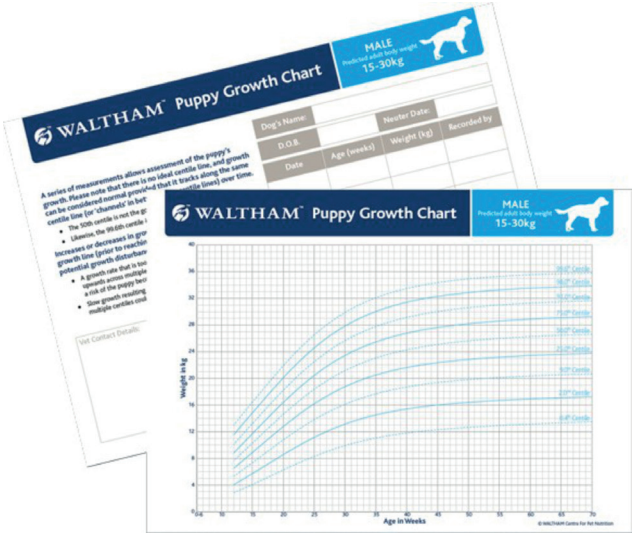

Figure 2. Puppy growth charts. From the Waltham Centre for Pet Nutrition (2020).

Determining how much a puppy should be fed can be difficult. Feeding instructions that come with diets should be used as a guide only, and the puppy should be assessed regularly to ensure that they are gaining weight and maintaining body condition as expected. The Waltham growth charts (*Figure 2*) can be helpful to track growth. *Table 2* summarises formulae for calculating average energy requirements for puppies at different stages of their growth (FEDIAF, 2020). In addition, many pet food manufacturers have daily allowance calculators to determine feeding quantities for their specific products.

While for many puppies the expected adult weight can be estimated easily based on the parent's size and breed, this can be difficult for some mixed breed puppies where the parentage is unknown. A best estimate based on the apparent breed(s), as well as regular monitoring of body condition as the puppy grows, is required to ensure that the nutritional recommendation is appropriate.

Considerations regarding weight

When feeding growing puppies, an important consideration to take into account is obesity. A common misconception is that it is harmless for puppies to carry extra weight, and, anecdotally, this is often viewed by owners as their puppy having a healthy appearance. However, obesity in dogs is a common problem in the UK. There is evidence to show that not only are 65% of adult dogs overweight, but this issue affects 37% of juvenile dogs, with 21% of dogs just 6 months of age being classified as overweight (German et al, 2018).

Overweight dogs are predisposed to certain diseases, including osteoarthritis, some types of neoplasia and diabetes mellitus (Lund et al, 2006). Obesity can also reduce lifespan in dogs (Kealy et al, 2002). Furthermore, one study found that when calorie intake was limited in Labrador Retrievers in the first 2 years of life, fewer dogs had signs of hip dysplasia (Kealy et al, 1992). Therefore, new owners should be educated early on regarding the importance of maintaining a healthy weight for their puppy. Using the Waltham growth charts can be helpful to reinforce this (*Figure 2*).

Table 2. Energy requirement formulae for puppies at various stages of growth

Age	Energy requirement
Newborn	25 kcal/100g body weight
Up to 50 % of adult weight	210 kcal/kg body weight$^{0.75}$
50–80 % of adult weight	175 kcal/kg body weight$^{0.75}$
80–100 % of adult weight	140 kcal/kg body weight$^{0.75}$
Adapted from the European Pet Food Industry Federation, 2020	

Advice should be given to owners on the practical aspects of feeding. Measuring cups are often considered a convenient method of controlling portions when feeding pets, although multiple studies have shown that these are inaccurate. One study by Coe et al (2019) found that inaccuracies in measuring kibble portions ranged from an underestimation of 47% to an overestimation of 152%. Another study by German et al (2011) found that inaccuracies ranged from an underestimation of 18% to an overestimation of 80%. Thus, many pets may be receiving a ration that is far in excess of the required amount, thereby putting them at risk of inappropriate weight gain from excess calories. Conversely, some pets may not be receiving enough food, putting them at risk of nutrient deficits. The recommendation for all puppies is that their food is weighed out using digital weighing scales for each meal throughout their lives, to ensure that they are receiving the correct amount. Ad lib feeding should be avoided. There are even bowls available with built in weighing scales for convenience.

In addition to weighing out food, educating owners regarding responsible treat provision is important. It has been shown that 83% of owners regularly purchase treats for their dogs (Morelli et al, 2020). Using treats with a clear calorie content can help owners understand how many treats their puppy should have each day. Ensuring that no more than 10% of the daily energy requirement comes from treat provision is advisable (Freeman et al, 2011).

Puppy growth charts are a helpful tool to help owners understand how their puppy is growing, and to identify growth rates that are inappropriately rapid or slow (*Figure 2*). These growth charts provide a standard for healthy growth and help owners and veterinary professionals determine if the puppy is following the expected pattern of growth, allowing for the detection of potential issues early on, and subsequent intervention if indicated. Ideally, puppies should be weighed monthly until they are 6 months old, and then every 3 months until they are an adult.

Considerations regarding alternative diets

Over recent years, alternative methods of feeding dogs have gained traction, in particular raw feeding (Davies et al, 2019). While there are many who advocate for this feeding style, there is currently no evidence to suggest that feeding a raw diet is superior to a cooked diet (Freeman et al, 2013; Davies et al, 2019). It also comes with notable risks to the pet, including bacterial and

KEY POINTS:

- The nutritional needs of weaning and growing puppies are complex, and choosing a complete and balanced diet for all stages of puppy development is essential to meet their nutritional needs.
- Particular attention should be applied to educating owners about portion sizes as their puppy grows to avoid inappropriate weight gain or nutrient deficits.
- Calcium and phosphorus levels in the puppy's diet should be carefully controlled to reduce the risk of developmental abnormalities that may be associated with imbalanced nutrition.
- Owners should be educated regarding the risks associated with feeding alternative diets, including raw diets and home prepared diets, so that they can make a fully informed decision regarding what to feed their puppy.
- The whole veterinary team has a role to play in communicating the importance of adequate nutrition for puppies to their owners.

endoparasitic disease, and hyperthyroidism from feeding thyroid tissue (Köhler et al, 2012). There are many risks associated with feeding bones as part of a raw diet, including oral injuries to both soft tissue structures and teeth, constipation, and oesophageal and gastrointestinal perforation (Freeman et al, 2013). There are also risks to human health, as raw food harbours bacteria and endoparasites to which humans are susceptible (Davies et al, 2019), particularly if they are immunocompromised (Freeman et al, 2013). Many home-prepared raw diets are also nutritionally unbalanced (Freeman et al, 2013). It should be noted that freezing raw food may only reduce and not completely remove bacterial contamination (Kananub et al, 2020). In addition, using a dishwasher and bleaching feeding equipment has been shown to not be fully effective at killing *Salmonella* (Weese and Rousseau, 2006). Owners wishing to feed their dogs a raw meat diet with or without bones should be educated as to the risks to their pet, themselves and anyone encountering their pet. They should also be educated on proper handling of raw food, hygiene measures, preparation and storage. The Pet Food Manufactures Association (2015b) has useful guidelines on handling raw pet food, and the World Small Animal Veterinary Association (WSAVA) has a factsheet on the risks associated with raw feeding (WSAVA, 2021a). Owners who insist on feeding raw food should be advised to feed a diet that is labelled as complete and balanced to avoid nutritional deficiencies or excess.

Home prepared diets have also recently become more popular, as many owners perceive them to strengthen the bond they have with their dogs (Oliveira et al, 2014). When used in the appropriate context and under appropriate veterinary nutritionist supervision, home prepared diets can be a useful tool for managing animals with very specific nutritional requirements. However, there are important considerations. Ensuring that the diet is complete and balanced is vital, as the consequences of feeding an unbalanced diet can be severe, such as nutrient deficiencies resulting in morbidity (Hutchinson et al, 2012). A study investigating home prepared diet recipes readily available to the public found that of 106 evaluated recipes, all diets had at least one nutrient below the recommended amount (Pedrinelli et al, 2017). It is essential that any owner considering this approach to feeding their puppy consults an appropriately qualified board-certified veterinary nutritionist. Additionally, when diet recipes are obtained from an appropriately qualified board-certified veterinary nutritionist, there is a responsibility on the owner's behalf to ensure that the recipe is adhered to. One study found that some owners admit to inadequately controlling the amounts of provided ingredients, and also incorrectly using vitamin, mineral and amino acid supplements. The same study found that a third of participants admitted to modifying the diets themselves, by altering quantities of ingredients, changing the ingredients, and even removing certain ingredients completely (Oliveira et al, 2014). Owners should be educated as to the importance of a balanced diet and directed to an appropriately qualified specialist in veterinary nutrition if they are considering this feeding method. Owner compliance may be reinforced by using the whole veterinary team, including nursing staff, to follow up on nutritional advice and instructions.

Considerations for selecting a diet

In Europe, the FEDIAF publish comprehensive nutritional guidelines annually that outline minimum nutritional requirements using data drawn from the National Research Council (NRC). One of the FEDIAF's main objectives is 'to ascertain the wellbeing of pets by providing well balanced and nutritionally sound pet food through its member companies' (FEDIAF, 2020). Selecting an appropriate diet, produced following these nutritional guidelines, ensures that a puppy is receiving a complete and balanced diet. In the United States and Canada, The Association of American Feed Control Officials (AAFCO) produce similar guidelines to ensure pet foods are complete and balanced.

In addition, the WSAVA has published guidelines on selecting pet foods in which they outline recommendations for selecting a particular brand. The WSAVA recommends asking several questions before choosing a brand, including whether the company employs a nutritionist, who formulates the diet, and asking what the quality control process for ingredients and finished products is (WSAVA, 2021b).

Conclusions

To conclude, the dietary requirements of weaning and growing puppies are incredibly complex. Owners should be educated on how and what to feed their puppies at the earliest opportunity for the wellbeing and safety of both puppy and owner. Consideration should be given to the life stage and expected adult size of the puppy, and advice given regarding practical aspects of feeding, including how frequently to feed and how to accurately determine feeding volumes.

Conflicts of interest

The author is a Veterinary Business Manager with Royal Canin UK.

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