

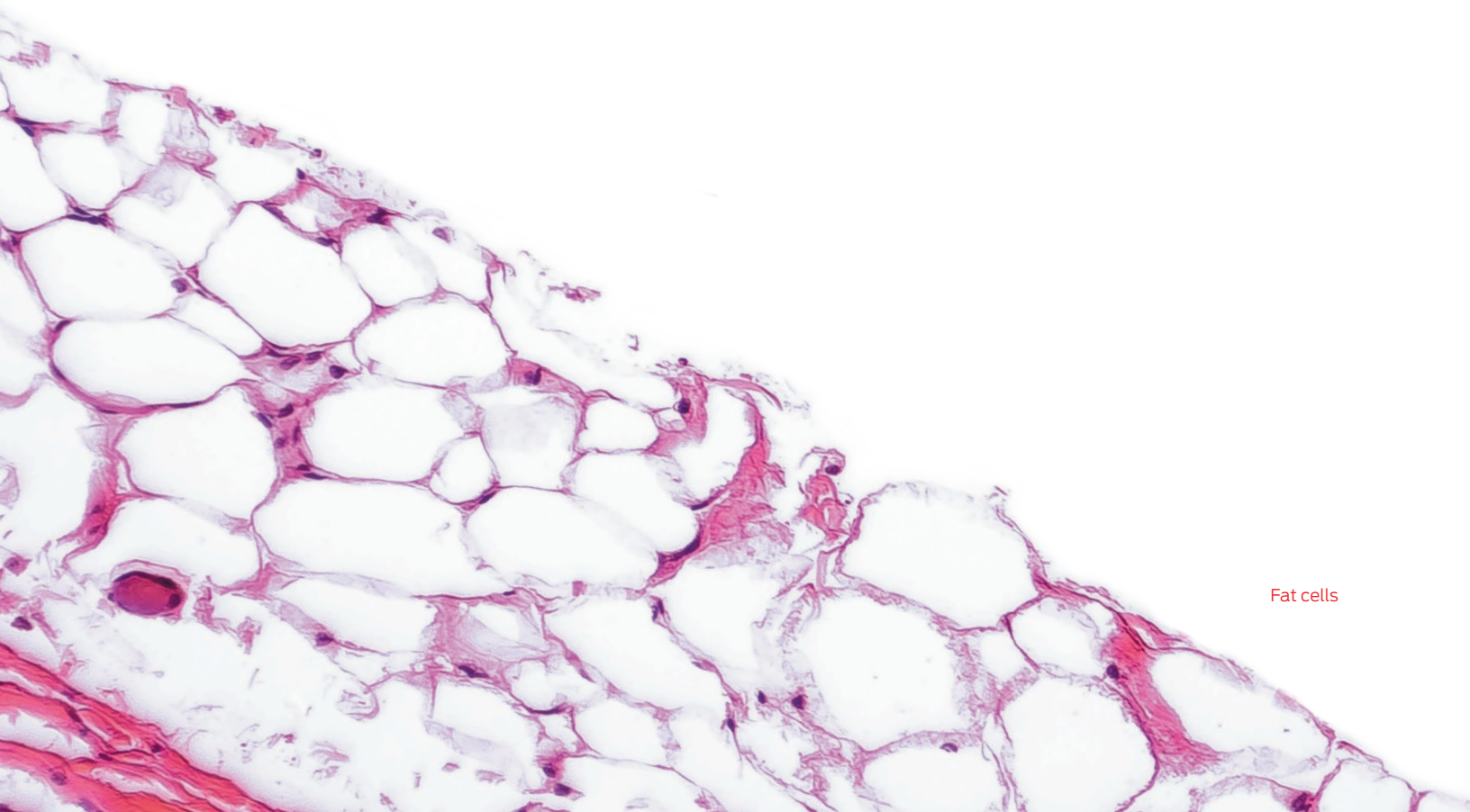
OBESITY IN PETS:

Nutritional and Behavioral Strategies for Preventing and Managing Excess Weight

FAT CELLS



An obese or overweight body condition occurs when energy intake exceeds energy expenditure on a chronic basis, resulting in an excessive deposition of lipids in white adipose tissue. An obese or overweight body condition adversely affects a pet's quality of life due to an increased risk of many chronic diseases, including osteoarthritis and feline diabetes, and has been shown to reduce longevity.¹⁻⁶ Despite the serious health consequences of obesity, research shows that pet owners often do not perceive their pet's weight as a problem.⁷⁻¹¹ In addition, many veterinarians find it challenging to talk with clients about their pet's weight.¹² However, effectively communicating the significance of maintaining a healthy body condition and the role of nutrition in preventing and managing weight gain can help dogs and cats lead better, and importantly, longer lives.¹²



Fat cells

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DEFINITION & DIAGNOSIS

The World Health Organization defines obesity in humans as an excess of body fat frequently resulting in adverse health effects. A body mass index (BMI, a measure of body fat in adults calculated based on height and weight) greater than 25 is considered overweight, and a BMI over 30 is considered obese in humans.¹³ There is no agreed-upon quantitative definition of obesity in pets, with a body weight such as 20, 25, or 30% above ideal body weight cited.^{11,14-16} However, while it is useful to monitor body weight, weight is just one component of a healthy body condition. The variation within breeds, especially mixed breeds of dogs, makes it difficult to assign one number that defines an individual pet's ideal weight. In addition, body weight can remain the same while fat mass increases and lean body mass decreases.

Body Condition Score

A widely accepted and practical method of assessing excess adiposity in dogs and cats is the body condition score (BCS) system.¹⁵⁻²⁰ The BCS system is a subjective and semi-quantitative method that uses visual and palpable characteristics to assess body fat and estimate a pet's optimal body weight, regardless of breed or body size.

Purina scientists developed a 9-point Body Condition Score system for dogs¹⁷ and cats¹⁸ that is currently recommended for use by the World Small Animal Veterinary Association (WSAVA). The tools were independently validated in published, peer-reviewed studies and are now used by veterinarians worldwide.¹⁹⁻²¹ (See Appendix for Purina Body Condition Score Charts.)

The ideal body condition is defined as a visible waist (when viewed from above) and abdominal tuck (side profile), and easily palpated ribs.

For dogs, the ideal BCS is 4-5.

For cats, an ideal BCS is 5.

Each point above the ideal BCS represents a 5 to 10% excess in body fat and 10 to 15% excess weight.^{17,18,20} Pets with a BCS of 8 or 9 are considered obese.

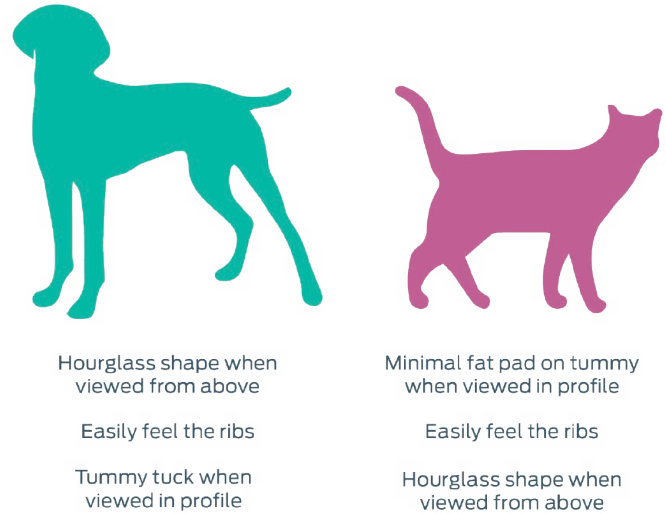


Figure 1:
Ideal body condition in dogs and cats

Muscle Condition Score

In addition to assessing body condition score, evaluating a pet's muscle mass is important to help account for losses of lean body mass that may occur even in overweight pets.²² The WSAVA muscle condition score (MCS) system, which has been validated in published, peer-reviewed research, provides a tool to assess for loss of muscle mass.^{22,23} Based on visual assessment and palpation, muscle mass is rated as normal, or as mild, moderate, or severe muscle loss.

Lean body mass includes skeletal muscle and organs—essentially everything except fat. Maintaining lean body mass is important for overall health.^{1,2} Lean body mass serves as an amino acid reservoir from which dogs and cats can build the proteins that are essential components of every cell, including immune cells, red blood cells, and hormones. Importantly, lean body mass also accounts for 95% of an animal's metabolic rate (the rate at which calories are used by the body).^{24,25} A higher percentage of lean body mass, compared to fat, generally increases a pet's basal energy metabolism.²⁶

If a pet is identified as overweight or obese, underlying medical conditions that may affect the pet's body weight, such as hypothyroidism, should be ruled out. Implementation of a weight management program may need to consider comorbid conditions.

PREVALENCE

Obesity is a disease of global significance. In some populations, the prevalence of veterinary-diagnosed overweight and obese animals has been cited as up to 65% in dogs and up to 63% in cats.^{7,8,27-45} As in humans, the prevalence of obesity in pet dogs and cats is rising.^{16,31,46-48}

ETIOLOGY & RISK FACTORS

Many factors may influence the development of an overweight or obese body condition in dogs and cats:

- **Genetic predisposition to weight gain.** Dogs reported to be at greater risk of being overweight or obese include Labrador Retrievers, Golden Retrievers, Cocker Spaniels, Dachshunds, Dalmatians, Shetland Sheepdogs, Rottweilers, and Beagles, as well as mixed breed dogs.^{11,39,41,42,49} Cats at greater risk include mixed breeds, Manx, British Shorthair, Norwegian Forest Cats, and Persians.^{11,30,32,34,50}
- **Age.** Middle-aged pets are more likely to be overweight or obese than young, senior, or geriatric pets.^{11,29,30,32,34,41,51} However, being overweight or obese in puppyhood or kittenhood may increase the risk as an adult.⁵² Kittens with a faster growth rate between 3 months and 1 year of age due to *ad libitum* feeding were more likely to be overweight as adults.⁵³
- **Sex and neuter status.** Research has shown an increased risk of overweight and obese body conditions in male cats and female dogs.^{11,29,30,34} In both species and

sexes, neutering increases the risk of weight gain.^{11,29,30,32-34,41,49,50,54-58} One study found 38% of neutered dogs were overweight or obese compared to approximately 25% of intact dogs.⁴¹

Research has shown that after neutering, dogs and cats increase food intake, thus energy intake.^{52,54,59-64} The increased risk of becoming overweight or obese after neutering may be related to the decrease in levels of sex hormones, especially estradiol, a hormone that has an inhibitory effect on appetite.⁵² Some studies have reported that dogs and cats expend less energy after neutering,^{54,55,57,61,65,66} while other research has not.^{62,63} Results may vary due to differences in methodology (e.g., use of indirect calorimetry, level of food restriction necessary to maintain body weight, or level of physical activity as measures of energy expenditure), and questions remain as to whether and how much a change in energy expenditure is a factor.⁵⁹ However, if neutering occurs during puppyhood or kittenhood when the growth rate has plateaued, it will coincide with a natural reduction in the pet's energy needs.^{47,67}

Levels of sex hormones may also affect physical activity, but data in pets is very limited.⁵² One study in female cats that had gained weight after neutering found changes in expression of genes involved in lipid metabolism, although whether this was a cause or effect of the weight gain was not determined.⁵⁴

- **Environment and activity levels.** As humans are leading more sedentary lifestyles,¹³ so, too, are pets. Many dogs and cats live inside and are fed meals and treats on a regular basis, resulting in reduced metabolic demands versus those of a dog or cat living outside and hunting for food.⁶⁸ Research has shown an increased risk of excess weight in dogs who exercise infrequently^{56,58} and in cats that live indoors.^{15,32,50}
- **Excessive caloric intake.** Feeding guidelines on commercial pet foods are based on pets' average energy requirements, which may differ from an individual pet's needs and can result in overfeeding by the owner.⁴⁷

Energy density of food varies widely. Since gram for gram, fat has approximately twice the calories as protein or carbohydrates, consuming a high-fat diet is a risk factor for becoming overweight or obese. A study found a high-fat diet, but not a high-carbohydrate diet, led to weight gain in cats.⁶⁹ Fat also typically enhances palatability, thus if fed *ad libitum*, the risk of overeating a high-fat diet rather than other diets is higher.

Since the addition of water dilutes the energy density of a food, cats fed wet food consumed fewer calories and lost weight compared to when fed the same wet food in a freeze-dried form.⁷⁰ Some research has suggested a dry food diet as a risk factor for becoming overweight or obese.^{15,29} Dry food typically has a higher energy density, as fed, than wet food.⁷¹ Owners may overfeed dry food if feeding *ad libitum* or, if meal-feeding, by not measuring accurately.^{15,29,47} However, other studies have found no association with food type.^{7,27,28,41}

Pets may have an “overeater” phenotype, while others may have a “grazer” phenotype.⁷² If fed *ad libitum*, those pets with an overeater phenotype will be more likely to consume excess calories.⁷² Some pets are also more likely to exhibit begging behavior or to steal food, increasing the risk of excessive caloric intake.⁷³ In multi-cat households, stress and other group dynamics may result in altered behaviors such as overeating when group-fed.⁷²

■ **Owner beliefs and behaviors.** Pet owners themselves influence the development of excess weight in their pets.^{51,74-76} Surveys have found that owners of overweight or obese pets were more likely to watch them during mealtime, give them table scraps or treats,^{51,56,74} and interpret any attention-seeking behavior as begging for food.⁷⁴ A study found that owners who exhibited a high degree of attachment towards their dogs provided more treats and interacted more, which was associated with a higher body condition score.⁷⁶ Pet owners may not measure or may inaccurately measure their pet’s food and thus overfeed.⁷⁷

The manner in which an owner feeds their pet may play a role, although research findings have been inconsistent.

Some research has found that owners of overweight or obese cats were more likely to feed *ad libitum* rather than meal feed,^{33,51} while a survey of Australian dog owners reported dogs fed once a day were at higher risk of obesity.⁵⁶

An association has been demonstrated between overweight or obese owners having overweight or obese pets.^{74,78}

Pet owners may understand the health risks associated with excess weight,⁷⁷ but may simply fail to recognize the condition in their own pets. Research has shown that pet owners often underestimate their pet’s body condition.^{7,11,27,28,51,72,79,80}

ADVERSE EFFECTS OF OBESITY

White adipose tissue does more than simply store excess energy; it is also an active endocrine organ.^{46,81,82} Adipocytes and other cells in white adipose tissue secrete hormones, cytokines, and other protein factors, known as adipokines. Adipokines have a variety of functions, including regulation of appetite and the inflammatory pathway.^{6,46,81,82}

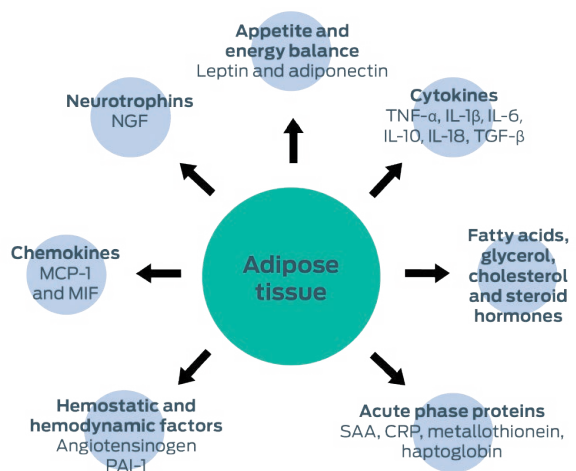


Figure 2: Various adipokines secreted by adipose tissue. TNF-α = tumor necrosis factor-alpha; IL = interleukin; TGF-β = transforming growth factor-beta; SAA = serum amyloid A; CRP = C-reactive protein; PAI-1 = plasminogen activator inhibitor-1; MCP-1 = monocyte chemoattractant protein-1; MIF = macrophage migration inhibitory factor; NGF = nerve growth factor

Adipokines of particular importance in obesity include the hormones leptin, adiponectin, and resistin; and inflammatory cytokines, such as tumor necrosis factor-alpha (TNF-α). Leptin influences energy expenditure and appetite and is considered pro-inflammatory. Normally, plasma levels of leptin rise after a meal and induce a feeling of satiety to stop eating. Adiponectin potentiates insulin signaling and is anti-inflammatory.^{46,83,84}

Research has shown that secretion of adipokines is altered in obesity. In human studies on obesity, blood levels of inflammatory cytokines are systemically elevated.⁸⁵ Similarly, research by Purina, as well as others, has shown that obese dogs and cats have increased concentrations of leptin and other inflammatory adipokines when compared to lean animals.^{54,83,84,86-89,95} This causes, among other effects, a long-term, low-grade inflammatory state in the body.⁸¹

The chronically elevated levels of leptin seen in obesity are thought to induce leptin resistance, in which leptin's effects on curbing appetite are blunted.^{6,46,84,89,90} Research has shown that adiponectin levels are typically reduced in obese humans and cats, but in obese dogs, results have been inconsistent.^{54,83,84,87,88,91,92,95}

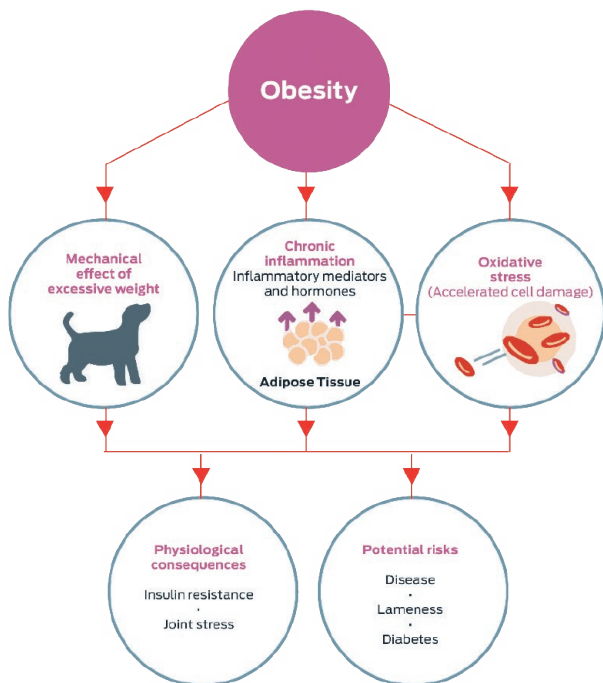


Figure 3:
Adverse effects of obesity

Since adipose tissue is a source for these inflammatory compounds, elevated levels of inflammatory adipokines appear to be the link between obesity and many weight-related diseases.^{5,6,84}

Research has also shown that obesity is associated with a greater production of free radicals, which leads to increased oxidative stress. Oxidative stress contributes to tissue damage that also plays a role in the development of many diseases.^{93,94}

It has been demonstrated that many of these adverse effects can be reduced or reversed with weight loss.^{86,88,91,95,96}

Diseases commonly associated with an overweight or obese body condition in dogs and cats include:

- **Osteoarthritis.** Osteoarthritis affects one in five adult dogs.^{97,98} This painful and progressive condition can reduce a pet's mobility and quality of life. It is the most common obesity-related condition for dogs, due to a combination of mechanical (the stress placed on the skeletal system by excess weight), metabolic, and biochemical factors.^{99,100}

In a landmark Purina 14-year longevity study, researchers monitored the health of 48 Labrador Retrievers from puppyhood throughout their lives.¹ The results showed that dogs fed to maintain a lean body condition from puppyhood throughout life had significantly less osteoarthritis.^{1,101,102}

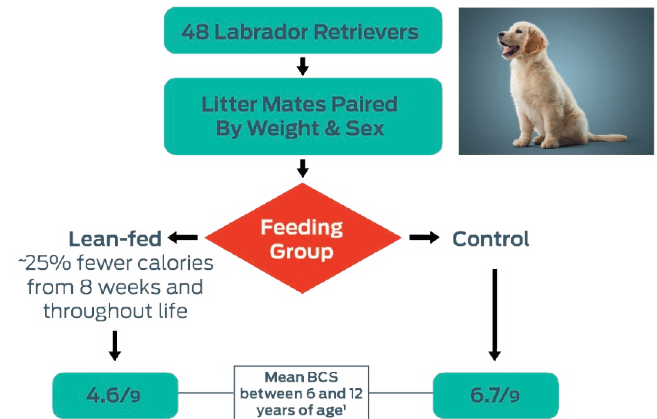


Figure 4:
Purina longevity study

In the Purina study, findings included:

- By two years of age, the lean-fed dogs had half the frequency of hip dysplasia than dogs in the control group, and the hip dysplasia was much less severe.¹⁰³

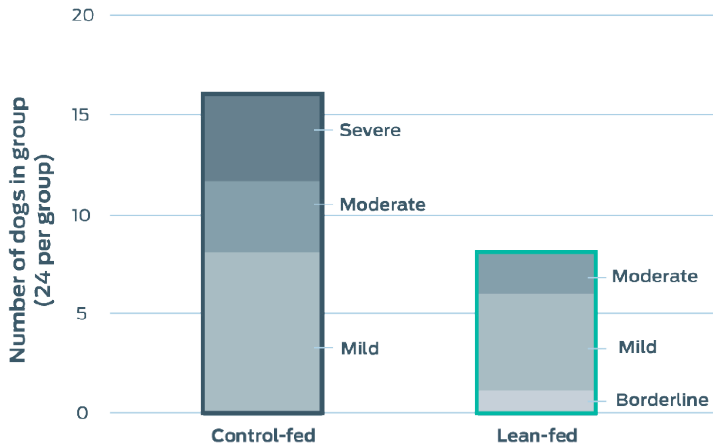


Figure 5: Severity of hip dysplasia at 2 years of age (OFA method)¹⁰³

- At 8 years of age, lean-fed dogs had a lower prevalence of osteoarthritis in multiple joints. Forty-five percent of control-fed dogs had radiographic evidence of osteoarthritis in 2 joints compared to only 5% of lean-fed dogs. Thirty-two percent of control-fed dogs had radiographic evidence of osteoarthritis in 3 joints versus only 5% of lean-fed dogs.¹⁰¹
- The mean age at which 50% of the dogs in each group first required long-term treatment for osteoarthritis was significantly later for the lean-fed group than for the control-fed group.¹

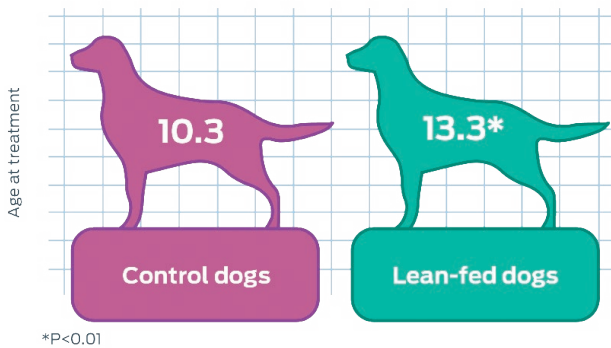


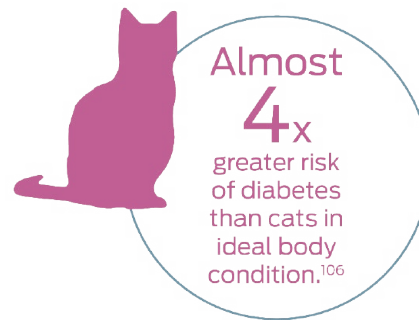
Figure 6: Mean age at which long-term treatment of osteoarthritis was initiated¹

- Lean-fed dogs not only lived on average 15% longer,¹ but only 50% of the lean-fed group ultimately had radiographic signs of hip osteoarthritis compared to 83% of control-fed dogs.¹⁰²

Additional research has shown that weight loss in overweight and obese dogs with osteoarthritis improved lameness scores.^{100,104}

In cats, an association between excess weight and degenerative joint disease is not as clear.¹⁰⁵ A prospective study of 1,457 cats found that overweight and obese cats were at higher risk (nearly 5 times the risk for obese cats) of being presented to a veterinarian for lameness. However, the study did not identify a cause for the lameness.¹⁰⁶ Another study in cats found no association between weight and the prevalence of degenerative joint disease.¹⁰⁷

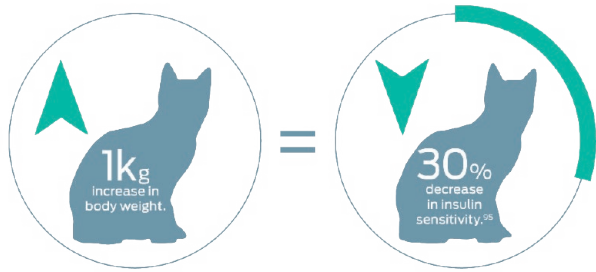
- **Diabetes mellitus.** Obesity is the most recognized risk factor for type 2 diabetes in cats.



In healthy cats, pancreatic beta cells secrete insulin in response to elevated glucose levels in the bloodstream. Insulin stimulates cells to take up and utilize glucose and/or store excess glucose in the liver as glycogen. In type 2 diabetes, cats develop insulin resistance in which the cells are not as responsive to insulin. The pancreatic beta cells thus continue to secrete insulin. However, eventually the beta cells fail to compensate, and hyperglycemia persists.

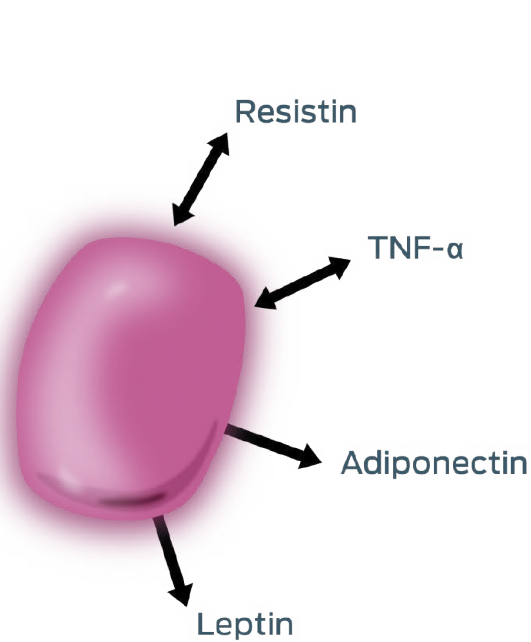
Obesity causes insulin resistance in cats.^{14,95,108}

Research has shown:



Diabetes in dogs is typically more similar to type 1 diabetes in people in which the underlying cause is often an autoimmune condition that destroys pancreatic beta cells. While obesity does not appear to be a direct risk factor for canine diabetes, insulin resistance has been reported in overweight and obese dogs and can make canine diabetes more difficult to manage.¹⁰⁹

Since the adipokines leptin, resistin, and TNF- α decrease insulin sensitivity in many tissues, they likely play a key role in the development of glucose intolerance, with adiponectin having the reverse effect.^{6,84,91,95}







-  Resistin
 - Insulin resistance
 - Upregulates the inflammatory response
-  TNF- α
 - Inflammatory mediator
 - Insulin resistance
-  Adiponectin
 - *Inversely* proportional to adiposity
 - Potentiates insulin signaling
 - Less adiponectin = more insulin resistance
-  Leptin
 - Regulates appetite
 - Obese individuals become resistant
 - Insulin resistance

Figure 7:

Adipose tissue acts as an endocrine organ. Response and effects of selected adipokines in obesity are shown.

■ **Cardiorespiratory disease.** Although obesity is not a primary risk factor for developing heart disease in dogs or cats, research has shown that a higher degree of intra-abdominal fat is linked with a higher incidence of heart disease in dogs.¹¹⁰ Overweight dogs can also have the following:¹¹¹

- higher resting heart rates and systolic blood pressure
- more inflammatory markers in their blood, a condition associated with heart disease
- abnormal thickness of the heart's left ventricle

Similar data are not available for cats. However, the links between obesity and feline diabetes and between feline diabetes and heart muscle dysfunction suggest an indirect association.^{112,113}

In dogs and cats, obesity can compromise respiratory function.¹¹⁴⁻¹¹⁶ In addition, excess weight may increase the risk for development of tracheal collapse in small dogs and can worsen laryngeal paralysis and brachycephalic airway obstruction syndrome.^{116,117}

■ **Other conditions.** In pets, obesity has also been linked with urinary disorders,^{29,34,41} hepatic lipidosis (cats),^{14,46} oral disease,³⁴ skin conditions,^{16,34} and neoplasia.¹⁶

ENERGY REQUIREMENTS IN DOGS & CATS

Maintenance Energy Requirement (MER) is the amount of energy expended by a moderately active adult animal per day. Energy requirements of animals are more closely related to their metabolic body weight, which is based on body surface area, than to their total body weight in kilograms or pounds.¹¹⁸

Numerous equations are available to estimate MER. Each equation may yield a different estimate, but all are based on the needs of an “average” dog or cat. However, individual

pets' needs can vary, based in part on age, gender, neuter status, lifestyle/activity, and individual metabolism. Cat needs, and cat aging, in particular, are highly variable. While adult cats show a decrease in energy requirement up to about 12 years, energy requirements for cats over 12 years of age may increase due, at least in part, to a reduced ability to digest fat and protein.¹¹⁹

OBESITY PREVENTION

Preventing obesity is key to helping pets live longer, healthier lives. The Purina 14-year longevity study showed that puppies fed to maintain a lean body condition from puppyhood throughout life (the lean-fed group) had a longer lifespan than the control-fed group (median of 13 years versus 11.2 years).¹ Dogs in the lean-fed group were first treated for a chronic condition significantly later in life on average than the control-fed group.¹ A slower decline in immune status was also found in the lean-fed group.¹²⁰

Tactics to help prevent dogs and cats from becoming overweight or obese include:

- A nutritional assessment should be performed on every pet at every veterinary visit.^{12,122} The pet's complete dietary history, including everything (e.g., commercial or homemade pet food, raw food, human food [e.g., table scraps or food used to administer medications], and treats) the pet eats in a day and the brand names of food and treats, should be obtained. The use of open-ended inquiries to start a dietary history discussion with a pet owner rather than questions to be answered with a simple “yes” or “no,” can aid in this process.¹² The pet should be fed a complete and balanced diet appropriate to their needs, e.g., life stage and lifestyle.^{12,122}
- Feeding the correct diet in the appropriate amount is essential. Pets should be fed to maintain ideal body condition. Estimates of MER (which provides a “daily calorie allowance”) or feeding recommendations on pet food labels based on the pet's weight can provide a starting

guideline for how much to feed. However, the quantity of food should be adjusted based on monitoring of body condition and weight to meet an individual pet's needs.⁴⁷

To ensure accuracy in measuring, the owner should ideally use a gram scale to measure food. Research has shown that the use of a 250 ml/8 oz. measuring cup to dispense food, while perceived as more convenient, may be inaccurate, with smaller portion sizes being the most inaccurate.^{47,123} Research has also reported that scoop and food bowl size are positively correlated with the amount of food provided to the pet.^{124,125} Thus, using smaller food bowls may help guard against overfeeding.

- In a multi-pet household, to prevent one pet from consuming excess calories by eating another pet's food, owners should feed pets separately or use an alternative feeding system such as a "smart bowl," which restricts access to an individual pet.
- For pets that eat rapidly, meals can be provided in puzzle feeders (commercial or homemade) to help slow the rate of eating which gives more time for satiety signals to reach the brain. Puzzle feeders also provide environmental enrichment.⁴⁷
- Owners should be counseled to limit treats to no more than 10% of the pet's daily caloric intake. The amount of food should be reduced to account for the treats.⁴⁷ If the pet is fed a dry kibble, the owner can utilize a portion of this as treats.
- Regular exercise should be encouraged to promote energy expenditure.

If prevention is not successful and the pet gains excess weight, the weight gain typically occurs gradually and thus may be overlooked by the owner and, potentially, the veterinarian. Recommendations to detect weight gain early when it is more easily addressed include:⁴⁷

- A pet's body weight should be recorded at every veterinary visit and monitored over time. (The use of a "smart device" [e.g., a device placed under a litterbox which weighs the pet] or baby scale by the owner may aid in monitoring

weight in cats who can be more challenging to bring into the veterinary office on a frequent basis.) Thus, a pattern of changes in weight can be identified and addressed.

- Teaching the pet owner how to perform BCS evaluations facilitates monitoring of body condition between veterinary visits. Although studies show that owners tend to underestimate the condition of their pet,^{7-11,27,28,51,72,79,80} some research has indicated that pet owners are better able to correctly identify BCS using an illustrated BCS chart rather than when using word descriptions of body condition.^{7,121}

WEIGHT LOSS STRATEGIES

During development of a weight loss plan for an overweight or obese pet, MER can be calculated based on the pet's current body weight or on target body weight (estimated based on current weight and BCS).¹²⁶ Online calculators for [dogs](#) and [cats](#) can be utilized. When making MER recommendations, it is important to note that drastic calorie restriction increases the risk of creating nutrient deficiencies, so obese pets should be monitored closely during weight loss.^{67,126,127} An alternative approach to making a recommendation based on MER calculations is to reduce current caloric intake, if a complete diet history is known.¹²⁶ Regardless of the method used to determine daily calories, calculations are estimates, and adjustments will likely be needed to achieve desired weight loss. (See further discussion under Partnering with Pet Owners & Understanding Their Motivations & Behaviors.)

Rather than rapid weight loss, gradual loss, i.e., 1-2% of body weight per week for dogs and 0.5% up to 1-2% of body weight per week for cats, helps maintain lean body mass and mitigate rebound weight gain.^{14,67,128,129} Rapid weight loss in cats should also be avoided since it puts cats at risk of developing hepatic lipidosis.^{67,92} Due to this risk, it is essential to counsel cat owners to report immediately if their pet is refusing to eat the recommended diet for weight loss.

A therapeutic weight loss diet, formulated to provide complete and balanced nutrition with less caloric impact,⁶ may be preferable to feeding a smaller amount of the pet's current food, as restricting maintenance diets may result in an inadequate intake of essential nutrients^{6,130} and may also leave the pet unsatiated leading to food-seeking behaviors.⁶⁷ If a pet owner elects to feed a homemade diet, a consultation with a board-certified veterinary nutritionist should be recommended to ensure a complete and balanced diet is fed. Many published recipes are nutritionally inadequate.^{131,132}

The same environmental modification strategies utilized for preventing weight gain are used for weight loss, including accurate measurement of food, feeding pets in multi-pet households separately, meal feeding, and utilization of puzzle feeders.^{67,73}

A study of calorie-restricted cats that were changed from *ad libitum* feeding to two restricted meals a day showed that even mild dietary restriction can dramatically affect cats' feeding behaviors (leading to more food-motivated activity, gulping rations, acting more aggressively to other cats). The behaviors resolved with a return to free feeding.¹³³ Such calorie-related changes may impact owner perceptions about the cat's well-being. This study supports feline weight loss recommendations to divide the day's daily ration into multiple small meals to be fed at intervals throughout the day. Utilizing puzzle feeders or other methods to slow the rate of eating, e.g., hiding food around the house, may help provide mental stimulation and increase activity.¹³³

An increase in exercise, e.g., via walks for dogs, play sessions, climbing perches or "trees" for cats, helps the pet expend more calories, to help energy expenditure exceed energy intake.^{14,67,73} Creative exercise options, e.g., teaching a cat to walk on a leash or on a treadmill, may be successful. Dogs may be amenable to using treadmills or to swimming.^{14,47} However, the form of exercise should be appropriate for the pet and the pet's life stage. Any limitations on exercise imposed by comorbid conditions

should be considered.⁴⁷ Exercise also helps the pet maintain lean body mass during weight loss and provides environmental enrichment as well as opportunities for pet-owner bonding that do not include food.

Increased activity may allow for less reduction in energy intake in a weight loss program. A Purina-funded study found that active dogs were able to consume more calories than inactive dogs while still losing weight.¹³⁴

PARTNERING WITH OWNERS & UNDERSTANDING THEIR MOTIVATIONS & BEHAVIORS

Veterinarians are often reluctant to discuss excess weight with pet owners. They may find it to be a difficult subject, or worry about offending the owner.^{11,12} However, initiating the discussion is the first step in helping the pet.

Pet owner motivations and behaviors that contributed to the pet becoming overweight or obese (see earlier discussion under Etiology & Risk Factors) must first be understood in order to design an effective weight loss strategy.^{12,79,80} Owner beliefs and behaviors also can affect an owner's ability to recognize the pet's excess weight, and subsequently, how ready and motivated the owner is to change their behavior(s).⁷⁹

The transtheoretical model of change, one of many behavior models, identifies the following stages of readiness:^{12,79}

- **Precontemplation.** The pet owner has not recognized or may refuse to recognize that the pet is overweight or obese. The owner is not prepared to change behavior. This is the time to introduce the idea of obesity as a disease.
- **Contemplation.** The pet owner has recognized or accepted that the pet is overweight or obese and is thinking about ways to address the excess weight within the next 6 months. This is the time to offer help when the owner is ready.

- **Preparation.** The pet owner is ready to act within the next month. This is the time to implement a weight loss plan.
- **Action.** At this stage, the pet owner has made a change or multiple changes in behavior to help their pet lose weight. To be successful, the weight loss strategy must provide a complete and balanced diet while reducing calories by at least 10-15%. Encouragement and celebration of success may be needed to keep the pet owner in the action stage.
- **Maintenance.** Once the target weight is achieved, the pet owner is continuing the changes in behavior to protect against weight regain. Ongoing encouragement is important at this stage as well.

Recognizing where the owner is along the continuum of changing a behavior, especially through the first 3 stages, helps guide further discussion with the owner.¹² Purina research showed that although owners of overweight and obese dogs were likely to underestimate their pet’s body condition score, they were also more likely than owners of lean dogs to think about their dog’s weight and to think that their pet was not fit.⁷⁹ Asking the pet owner open-ended questions, such as to describe the pet’s daily activities and changes in mobility or “fitness,” may reveal concerns about the pet’s weight that were not immediately evident. In turn, the pet owner may be more receptive than they initially appeared to be regarding a weight loss plan for the pet.⁷⁹ If, however, an owner is in the action stage, but the pet has not yet lost weight, a discussion about alternative weight loss strategies is warranted before the owner becomes discouraged and the weight loss attempt is discontinued.

Research with owners of overweight dogs has suggested that a variety of behavior modification strategies can lead to successful weight loss in pets.^{11,47,73,76,135} Since an effective approach to behavior modification for one owner may not be effective for another, counseling may need to differ among owners. Weight management plans should be tailored to the needs of the individual pet and owner to have the best chance of success.

Strategies may involve helping pet owners set attainable goals. In severely obese pets, to avoid a drastic decrease in calories at one time, a weight goal or goals between the current and target weight may be set. Multiple smaller goals can help keep pet owners motivated and engaged.¹⁴ “If/then help sheets” may be a useful tool. The help sheets involve, in collaboration with the pet owner, identification of “if” scenarios most likely to disrupt progress of weight loss with “then” responses.^{73,77,135,136}

Examples of common “if/then” scenarios and responses:

- If pet will not eat the weight loss diet, try another diet.
- If pet is perceived to be food seeking, start a play session.
- If giving treats is very important, offer low-calorie options, e.g., restricted calorie treats or vegetables such as beans or cauliflower.

Research has suggested that a clear understanding of the weight management plan (feeding management and how much to exercise) by the owner is key to whether a pet loses weight.¹³⁶ This includes an appreciation of the commitment involved in the weight loss plan and that weight loss will be a gradual process.⁷⁹ The research also suggests that support from friends can help motivate owners.⁷⁹

Frequent rechecks of body condition, weight, and muscle condition are crucial to assess progress, ensure compliance, make any necessary adjustments (e.g., to the diet or amount of food or to exercise strategies), and to encourage the owner. Research has shown that as a pet loses weight, energy needs may decrease and require an adjustment of the daily calorie allowance.^{46,67,128,129,137-140} Over time, the rate of weight loss may slow,^{137,140-142} which can make compliance progressively more difficult.

Research has demonstrated that only about 50-60% of overweight or obese pets reach their target weight.¹⁴¹⁻¹⁴⁴ Pets, owners, or both may be non-compliant with a weight loss plan, e.g., pets may refuse the new diet, owners may find it difficult to increase exercise.^{143,144} Detecting and addressing these issues early through frequent rechecks (examinations and by phone or email) can help a weight loss program succeed.

The pet's lower energy needs also increase the risk of weight rebound after weight loss is achieved.^{128,137} Approximately half of the pets that successfully lose weight regain at least a portion of the weight.¹⁴⁴⁻¹⁴⁶ Studies have shown that cats under 9 years of age and dogs that are switched from a therapeutic weight loss diet to a maintenance diet after weight loss are more likely to regain weight. Cats that lose weight are more likely than dogs to regain more than half of the weight lost.^{145,146} To help prevent weight rebound, the therapeutic weight loss diet may be continued, and regular monitoring of the pet's body condition, weight, and muscle condition should continue.^{47,128}

To increase the likelihood of success:

- Weight management plans for pets should incorporate nutrition, exercise, and an understanding of the interaction between pet and pet owner.
- Compliance increases when plans are tailored to suit each individual pet, owner, and environment.
- Understanding the complex and unique connection between owners and their pets helps build long-term client trust.

THE ROLE OF NUTRITION

Since fat is more calorically dense than carbohydrates or protein, weight loss strategies have often focused on feeding low-fat diets. However, other dietary nutrients also play an important role in successful and sustainable weight loss.

Protein

Since a higher percentage of lean body mass, relative to fat, generally increases basal energy metabolism, maintaining lean body mass during weight loss can help prevent weight regain.^{26,128,147-149} Research has shown that increasing dietary protein levels can help overweight pets lose more weight as fat and less as lean body mass.^{95,138,147,148,150}

In one study, overweight dogs were fed low-calorie diets that differed in protein levels, containing 20%, 30%, or 39% protein (on a metabolizable energy basis). Dogs were fed to achieve a loss of 1% body weight per week until each dog reached an ideal body condition score.

The overweight dogs fed the 30% or 39% protein diets lost approximately half as much lean body mass and more fat mass than the dogs fed the 20% protein diet.¹⁴⁷

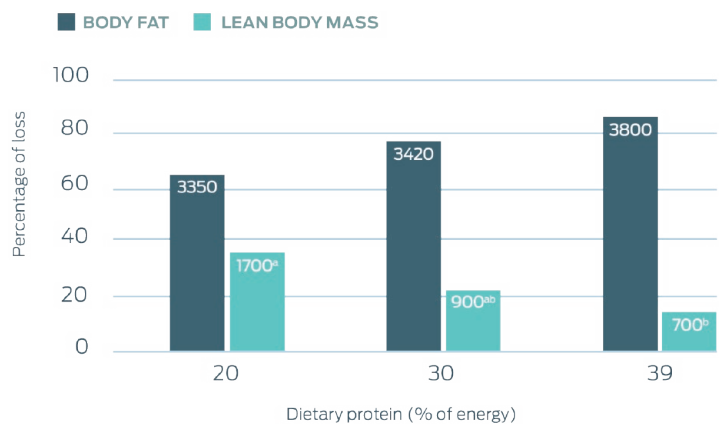


Figure 8:

Protein reduces loss of lean body mass and increases fat loss. Numbers within bars indicate grams of tissue loss. Different superscripted letters indicate statistically significant differences between diets ($P \leq 0.05$).¹⁴⁷

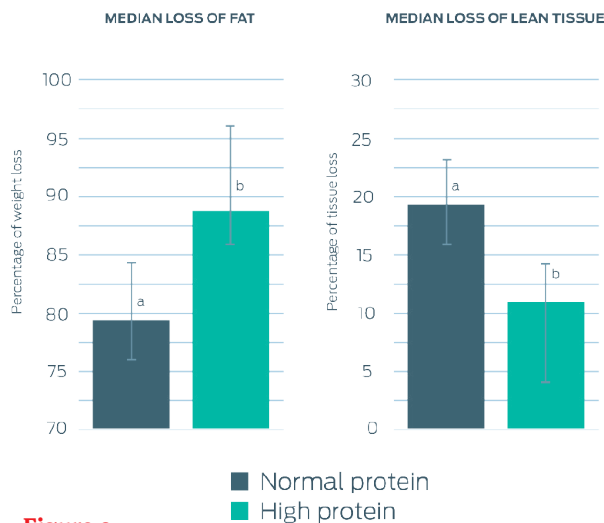


Figure 9:

Changes in body composition in cats fed 35% or 45% protein (on metabolizable energy basis) diet for weight loss. Different letters above the bars indicate statistically significant differences between diets ($P=0.014$).¹⁴⁸

In a feline study, obese cats were fed low-calorie diets that differed in the amount of protein (35% versus 45% of metabolizable energy). Cats were fed to achieve a loss of 1% body weight per week. Cats in both groups lost comparable amounts of total weight. However, compared with cats fed the 35% protein diet, the cats fed the 45% protein diet lost significantly more weight as fat and less as lean body mass.¹⁴⁸ Additional research also found that obese cats fed a high-protein diet lost more fat mass than those fed a low-protein diet.⁹⁵

A high-protein diet may also mitigate the decrease in energy expenditure that occurs after weight loss, perhaps due to the higher thermogenic effect of protein compared to carbohydrate and fat.^{138,151,152}

- Energy expenditure on a body weight or lean body mass basis decreased after weight loss in obese cats fed a moderate-protein diet but did not in cats fed a high-protein diet.¹⁵⁰ Even when obese cats were fed *ad libitum* (i.e., not for weight loss), energy expenditure was lower in cats fed a moderate-protein diet compared to cats fed a high-protein diet.¹⁵³
- While losing weight at the same rate, obese cats fed a high-protein diet initially consumed more calories than obese cats on a control weight loss diet. Once weight loss goals were met, all cats were fed an energy-restricted diet to maintain target weight. Over time, cats fed the high-protein diet during the weight loss period

consumed more calories than control cats. Higher energy intake, while initially losing weight and subsequently maintaining weight over the long term, reflects higher energy expenditure in cats fed the high-protein diet for weight loss.¹³⁸ Thus, by allowing less energy restriction, high-protein diets may help prevent weight regain in addition to allowing more calories to be consumed during the weight loss period.

A high protein diet during weight loss may:



A study suggested that feeding a high-protein diet could improve satiety in overweight and obese dogs by mitigating leptin resistance.⁹⁰ Levels of the pro-inflammatory C-reactive protein and interleukin-6 were significantly better in obese cats that lost weight while fed a high-protein low-calorie diet versus obese cats that lost weight while fed a high-carbohydrate low-calorie diet.⁹⁴ The cats fed the high-protein diet also displayed reduced oxidative stress after weight loss.⁹⁴

Dietary Fiber

Fiber is the fraction of a carbohydrate that cannot be broken down by the body's digestive enzymes. It can be classified as either soluble or insoluble, which simply describes whether it can dissolve in water. Many natural fibers contain a mixture of soluble and insoluble components.¹⁵⁴

Fiber adds very little usable energy (i.e., calories) to the diet, thus it can be used to reduce the overall metabolizable energy content of a diet.^{6,14,145} Additionally, dietary fiber may support weight management by improving satiety.^{6,14,47,140,155-157} Satiety is a physiologic state during or after eating in which hunger and appetite are inhibited. Unlike people, pets cannot report feeling "full." Thus, in feeding studies, hunger or satiety in pets is measured by changes in voluntary food intake.^{156,157}

In one study, dogs were fed either a low-fiber diet (2% crude fiber) or a high-fiber diet (9% crude fiber) during the morning feeding. During the afternoon feeding, both groups were fed an unrestricted amount of the control diet and were allowed to eat until their appetite was satisfied. Total daily calorie intake was significantly lower for dogs fed the high-fiber diet compared to low-fiber.¹⁵⁶

In other research evaluating the combination of high fiber and high protein, dogs fed a diet high in fiber and protein were more satiated than dogs fed a high-fiber diet or a high-protein diet.¹⁵⁵

Carnitine

Carnitine is an amino acid derivative that transports long-chain fatty acids (LCFAs) into mitochondria to allow oxidation and to produce energy.



This key role in energy metabolism makes this substance beneficial in weight management. Although it is produced endogenously so long as protein intake is adequate, food and calorie restriction can lead to reduced protein intake and may compromise carnitine biosynthesis.

One study found that obese Labrador Retrievers had significantly lower plasma carnitine levels compared to lean Labrador Retrievers. However, whether the low carnitine levels contributed to or resulted from obesity could not be determined.¹⁵⁸ Research has indicated that carnitine supplementation may help dogs preserve more lean body mass during weight loss,¹⁵⁹ and enhance metabolism and weight loss in cats.^{160,161} The relative role of increased protein versus carnitine supplementation for this benefit has not been explored.

Soy Isoflavones

Soy isoflavones are natural compounds with antioxidant activity that can aid in canine weight management. In humans, research shows that isoflavones may have a number of benefits, from helping to protect against certain kinds of cancers¹⁶² to lowering cholesterol, body weight, and the accumulation of abdominal fat.^{163,164}

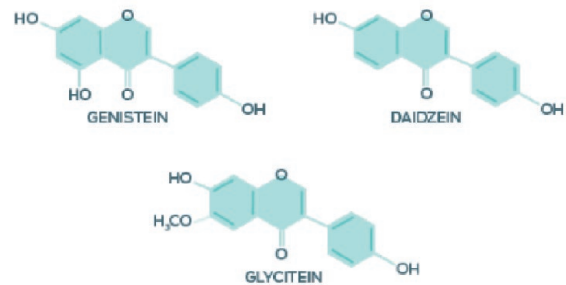


Figure 10:
Chemical structure of soy isoflavones

Purina research has identified several benefits of soy isoflavones that can help manage weight in dogs at risk of obesity.¹⁶⁵⁻¹⁶⁸ When fed 25% above their maintenance energy needs, neutered dogs fed a diet enriched with isoflavones from soybean germ meal showed 50% less weight gain¹⁶⁵ and reduced body fat accumulation compared to dogs fed similar amounts of a control diet.¹⁶⁵⁻¹⁶⁷

Additionally, feeding neutered dogs an isoflavone-enriched diet:

- increased energy metabolism¹⁶⁷
- decreased oxidative stress¹⁶⁸

In cats, limited research has been done to evaluate the benefits of soy isoflavones.⁶⁰ Further investigation is needed to determine relevance.

Intermittent Caloric Restriction

Weight loss strategies for pets typically utilize continuous caloric restriction, or CCR, the same degree of energy restriction daily. Intermittent caloric restriction, or ICR, is an alternative approach utilizing periods of fasting or reduced caloric intake alternated with periods of unrestricted intake.

A Purina study compared obese cats that were fed 75% MER daily (a CCR weight loss program) to obese cats that were fed 75% MER for the 1st half of the month and 100% MER for the remainder of the month (an ICR weight loss program). Cats in the CCR program were followed for 6 months and cats in the ICR program for 12 months, or until they reached ideal body condition. Overall, more cats in the ICR program reached ideal body condition by the end of the study. On a monthly basis, rates of fat and weight loss did not differ. Since cats in the ICR program were energy restricted for only half of the month, this suggested that they maintained higher energy expenditures than the cats in the CCR program.¹³⁹

Intermittent caloric restriction may provide another option for weight loss. More studies are needed to develop optimal ICR regimens for obese pets.

THE ROLE OF THE MICROBIOME IN OBESITY

The gut microbiome (the collection of the microbiota, their genes, and the surrounding environmental conditions) plays a key role in energy metabolism and balance. Research has revealed an association between the gut microbiome and body composition.¹⁶⁹⁻¹⁷² Some studies have shown the gut microbiome of obese dogs and cats to be less diverse and less stable than that of lean pets.¹⁷¹⁻¹⁷⁵ A more diverse microbiome may reflect a healthier microbiome.¹⁷⁶ However, it is not clear if the differences observed are a contributing factor to the development of excess weight or if obesity causes these changes.¹⁷⁵

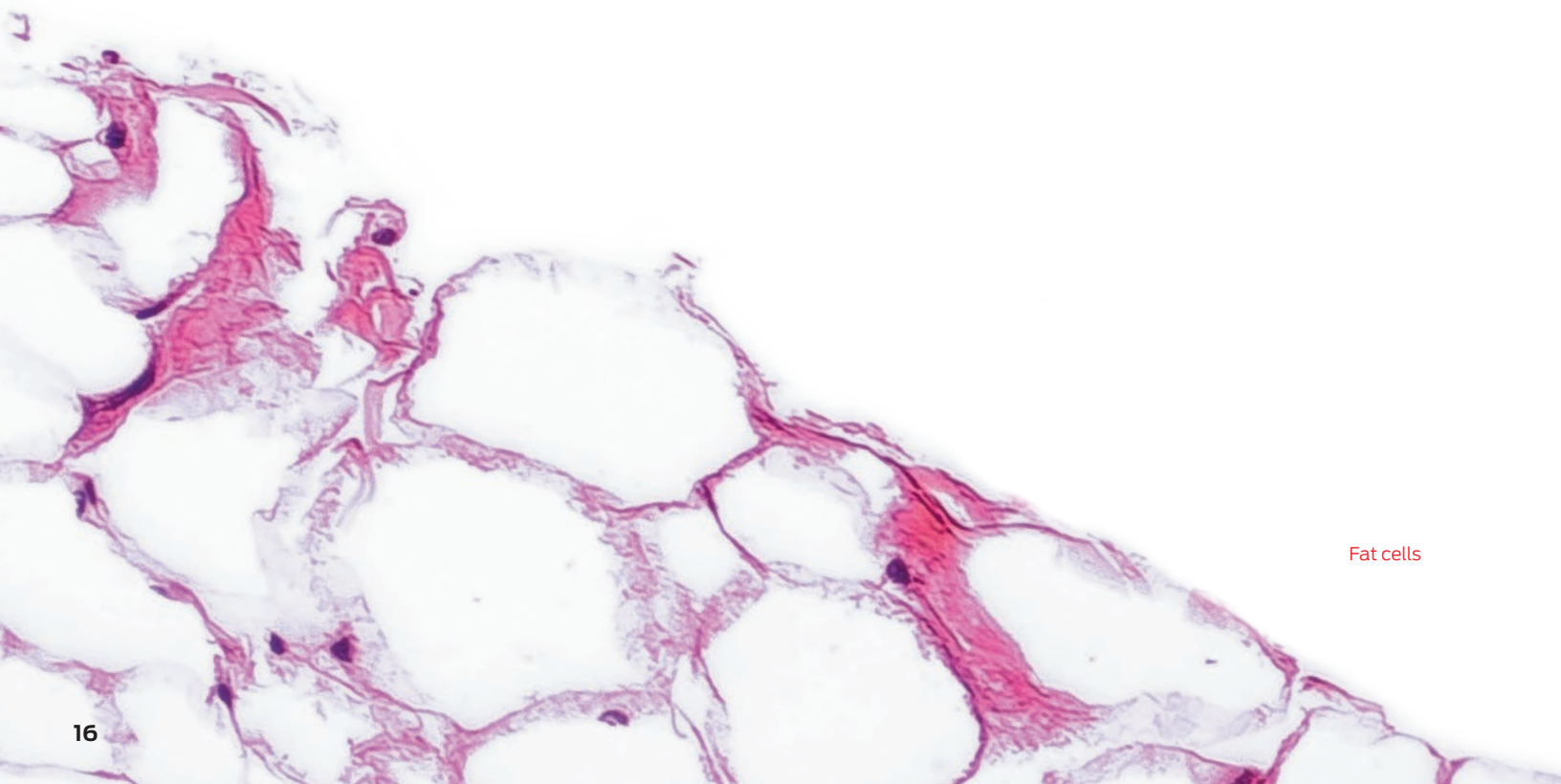
Nutrigenomics is the study of how nutrition affects gene expression. Research by Purina and others has explored the effect of diet and weight loss on gene expression of gut microbiota and the metabolic pathways affected by the microbiota.

Macronutrients in the diet can affect the composition of the gut microbiome, i.e., the relative abundances of bacteria that are involved in metabolic pathways, such as those that ferment carbohydrates or hydrolyze proteins.^{172,173,176,177} Research has demonstrated that the ratio of dietary protein to carbohydrate can affect the composition of the gut microbiome and influence metabolism in both dogs and cats. More significant effects were seen in overweight and obese animals than in lean animals.^{172,173,176,177}

In overweight and obese dogs fed a high-fiber, high-protein diet for weight loss, bacterial diversity increased^{171,174,175} and microbiome composition shifted to be more similar to the microbiome of lean dogs.¹⁷⁵

A greater understanding of the complex relationships between diet, the microbiome, the metabolome, and body composition may present an opportunity for novel nutritional interventions to prevent or manage excess weight in pets.

A healthy weight starting from puppyhood or kittenhood is a crucial part of helping pets live better, longer lives. In combination with mitigating risk factors for obesity and promoting exercise, nutrition plays a key role in preventing and managing obesity. Understanding the motivations and behaviors of owners of overweight and obese pets can help direct approaches for behavioral modification. An individualized weight management plan developed in consideration of the needs of the pet and owner, and frequent rechecks can help ensure success.



Fat cells

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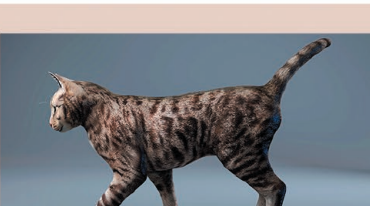

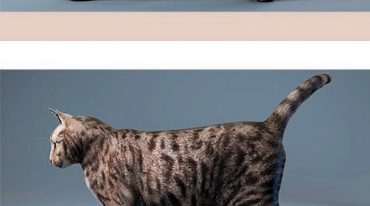






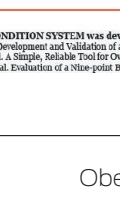
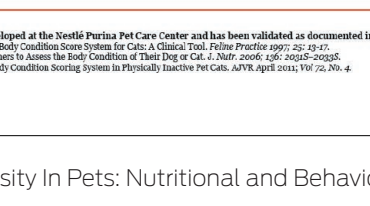


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APPENDIX

BODY CONDITION SYSTEM

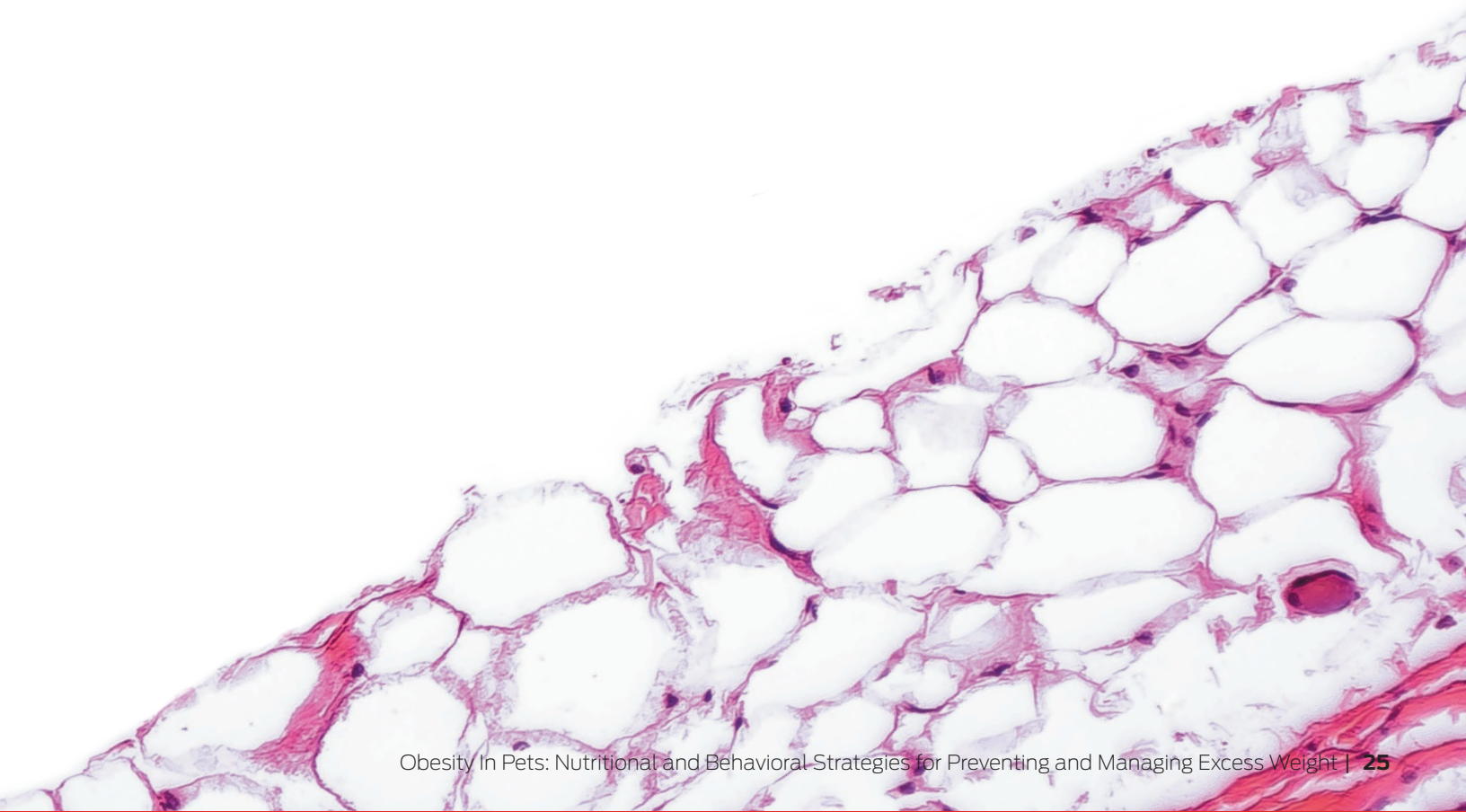
TOO THIN			1 Ribs visible on shorthaired cats; no palpable fat; severe abdominal tuck; lumbar vertebrae and wings of ilia easily palpated.
			2 Ribs easily visible on shorthaired cats; lumbar vertebrae obvious with minimal muscle mass; pronounced abdominal tuck; no palpable fat.
			3 Ribs easily palpable with minimal fat covering; lumbar vertebrae obvious; obvious waist behind ribs; minimal abdominal fat.
			4 Ribs easily palpable with minimal fat covering; noticeable waist behind ribs; slight abdominal tuck; abdominal fat pad absent.
IDEAL			5 Well-proportioned; observe waist behind ribs; ribs palpable with slight fat covering; abdominal fat pad minimal.
			6 Ribs palpable with slight excess fat covering; waist and abdominal fat pad distinguishable, but not obvious; abdominal tuck absent.
TOO HEAVY			7 Ribs not easily palpated with moderate fat covering; waist poorly discernible; obvious rounding of abdomen; moderate abdominal fat pad.
			8 Ribs not palpable with excess fat covering; waist absent; obvious rounding of abdomen with prominent abdominal fat pad; fat deposits present over lumbar area.
			9 Ribs not palpable under heavy fat cover; heavy fat deposits over lumbar area, face and limbs; distention of abdomen with no waist; extensive abdominal fat deposits.

The BODY CONDITION SYSTEM was developed at the Nestlé Purina Pet Care Center and has been validated as documented in the following publications:
 Laflamme DP. Development and Validation of a Body Condition Score System for Cats: A Clinical Tool. *Feline Practice* 1997; 25: 19-17.
 German AJ et al. A Simple, Reliable Tool for Owners to Assess the Body Condition of Their Dog or Cat. *J. Nutr.* 2006; 136: 2025S-2026S.
 Borjesson CL et al. Evaluation of a Nine-point Body Condition Scoring System in Physically Inactive Pet Cats. *JAVMA*. April 2014; 195: 726-730. 4.

BODY CONDITION SYSTEM

TOO THIN			<p>1 Ribs, lumbar vertebrae, pelvic bones and all bony prominences evident from a distance; no discernible body fat; obvious loss of muscle mass.</p> <p>2 Ribs, lumbar vertebrae, pelvic bones easily visible; no palpable fat; some evidence of other bony prominence; minimal loss of muscle mass.</p> <p>3 Ribs easily palpated and may be visible with no palpable fat; tops of lumbar vertebrae visible; pelvic bones becoming prominent; obvious waist and abdominal tuck.</p>	
				
				<p>4 Ribs easily palpable, with minimal fat covering; waist easily noted when viewed from above; abdominal tuck evident.</p> <p>5 Ribs palpable without excess fat covering; waist observed behind ribs when viewed from above; abdomen tucked up when viewed from the side.</p>
				
TOO HEAVY			<p>6 Ribs palpable with slight excess fat covering; waist is discernible viewed from above, but is not prominent; abdominal tuck apparent.</p> <p>7 Ribs palpable with difficulty; heavy fat cover; noticeable fat deposits over lumbar area and base of tail; waist absent or barely visible; abdominal tuck may be present.</p> <p>8 Ribs not palpable under very heavy fat cover, or palpable only with significant pressure; heavy fat deposits over lumbar area and base of tail; waist absent; no abdominal tuck; obvious abdominal distention may be present.</p> <p>9 Massive fat deposits over thorax, spine and base of tail; waist and abdominal tuck absent; fat deposits on neck and limbs; obvious abdominal distention.</p>	

The BODY CONDITION SYSTEM was developed at the Nestlé Purina Pet Care Center and has been validated as documented in the following publications:
 Laflamme DP. Development and Validation of a Body Condition Score System for Dogs. *Canine Practice* July/August 1997; 22: 10-15.
 Mansby DJ et al. Comparison of Various Methods for Estimating Body Fat in Dogs. *J Am Anim Hosp Assoc* 2004; 40: 109-114.
 German AJ et al. A Simple, Reliable Tool for Owners to Assess the Body Condition of Their Dog or Cat. *J. Nutr.* 2009; 139: 2025S-2033S.
 German AJ et al. Comparison of a Bioimpedance Monitor with Dual-energy X-ray Absorptiometry for Noninvasive Estimation of Percentage Body Fat in Dogs. *JAFR* April 2010; Vol 7, No. 4.



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