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## Obesity in dogs: dimension of the problem and effects of feeding

### Abstract

Obesity in dogs is a growing problem that affects 30-60% of the pet population worldwide. It is mainly caused by an energy consumption greater than the animal's requirement; and needs to be detected, and faced accordingly because it negatively affects their well-being and longevity. Although it depends on the composition of the diet, it has been reported that dogs fed 2 times a day have lower blood glucose and insulin levels. Conversely, Ghrelin and GLP1 concentrations do not vary when dogs are fed once or twice per day. Energy expenditure through physical activity is important as it increases the rate of energy use and helps to raise the metabolic rate, which contributes to a comprehensive weight reduction program. The metabolic energy rate (MER) in sterilized dogs is lower than that in intact animals; therefore, sterilization of pets increases the risk of obesity. The protein content of the diet is important for promoting body protein synthesis and tissue repair. High protein diets work best when feed is offered ad libitum. Omega fatty acids reduce plasma concentrations of C-reactive protein and insulin. Dietary fiber helps to significantly reduce blood cholesterol and triglycerides.

**Keywords:** obesity; energy consumption; energy expenditure; diet composition.

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## Study contribution

Obesity is a frequent problem in veterinary consultations and affects the overall health of dogs. It has been observed that the number of obese dogs is increasing, especially in developed countries. The triggers of obesity in dogs are diverse; ranging from genetic predisposition associated with the breed, factors that have to do with pet food and treats formulation, as well as owners' lifestyle and the way they feed their dogs. This article reviews the principal causes involved in the development of obesity in dogs, to have a comprehensive understanding of the problem and thus be able to prevent or address it in a better way. The awareness of dog owners in terms of feeding strategies and maintenance of healthy weight is essential to avoid the health problems associated with obesity.

## Introduction

Obesity has been defined as the excessive accumulation of adipose tissue in the body, caused by an energy consumption greater than the requirement, with the consequent deterioration of some physiological functions.<sup>(1)</sup> When an animal's body weight is 10 % above its ideal weight, it is considered to be overweight, and when it is greater than 20 % they are qualified as obese.<sup>(2)</sup>

The phenomenon in dogs has increased in recent years at a rate similar to that of human obesity, and the incidence in developed countries fluctuates from 30 to 60%.<sup>(3-7)</sup> In a survey conducted in Querétaro, Mexico, the figure was 42 percent (personal communication).

## Physiological causes

The systems that control feed consumption are complex and include the feedback to the brain from adipose tissue to the gastrointestinal tract through hormonal and nerve signals. Consumption elevates of the blood concentration of ghrelin, which stimulates appetite and increases gastric emptying because of low blood glucose levels.<sup>(8)</sup> In addition, it has been determined that excess adipose tissue produces a series of hormones and inflammatory cytokines that will develop a state of chronic inflammation in the body, which is related to respiratory disorders, renal dysfunction, increased risk of metabolic problems, endocrine, orthopedic diseases, and some types of cancer.<sup>(9)</sup>

## Causes attributable to feed

Feed composition exerts an effect on hunger and satiety signals. Commercial feed formulations are in accordance with the recommendations developed by the National Research Council (NRC),<sup>(10)</sup> and the Association of American Feed Control Officials (AAFCO),<sup>(11)</sup> which establish the minimum requirements across growing stages for

dogs. Consumption is calculated considering the metabolic weight, which is a factor that determines the amount of energy required per unit of body surface: that is, the body weight (BW) is measured and raised to a power that has been determined at The NRC<sup>(10)</sup> recommends MER values depending on the degree of activity, breed, and age for dogs three to seven years old and in a range of  $95 \times BW^{0.75}$  to  $130 \times BW^{0.75}$ .

Considering that the requirements may vary according to age, sex, environment, level of activity and physiological state, it is necessary to adjust the amount of energy provided by the feed for each individual. In dogs with a tendency to obesity, as well as in those that are obese or sterilized, the recommended energy rate should be 20-30% lower. Thus, their feed rations should be adjusted. Commercial feed manufacturers determine the ration recommendation based on the NRC formula. However, it is important to note that the feeding dosage tables present on the labels of commercial feed consider general recommendations for healthy dogs and do not include adjustments that must be made individually, as in the case of overweight or obese dogs. The amount of metabolizable energy (ME) of a given feed can be obtained from its label or can be calculated by the following equation:<sup>(11)</sup>

$$\text{ME kcal/100 g} = [\% \text{ crude protein} \times 3.5] + [\% \text{ crude fat} \times 8.5] + [\text{nitrogen free extract} \times 3.5]$$

This calculation will not give an exact value of the amount of ME because the labels only show the minimum and maximum nutrient levels the feed contains, but it is a base reference of the amount of ME for feed ration calculation. Animal consumption is generally regulated by the amount of energy contained in the feed.<sup>(12)</sup> However, market competition results in some products designed to increase their palatability, giving rise to commercial feeds in which the regulation of consumption by physiological mechanisms is not very efficient. The availability of these highly palatable feeds causes dogs to consume a greater quantity of such products and therefore more energy with respect to their needs.

Another factor to consider is the increasing practice of offering treats and supplements to dogs. Although treats should not represent more than 10% of the dog's ration, it is important to consider that most treats have low percentages of protein (less than 12%), which leads to an imbalance in the diet. This same situation occurs with table leftovers, which are usually high in energy. Moreover, diets that have a low protein level or close to the recommended daily minimum tend to further reduce the contribution of protein to tissue turnover as well as other nutrients such as vitamins and minerals.<sup>(13)</sup> In summary, the increase in obesity is associated with the type and amount of feed consumed, the number of meals, the number of treats or the amount table leftovers provided to them.

## Other causes

Physical activity is essential to maintain good health in dogs. The commitment or lifestyle of dog owners is an important factor that determines how much exercise a dog can do. A sedentary lifestyle keeps the dog inside the house with minimal

**Table 1.** Factor required in the equation for calculating metabolizable energy according to the level of physical activity a dog performs

Activity level (h/day)	ME kcal/BW <sup>75</sup>
Low (<1)	95
Moderate (1-3)	110
Elevated (>3)	125

FEDIAF<sup>(14)</sup>

physical activity, which causes an imbalance between energy requirement and expenditure and promotes the accumulation of adipose tissue (Table 1).

Sterilization is another factor that can lead to obesity in dogs because it modifies hormonal patterns and reduces the expression of estrogen genes in the body. Estrogens are important because they are mediators of feed consumption in the central nervous system and also synergize the effect of other hormones that regulate neuronal signals, feeding behavior and appetite.<sup>(15,16)</sup> In general, the loosening of sex hormones by sterilization can reduce the metabolic rate by up to 30 %, <sup>(3,17)</sup> which represents a risk factor for obesity. For obese dogs, energy requirements are < 90 kcal per kg BW<sup>75</sup>. Thus, their feed consumption should be adjusted, as long as the amount of protein provided in the food is > 2.5 g/BW<sup>75</sup>. In dogs that are ≥7 years of age, the dietary protein consumption should be > 4 g/BW<sup>75</sup> to prevent a decrease in muscle mass.<sup>(17,18)</sup>

## Problem identification

Veterinarians should provide information to pet owners about the implications of weight gain and body condition on the health of their animals. In this regard, different methodologies have been developed to determine dogs' body condition score (BCS). These methods consider the weight of the dog as an objective measure, adjusted to the dimensions of the animal by means of metabolic weight, which allows to determine when an animal is overweight. The most commonly used scale for dogs and cats, due to its degree of repetitiveness and predictability, is the scale 1 to 9 developed by Laflamme.<sup>(19,20)</sup> Pet owners play a crucial role in the nutrition of dogs, since they provide the feed daily, and adjust the amount they are consuming according to the perception of the body condition of their dog.

Unfortunately, most times the perception of the body condition by pet owners is different from reality. In fact, several studies have shown that owners tend to underestimate the dog's weight. Even if they are provided with the scale to qualify body condition, owners usually give values up to 2 units below the actual condition of the pet, which represents a difference of 25-30 percent (Table 2).<sup>(21,22)</sup>

In a study with dogs classified by a veterinarian (as underweight, ideal weight, overweight, and obese),<sup>(24)</sup> half of the owners overestimated the weight of animals in the underweight group. For dogs with ideal weight, the coincidence between the owner and the veterinarian was 80%. However, in overweight and obese dogs, nearly 50% of their owners considered that their dogs were overestimated in their

**Table 2.** Body condition scale and its relationship to body fat, and overweight

Scale of 9	Scale of 5	Body fat %*	Overweight %
4	2.5	15-19	----
5	3	20-24	Ideal
6	3.5	25-29	10
7	4	30-34	20
8	4.5	35-39	30
9	5	40-44	40
>9	>5	>45	>40

\* $BW \times (100 - \%BF) / 0.8$ . Lean mass is 80% of the ideal weight (assuming 20% BF).<sup>(23)</sup>

body condition and thought that they were at the ideal weight. Furthermore, among obese owners, 50 % said that their dogs were not obese.

The above evidence suggests the convenience of detecting the problem in a timely manner by the veterinarian. It is essential to monitor the animal's weight and body condition, as well as to adjust the pet's ration individually according to age, physical activity, and physiological and hormonal status. A high percentage (>65 %) of commercial feeds are low-cost products, in which the protein content is low (in some cases being up to 18 % below the recommendations of AFFCO<sup>(11)</sup> and FEDIAF<sup>(14)</sup>) for adult dogs. These feeds contain a high proportion (> 60 %) of carbohydrates and in dogs with a tendency to obesity or overweight, the restriction of the ration below the manufacturer's recommendations would lead to deficiencies of protein and other nutrients, being within the limit of the nutritional recommendations already established.

A study conducted with Labrador dogs for 14 years<sup>(25)</sup> established that feed restriction was associated with an increase in the half-life of the dog, and a late onset of chronic diseases. In that research, the dogs had a BCS of 4-5 on the scale of 9 with a percentage of fat ranging from 12 to 20%. Likewise, other studies have found that an ideal BCS is 4 to 5 on the Lafflame scale of 9.<sup>(19, 26)</sup>

Lean mass is the strongest predictor of metabolic rate, followed by surface area, and body weight. In such a way that when an animal is overweight and experiences an increase in body fat, there is a decrease in the proportion of lean mass in relation to total body weight; so that energy expenditure per unit of weight decreases.<sup>(27)</sup> Dogs with a high percentage of fat, decrease their energy expenditure. It is important to help them preserve muscle mass, to increase metabolism and energy expenditure; factors that reduce the problems of resistance to losing weight and a possible recovery of lost weight.

When feed is consumed, a specific dynamic effect generates heat, which is the thermogenic effect of the diet and represents 10% of the dog's daily energy expenditure, and this is influenced by the type and energy composition of the diet. For this reason, when the number of meals increases, there is an increase in energy expenditure with each meal that the dog consumes. With age, as the pet gets older, the basal metabolic rate decreases, and this is due to the loss of lean tissue, so the energy requirement will also decrease. Work has been carried out in which it has been concluded that dogs that are overweight in their growth stage have a greater

probability of being obese in their adult stage.<sup>(28)</sup> The prevalence of overweight increases by 50% from 6 to 11 years of age.<sup>(2, 4, 29-30)</sup>

According to a study conducted by Edney,<sup>(31)</sup> dogs with free access to feed tend to accumulate a greater amount of body fat and show high levels of triglycerides in serum, mainly when they ingest feeds rich in carbohydrates that will cause glucose and insulin spikes; some authors note that 61% of obese dogs have hyperinsulinemia, glucose intolerance, or both.<sup>(32)</sup> In these cases, controlled portions are the best way to have a balance in the energy consumption of dogs. Phungviwatnikul et al.<sup>(33)</sup> carried out a study with 28 Beagle dogs provided with 3 different diets: 1) moderate protein, moderate fiber (COSP control); 2) high protein and high fiber (HP-HF); and (3) same as 2, plus medium-chain fatty acids and omega (HP-HF-O). Twenty-four animals were sterilized and distributed in the three groups, while four remained intact and were given the control diet (COSH).

The above experiment lasted 24 weeks. During the first 12 weeks, controlled amounts of feed were provided and the following 12 weeks they received *ad libitum* feeding. In the first stage, the weights remained constant for all treatments. In the second stage, the unsterilized dogs (control diet) were the ones that had the smallest weight increases, followed by the dogs that consumed the HP-HF-O and HP-HF diets, in this order, while animals on the COSP diet had the highest weight gain. Body condition followed the same trend as weight gain. During the second twelve weeks, the ones on HP-HF or HP-HF-O, ate more feed than those on the COSH and COSP diets. During the *ad libitum* feeding period, the groups of unsterilized, HP-HF, and HP-HF-O dogs had smaller increases in BCS compared with sterilized dogs on a moderate protein-moderate fiber diet. Animals in the COSP treatment had the largest increase in BCS (3 units), compared to COSH (0.88 units), HP-HF (2.34 units) and HP-HF-O (2.34 units).<sup>(33)</sup>

As for muscle mass, the ones on the HP-HF diet had greater lean mass than the intact ones. One of the hypotheses that was not met in this work, is that a better performance of the HP-HF-O diet was expected, which had a lower performance than HP-HF. Perhaps, this lower performance could be attributed to inadequate (low) doses of omega and medium-chain fatty acids used in that experiment. Therefore, care must be taken to ensure that the proportion of muscle mass in relation to body fat is not affected in too intense weight reduction programs. The increase in body fat for the COSP group was greater compared with unsterilized dogs at week 24, while those fed HP-HF and HP-HF-O diets had intermediate values.<sup>(33)</sup>

### Recommendations for preventing obesity

As mentioned before, the energy imbalance between consumption and expenditure causes the accumulation of excess adipose tissue in the body. Physical activity is important to increase the rate of energy expenditure and help to raise the metabolic rate, which contributes to a comprehensive weight reduction program. In addition, there are physiological mechanisms in the reduction of consumption that are not activated when there is little physical activity, because of a decrease in

the resting metabolic rate. The duration and intensity of exercise should gradually increase in animals starting a weight control program to achieve weight reduction and increase exercise tolerance.

The reduction of calories consumed through feed restriction should be carried out by reviewing the contributions of the other nutrients present in the diet such as protein, vitamins, and minerals. Diets marginal in these nutrients at the time of restricting consumption can lead to deficiencies and reduction of lean tissue in the pet. The important thing is that the calories provided should be less than the metabolic rate at rest according to the activity and age of the pet, to achieve weight reduction. It has been determined that diets high in protein increase satiety, reduce hunger, and preserve muscle mass during weight reduction programs.<sup>(34)</sup> Therefore, the quality of feed is a determining factor: those rich in soluble carbohydrates, high in fat, and low in protein, are more likely to produce obesity problems. Reducing fat in the diet for dogs that need to lose weight is important as it is the nutrient that contains the highest energy density per unit weight; however, fat also influences the palatability of the feed. Commercial low-energy density diets contain a maximum of 11 % dry-based fat.

Other important factor is dietary fiber, as it produces an energy-diluting effect, as well as increases energy expenditure to digest the feed. Dietary fiber influences the digestibility of soluble carbohydrates and protein;<sup>(32-37)</sup> for which there are several recommendations. It is important to consider that the fiber reported in feed is determined as crude fiber, and does not consider the soluble part that contains the dietary fiber present in feed. Diets high in fiber and low in fat usually have lower caloric density; however, the digestibility of some nutrients such as protein, vitamins, and minerals are affected, so they should not be used for long periods of time.

High rates of weight loss have been shown to be related to the loss of muscle, and if dietary protein is limited, this loss could be greater. Dogs under a weight reduction program should receive multiple servings during the day rather than just one. This practice allows taking advantage of the energy cost of the metabolic process of feed consumption.

Finally, omega 3 and 6 fatty acids supplementation, in a ratio between 5 and 10 units, helps in inflammatory states, reducing the production of inflammation mediators, and thus benefits obese dogs. It is important to provide an amount of long-chain omega 3 fatty acids (DHA: EPA) to achieve better health results.

## Conclusions

Obesity in dogs is multifactorial and to address it, emphasis should be placed on the individual profile of the dog, the most convenient type of commercial food, as well as an adequate supply of calories in accordance with a comprehensive weight management program.

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## Conflicts of interest

The authors have no conflict of interest to declare in regard to this publication.

## Author contributions

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Writing-review and editing: P Pohls

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