TREATMENT OF OBESITY
Current Research & Recommendations

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Obesity is a frequently encountered condition in small animal veterinary practice and arguably the most common form of malnutrition.

Weight loss in overweight animals is associated with greater longevity, increased vitality, and reduced pain.[1] Recent research has better characterized the condition and identified new therapeutic approaches.

DEFINITION

Obesity is commonly defined either mathematically or descriptively. **Table 1** identifies mathematical definitions; alternatively, obesity is described as *a clinical condition characterized by excessive accumulation of body fat that leads to pathology or impaired function*.

PREVALENCE

Estimates suggest that at least 25% to 30% of dogs and cats in industrialized countries are obese. The prevalence of overweight animals warrants clinical efforts aimed at treatment and prevention of this nutritionally responsive disease.

IDENTIFICATION

The body condition score (BCS) provides an objective measurement for assessment of nutritional status; both 5-point and 9-point scoring systems (**Figures 1 and 2,** pages 61 and 62) have been validated for veterinary use by advanced techniques that determine body composition.

When used appropriately, BCS permits calculation of ideal body weight (BW), a value necessary for estimating any overweight animal's caloric intake for weight loss. **Table 2** describes how to calculate ideal BW in dogs. BCSs also identify obesity in cats; however, mathematical equations are generally unnecessary, as most cats should weigh between 3 to 5 kg when lean.

An educational component may be required when explaining an animal's BW to its owner, as owner disagreement can be common when veterinarians identify an overweight patient.[2]

TABLE 1. OBESITY DEFINITIONS FOR DOGS & CATS

METHOD	OVERWEIGHT	OBESE
Percentage	All body weights between "obese" and "ideal" weights	Weight exceeds 120% to 130% of ideal body weight
BCS 5-Point Scale	4/5	5/5
BCS 9-Point Scale	6/9	≥ 7/9

TABLE 2. CALCULATING IDEAL BODY WEIGHT IN DOGS

5-POINT SCALE	9-POINT SCALE	% OVERWEIGHT	MEASURED BW / × = IDEAL BW
3	4–5	0%	Ideal
3.5	6	15%	× = 1.15
4	7	30%	× = 1.3
4.5	8	45%	× = 1.45
5	9	60%	× = 1.6 (or greater)

For the 9-point scale, each point above 5 represents a 10%–15% increase above ideal body weight; for purposes of calculation, I commonly employ 15%.

RISK FACTORS

Risk factors for canine and feline obesity are outlined in **Table 3**, page 63.

CONSEQUENCES

Caloric restriction increases lifespan in a number of species, and obesity has a negative association with longevity in humans and dogs.

Dogs

A lifetime feeding study in Labrador retrievers showed that:[3]

1. Lean dogs live, on average, 1.8 years longer than obese dogs.
2. Radiographic and clinical signs of osteoarthritis (OA) were detected earlier, and were generally more severe, in the group fed ad libitum compared to energy-restricted control dogs.

A reduction in spontaneous activity associated with OA likely further decreases energy expenditure, contributing to an obesity–arthritis cycle. Conversely, recovery from orthopedic injury, such as cranial cruciate rupture managed with or without surgery, is improved with concurrent weight loss.[4]

Other pathologies associated with canine obesity include respiratory diseases (eg, tracheal collapse), cardiovascular disease, and insulin resistance.[5,6]

Cats

The effect of feline obesity on longevity has not been confirmed. However, obesity is associated with diabetes mellitus (see **Diabetes Mellitus in Obese Cats**), hepatic lipidosis, dermatologic diseases (eg, alopecia, epidermal scaling), various gastrointestinal disorders, and feline lower urinary tract disease.[7] A link with OA is expected, although this is less well studied than in dogs.

PATHOPHYSIOLOGY

The pathophysiology of obesity is related to a number of hormones secreted by adipose tissue, known as adipokines. The mechanical consequences of excess fat accumulation are intuitively understood, but only recently have the metabolic and hormonal consequences been better described.

Leptin is produced by fat cells and, in normal individuals:

- Suppresses appetite
- Increases energy expenditure.

However, both humans and dogs develop leptinemia when overweight, possibly due to leptin resistance. Adverse effects from high circulating leptin have not yet been fully described in dogs.[6]

Adiponectin, a more frequently studied adipokine:

- Increases insulin sensitivity by increasing skeletal muscle glucose uptake and decreasing hepatic production of glucose.[8]
- May also increase fatty acid oxidation and reduce inflammation.[9]

Increased adiposity appears to be inversely correlated with serum adiponectin levels. Research has found that:

- 20% of obese dogs develop metabolic abnormalities characterized by increased insulin and decreased adiponectin levels[10]
- Weight loss reverses hypoadiponectinemia[11]

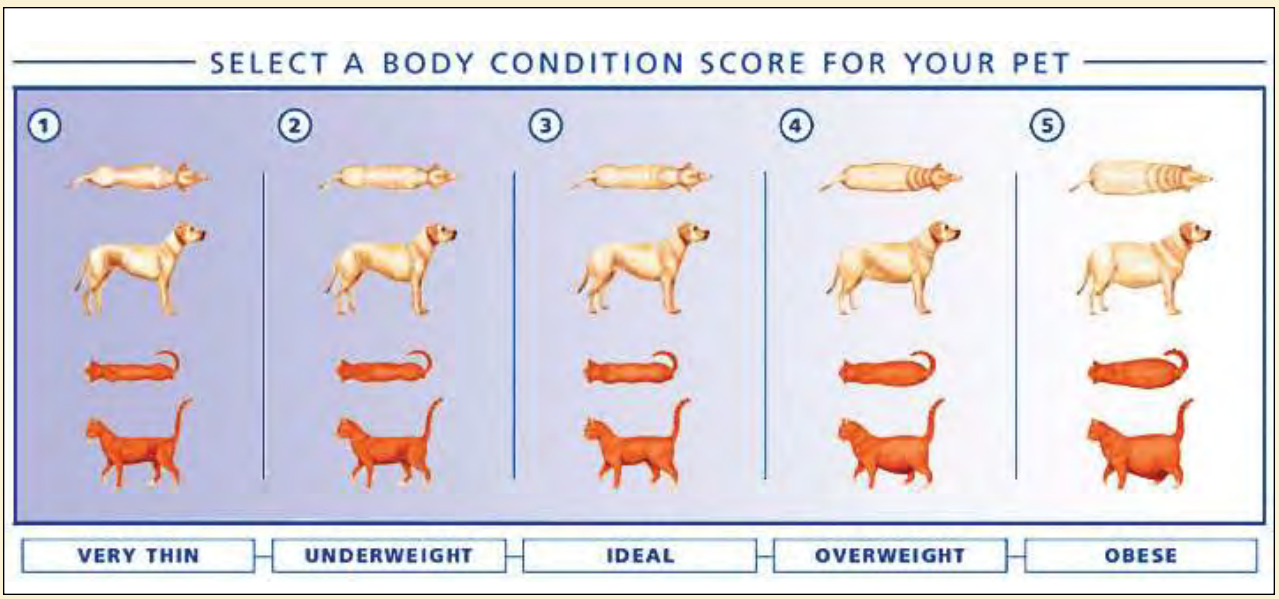

Figure 1. *The 5-point body condition score scale, courtesy Hill's Pet Nutrition (hillsvet.com); visit todaysveterinarypractice.com (Resources) to download this scale and the Hill's Pet Nutrition Body Fat Index (BFI) Risk Charts. The current 5- and 9-point scales do not account for pets with body fat > 47%; the BFI Risk Charts account for pets with up to 75% body fat.*

- In other studies, however, no changes in adiponectin levels were found before or after weight loss in dogs.[12]

Hypoadiponectinemia consistently occurs in obese cats,[8] which may explain why they have more severe insulin resistance and increased predisposition to NIDDM.

A number of other adipokines that create a chronic mild inflammatory state in obese individuals have been characterized in humans and laboratory animals. This may contribute to obesity's documented adverse effects.[9] Hormones, such as TNF-alpha and C-reactive protein, are elevated in some obese dogs, and decrease after weight loss.[12]

Future investigations and therapies are likely to focus on the hormonal components of excess adipose tissue.

OBESITY INTERVENTIONS: EXERCISE

Active dogs, as measured by pedometers, have lower BCSs than inactive dogs.[13]

Paired with Therapeutic Diet

A recent study demonstrated that active dogs fed a therapeutic diet formulated for weight loss used approximately 25% more energy than inactive dogs, while achieving 2% weight loss weekly.[14] Each 1000-step interval was associated with an approximately 2% increase in daily energy expenditure. Other studies suggest that, for each km traveled, caloric expenditure increases by approximately 2 kcal/kg$^{0.75}$.[15]

Underwater Treadmill Therapy

Underwater treadmill therapy has been part of a successful weight loss program in combination with owner education, a high-protein low-fat diet, and owner-supervised exercise.[16] A recent study demonstrated that a healthy dog, walking at a normal pace in elbow-height water for 30 minutes daily, would use 2.5% more calories per day (eg, 25-kg dog consuming 1000 calories daily uses 25 additional calories).[17]

Therefore, exercise, unless performed over extended distances, is unlikely to cause weight loss without concurrent restriction of caloric intake.

OBESITY INTERVENTIONS: MEDICATION

Dirlotapide (Slentrol, zoetis.com), a selective microsomal triglyceride transfer protein inhibitor, is licensed for treatment of obesity in dogs. It prevents lipoprotein formation in the enterocyte, increasing intracellular concentration of lipids, which is thought to increase circulating levels of the hormone PYY, a satiety signal

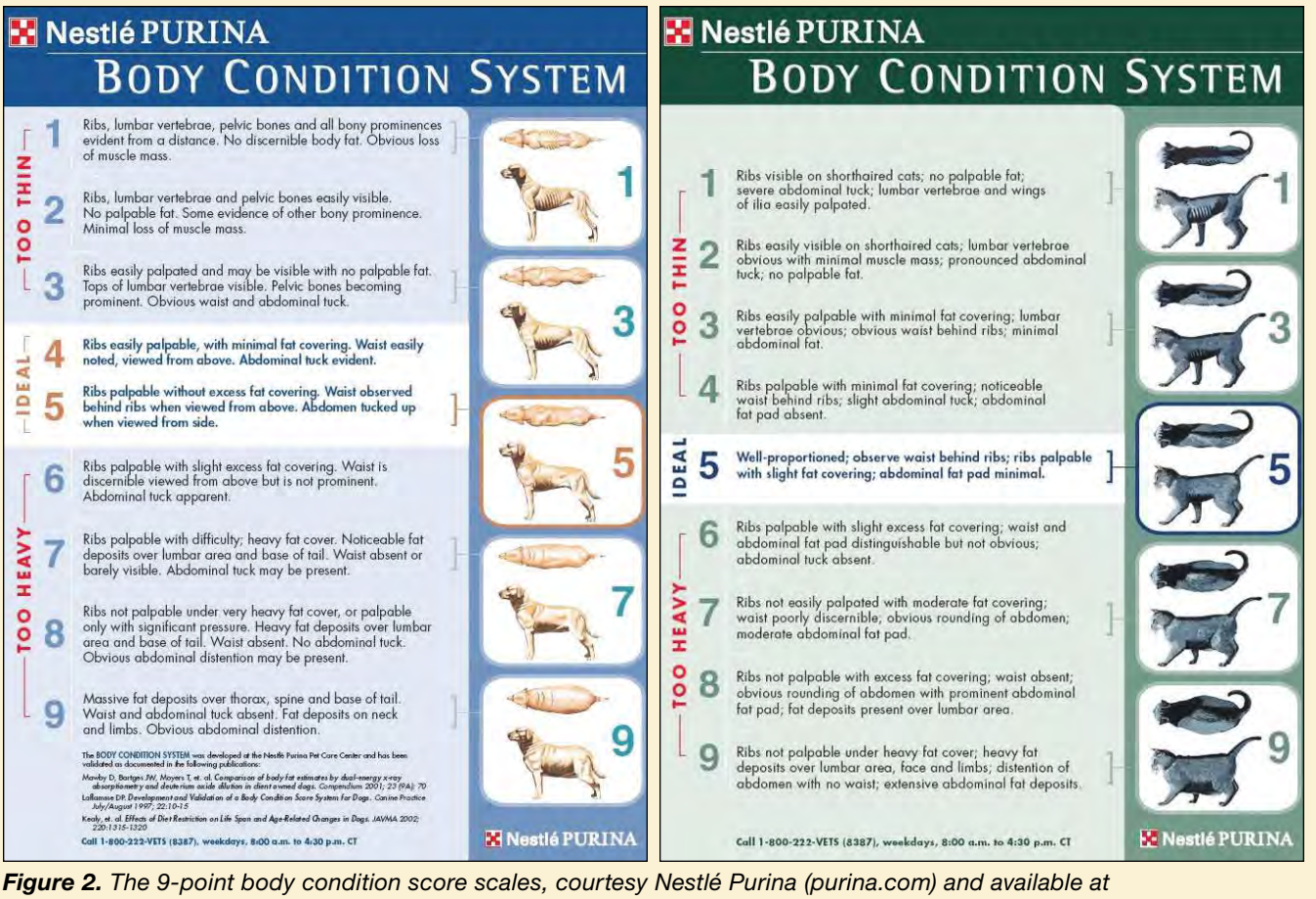

Figure 2. *The 9-point body condition score scales, courtesy Nestlé Purina (purina.com) and available at todaysveterinarypractice.com (Resources)*

TABLE 3. RISK FACTORS FOR OBESITY

CANINE RISK FACTORS[6,15,18-20]	FELINE RISK FACTORS[7]
Age. Prevalence increases with age **Breed.** Some breeds have lower energy needs **Concurrent conditions** **Genetics** **Neutering.** Causes weight gain in both males and females **Overfeeding.** Especially calorically-dense dry foods and commercial treats; also with once daily *or* 3+/day feeding(s) **Reduced exercise** **Sex.** Increased prevalence in females; increases after ovariectomy	**Age.** Prevalence decreases in senior cats; obesity most likely from ages 5–11 **Breed.** Mixed breeds more commonly obese **Concurrent conditions** **Genetics.** Studies are conflicting **Neutering.** Significant correlation between neutering and obesity **Overfeeding.** Free-choice feeding and inactivity are major factors in development of obesity **Reduced exercise**

- **Breed:** Accepted official breed standards may contribute to the obesity epidemic; a European study found that nearly 1 out of 5 show dogs had a BCS > 5.[18]
- **Exercise:** Pets with reduced exercise required about 20% less energy than research dogs.[15]
- **Neutering:** Most likely related to the influence of sex hormones on appetite, exercise, and perhaps, most important, loss of lean body mass (metabolically active tissue).[4,7,15]
- **Overfeeding:** It is not clear why once daily feeding predisposes to obesity; potential reasons include owners providing more liberal amounts of food when feeding once daily or reduced dietary thermogenesis.

that acts on the hypothalamus. While the complete mechanism of action of dirlotapide is unclear, appetite reduction is most likely responsible for weight loss.

In clinical and field trials, dogs given dirlotapide:[21]

- Were not fed any specific diet; owners were asked to make minimal dietary changes before starting the drug
- Lost weight at a rate of approximately 0.74% to 1.4% per week, which is consistent with rates observed for caloric restriction associated with therapeutic weight-loss diets
- Demonstrated some adverse reactions including, but not limited to, gastrointestinal signs and elevated alanine transaminase and aspartate aminotransferase
- Regained some weight during an 8-week monitoring period following discontinuation of the drug.

The starting dose for dirlotapide is 0.05 mg/kg (0.01 mL/kg) PO Q 24 H for 14 days. Refer to the product insert for further dosing instructions.

OBESITY INTERVENTIONS: NUTRITION

Caloric restriction is considered the primary treatment of small animal obesity. However, reduction in volume of food and number of treats fed is often a significant barrier for owners.

Protein

High-protein diets are recommended during the weight loss period. Animals have well defined amino acid requirements; providing additional protein can prevent possible deficiencies of taurine or other amino acids. In addition, high-protein diets preserve lean body mass during weight loss.[22]

Recent research has shown that:[23-25]

- A high-protein diet (≈120 g/Mcal) allowed cats to consume about 10% more calories to achieve the same degree of weight loss as those fed a lower-protein alternative (≈90 g/Mcal).
- Cats fed a high-protein diet consumed a higher number of calories than those on a lower-protein diet and better maintained their weight following weight loss.
- Cats fed ad libitum on a high-protein diet (≈120 g/Mcal) showed an increase in daily energy expen-

Diabetes Mellitus in Obese Cats

Diabetes mellitus (DM) is one of the most commonly recognized sequelae of obesity in cats, which has drawn considerable research interest given similarities to the development of DM in obese humans.

Cats generally develop noninsulin-dependent diabetes mellitus (NIDDM):

- NIDDM is characterized by insulin resistance, which progresses to hyperglycemia then possible glucotoxicity or exhaustion of insulin-secreting pancreatic beta cells.[7]
- Amylin, a co-secretory product of beta-cells, normally inhibits food intake and limits hyperglycemia; however, there is evidence in humans that amylin may be critical to formation of amyloid and destruction of beta-cells.[26]
- Increased BCS in cats is associated with higher levels of amylin and insulin, even in nondiabetic animals, suggesting possible parallels to human DM.[26]

Dogs also develop insulin resistance with obesity, but chronically secrete high levels of insulin without evidence of loss of sensitivity in pancreatic beta-cells.[27,28] This likely explains the rarity of NIDDM in dogs.

Read **Feline Diabetes Mellitus: Updates on Diagnosis & Treatment** in the July/August 2013 issue, available at **todaysveterinarypractice.com**.

diture. This effect may be due to a principle called *dietary thermogenesis*, in which different energy substrates have different energy costs associated with metabolism.

- High-protein diets may increase palatability of reduced-calorie diets, as cats typically prefer protein to fat and carbohydrate.

Carbohydrate & Fat

Modifications in carbohydrate and fat concentrations are variable in therapeutic weight-loss diets. Fat is often reduced since it provides over 2 times as many calories by weight as carbohydrate or protein. However, essential fatty acids are required and fat cannot be reduced below a certain threshold. Carbohydrate and protein are commonly both increased in a diet when fat is reduced.

Fiber

Fiber is added to increase both volume and weight of a food, while minimally affecting its caloric content. It is the most controversial nutrient modification for obesity because studies examining rates of weight loss or satiety have had mixed or poorly-controlled results.[22]

- **Insoluble fiber**, like cellulose or peanut hulls, is eliminated in the feces and increases fecal volume, which can be negatively perceived by some owners. Diets with large amounts of insoluble fiber may reduce food consumption in cats.
- **Soluble fiber**, generally fermented by intestinal bacteria, is employed in other weight-loss diets.
- **Crude fiber percentage** on most product labels refers to insoluble fiber, while **total dietary fiber** (TDF) reported by some companies better reflects both soluble and insoluble fiber sources.

A recent study in obese dogs demonstrated that a high-protein, high-fiber diet (103 g protein, 97 g TDF/Mcal) produced greater weight loss (1% vs 0.7%/week) than a high-protein, moderate-fiber diet (104 g, 56 g TDF/Mcal).[29]

Moisture Content

Diets formulated for weight loss may increase moisture content of canned diets during extrusion to increase food volume during caloric restriction.

High-moisture diets reduced ad libitum caloric intake of cats in 1 study,[30] while another showed no intake difference during the weight loss period. The latter study did show that weight *regain* was significantly reduced.[31]

It has been hypothesized that some animals find canned food more palatable, but this likely depends on pre-existing preferences.

Additional Ingredients

Weight-loss diets occasionally incorporate ingredients purported to improve the efficiency of weight loss.

- **L-carnitine** has been suggested to help increase weight loss and preserve muscle mass.[22] It is responsible for transporting acyl groups from fatty acids into the mitochondrial matrix, and may also increase muscle mass.
- **Fish oils** are a source of the polyunsaturated fatty acids EPA and DHA (omega 3). Some limited work examined the effect of EPA on preventing the decrease of adiponectin and increase in insulin seen in obese cats.[8]
- Other diets provide increased **antioxidants, conjugated linoleic acid, chromium**, and other nutrients, but there is limited information supporting use of these compounds.

Weight Loss: Nutritional Challenges

Label Claims

Many manufacturers claim their diets facilitate weight loss through alterations in nutritional composition or via inclusion of dietary supplements. A recent survey of such foods demonstrated significant variability in caloric density as well as in the provided feeding instructions.[32] Product labels are, therefore, an unreliable source of nutritional guidance for obese animals.

Reduced Nutrients

Most commercial diets are formulated assuming a higher caloric intake than that consumed by most pets. As a result, a reduction in the calories fed further reduces intake of essential vitamins and minerals. A study that evaluated the essential nutrients provided by a maintenance diet when hypothetically fed for weight loss found that intake of multiple nutrients may be suboptimal.[33]

REBOUND WEIGHT GAIN PREVENTION

After the weight loss period, it is suggested that nearly 50% of dogs regain more than 5% of BW in a "rebound" phenomenon; dogs maintained on a weight-loss diet

Talking to Pet Owners About Obesity

While owners frequently consider nutrition a cornerstone of wellness care, they may be reluctant to accept obesity as a legitimate medical disorder in need of appropriate and targeted treatment. Counsel owners that obesity and its adverse effects negate dietary strategies aimed at promoting health, and also provide evidence-based recommendations.

Turn to page 66 for an in-clinic form, **Developing Protocols for Obese Animals**, for guidelines on how to formulate a successful weight loss plan.

Go to todaysveterinarypractice.com (Resources) to download the client handouts, **Nutritional Recommendations for Your Overweight Dog** and **Nutritional Recommendations for Your Overweight Cat**, for use in your practice.

gained less than those switched to maintenance diets.[34]

Reduction in energy expenditure, after target weight is achieved, has been observed in dogs and cats.

- **Cats:** One study found that energy expenditure decreased 19% compared to baseline expenditure during weight loss, and was decreased 12% after weight loss.[35]
- **Dogs:** The energy expenditure needed to maintain post-loss BW was found to be only about 10% greater than that needed for weight loss.[36]

Therefore, dogs and cats may require an energy-restricted high-protein diet after ideal weight is achieved, and dietary management for treatment and subsequent prevention of obesity is likely lifelong. ■

BCS = body condition score; BW = body weight; DM = diabetes mellitus; NIDDM = noninsulin-dependent diabetes mellitus; OA = osteoarthritis ; TDF = total dietary fiber

References

1. German AJ, Holden SL, Wiseman-Orr ML, et al. Quality of life is reduced in obese dogs but improves after successful weight loss. *Veterinary J* 2012; 192:428-434.
2. White GA, Hobson-West P, Cobb K, et al. Canine obesity: Is there a difference between veterinarian and owner perception? *J Small Anim Pract* 2011; 52:622-626.
3. Kealy RD, Lawler DF, BNallam JM, et al. Effects of diet restriction on lifespan and age-related changes in dogs. *JAVMA* 2002; 220:1315-1320.
4. Wucherer KL, Conzemius MG, Evans R, Wilke VL. Short-term and long-term outcomes for overweight dogs with cranial cruciate rupture treated surgically or nonsurgically. *JAVMA* 2013; 242(10):1364-1372.
5. Pelosi A, Rosenstein D, Abood SK, Olivier BN. Cardiac effect of short-term experimental weight gain and loss in dogs. *Vet Rec* 2013; 172(6):153.
6. Diez M, Nguyen P. Obesity: Epidemiology, pathophysiology and management of the obese dog. *Encyclopedia of Canine Clinical Nutrition*. Aimargues, France: Royal Canin Centre de Recherche, 2006, pp 2-57.
7. German AJ, Martin L. Feline obesity: Epidemiology, pathophysiology and management. *Encyclopedia of Feline Clinical Nutrition*. Ithaca, NY: Royal Canin, 2008, pp 3-49.
8. Mazaki-Tovi M, Abood SK, Schenck PA. Effect of omega-3 fatty acids on serum concentrations of adipokines in healthy cats. *Am J Vet Res* 2011; 72(9):1256-1259.
9. German AJ. Barking up the wrong tree: What's the deal with obesity, adiponectin and inflammation in dogs? *Vet J* 2012; 194:272-273.
10. Tvarijonaviciute A, Ceron JJ, Holden SL, et al. Obesity-related metabolic dysfunction in dogs: A comparison with human metabolic syndrome. *BMC Vet Res* 2012; 8:147.
11. Tvarijonaviciute A, Tecles F, Martinez-Subiela S, Ceron JJ. Effect of weight loss on inflammatory biomarkers in obese dogs. *Vet J* 2012; 193:570-572.
12. Wakshlag JJ, Struble AM, Levine CB, et al. The effects of weight loss on adipokines and markers of inflammation in dogs. *Brit J Nutrit* 2011; 106:S85-S89.
13. Warren BS, Wakshlag JJ, Maley M, et al. Use of pedometers to measure the relationship of dog walking to body condition score in obese and non-obese dogs. *Brit J Nutrit* 2011; 106:S85-S89.
14. Wakshlag JJ, Struble AM, Warren BS, et al. Evaluation of dietary energy intake and physical activity in dogs undergoing a controlled weight-loss program. *JAVMA* 2012; 240(4):413-419.
15. National Research Council Ad Hoc Committee on Dog and Cat Nutrition. Nutrient Requirements of Dogs and Cats. Washington DC: *National Academics Press*, 2006, pp 35-7, 179-181, 231-234, 276-277.
16. Chauvet A, Laclair J, Elliott DA, German AJ. Incorporation of exercise, using an underwater treadmill, and active client education into a weight management program for obese dogs. *Can Vet J* 2011; 52:491-496.
17. Shmalberg J, Scott KC, Williams JM, Hill RC. Energy expenditure of dogs exercising on an underwater treadmill compared to that on a dry treadmill. *AAVN Proc*, 2013.
18. Corbee RJ. Obesity in show dogs. *J Anim Physiol Anim Nutr* 2012; epub ahead of print.
19. German AJ, Holden SL, Gernon LJ, et al. Do feeding practices of obese dogs, before weight loss, affect the success of weight management? *Brit J Nutr* 2011; 106:S97-S100.
20. Bland IM, Guthrie-Jones A, Taylor RD, Hill J. Dog obesity: Owner attitudes and behavior. *Prevent Vet Med* 2009; 92:333-340.
21. Wren JA, Ramudo AA, Campbell SL, et al. Efficacy and safety of dirlotapide in the management of obese dogs evaluated in two placebo-controlled, masked clinical studies in North America. *J Vet Pharmacol Thera* 2007; 30(S1):81-89.
22. Roudebusch P, Schoenherr WD, Delaney SJ. An evidence-based review of the use of therapeutic foods, owner education, exercise, and drugs for the management of obese and overweight pets. *JAVMA* 2008; 233(5):717-725.
23. Vasconcellos RS, Borges NC, Goncalves NV, et al. Protein intake during weight loss influences the energy required for weight loss and maintenance in cats. *J Nutrit* 2009; 139(5):855-860.
24. Wei A, Fascetti AJ, Liu KJ, et al. Influence of a high-protein diet on energy balance in obese cats allowed ad libitum access to food. *J Anim Physiol Anim Nutrit* 2011; 95:359-367.
25. Hewson-Hughes AK, Hewson-Hughes VL, Miller AT, et al. Geometric analysis of macronutrient selection in the adult domestic cat, *Felis catus*. *J Exp Biol* 2011; 214:1039-1051.
26. Henson MS, Hegstad-Davies RL, Wang Q, et al. Evaluation of plasma islet amyloid polypeptide and serum glucose and insulin concentrations in nondiabetic cats classified by body condition score and in cats with naturally occurring diabetes mellitus. *AJVR* 2011; 72(8):1052-1058.
27. Verkest KR, Fleeman LM, Rand JS, Morton JM. Evaluation of beta-cell sensitivity to glucose and first-phase insulin secretion in obese dogs. *AJVR* 2011; 72(3):357-366.
28. Verkest KR, Rand JS, Fleeman LM, Morton JM. Spontaneously obese dogs exhibit greater postprandial glucose, triglyceride, and insulin concentrations than lean dogs. *Domest Anim Endocrinol* 2012; 42:103-112.
29. German AJ, Holden SL, Bissot T, et al. A high protein high fibre diet improves weight loss in obese dogs. *Vet J* 2010; 183:294-297.
30. Wei A, Fascetti AJ, Villaverde C, et al. Effect of water content in canned food on voluntary food intake and body weight in cats. *Am J Vet Res* 2011; 72(7):918-923.
31. Cameron KM, Morris PJ, Hackett RM, Speakman JR. The effects of increasing water content to reduce the energy density of the diet on body mass changes following caloric restriction in domestic cats. *J Anim Physiol Anim Nutrit* 2011; 95:399-408.
32. Linder DE, Freeman LM. Evaluation of calorie density and feeding directions for commercially available diets designed for weight loss in dogs and cats *JAVMA* 2010; 236(1):74-77.
33. Linder DE, Freeman LM, Morris P, et al. Theoretical evaluation of risk for nutritional deficiency with caloric restriction in dogs. *Vet Quar* 2012; 32(3-4):123-129.
34. German AJ, Holden SL, Morris PJ, Biourge V. Long-term follow-up after weight management in obese dogs: The role of diet in preventing weight regain. *Vet J* 2012; 192:65-70.
35. Villaverde C, Ramsey JJ, Green AS, et al. Energy restriction results in a mass-adjusted decrease in energy expenditure in cats that is maintained after weight regain. *J Nutrit* 2008; 138:856-860.
36. German AJ, Holden SL, Mather NJ, et al. Low-maintenance energy requirements of obese dogs after weight loss. *Brit J Nutrit* 2011; 106:S93-S96.

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