

Short Review

Obesity in Canines: Issues, Causes, Treatments and Managements

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Abstract

Obesity is a nutritional disorder resulting due to positive energy balance in which excessive amount of adipose tissue is accumulated in the body of an organism. Determination of degree of obesity depends mainly on Body Condition Score (BCS) estimated by palpation of ribs, tail base etc. Dog with BCS “5 or 9” is considered to be obese depending on the system chosen i.e. 5 or 9 point system. Various metabolic disorder, neutering, age and sex, unhealthy diet etc. can be major causes of obesity. Osteoarthritis is one of the major issues related to obesity followed by cardiopulmonary disorder, urolithiasis, reproductive disorder etc. There is no specific treatment for obesity but dietary management plays pivotal role in weight reduction. Dietary management mainly includes L-carnitine and conjugated linoleic acid. L-carnitine enhances fatty acid oxidation whereas conjugated linoleic acid acts by inhibiting Stearoyl-CoA desaturase activity, which prevents the synthesis of monounsaturated fatty acids. Some Microsomal Triglyceride Transfer (MTP) protein inhibitors are also manufactured recently which prevents formation of chylomicrons and prevents its absorption from intestine.

Keywords: Adipokines; Chylomicrons; Conjugated linoleic acid; L-carnitine; Osteoarthritis; Urolithiasis

Introduction

Dogs are kept as a companion animal from centuries. Obesity is one of the major issues seen in canines maintained on a highly nutritious diet with lower exercise for energy utilization leading to positive energy balance [1]. It can be defined as an accumulation of excessive amounts of adipose tissue in the body. Dogs with body weight 15- 30 percent above normal is considered to be obese (17_Clinical_Weight_Management_for_Dogs_and_Cats.pdf, n.d.). Determination of obese

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condition in dogs mainly depends on (Table 1) fat mass and lean body mass. Body Mass Index (BMI) is used as a rough indication for obesity determination in humans. BMI in dogs can be predicted by calculating the ratio of pelvic circumference to the distance between the patella and the hock joint. Dogs are categorized as overweight and obese when BMI is greater than 25 kg/m² and 30kg/m² respectively. Some reports also suggested that dogs are overweight and obese when their body weight exceeds 15% and 30% above their normal body weight respectively [2]. But this technique proves to be unsuccessful due to the presence of diverse number of breeds with altered conformation [3]. The Body Condition Score (BCS) technique is also widely used for assessment of obesity and depends on visual interpretation (Table 2) and palpation of various body parts like ribs, tail base etc. to determine the amount of fat present. There are two main systems to determine the degree of obesity i.e. 5 and 9 point system in which “1” is considered to be emaciated and “5 or 9” is considered to be obese based on system chosen.

Condition	BCS	Findings	Fat (%)
Very thin	1/5	easily palpable rib cage, prominent bony structures	0
Lean	2/5	Skeletal structure visible	10
Optimal	3/5	easily palpable rib cage but not showing, smooth contour of tail base	20
Overweight	4/5	barely palpable rib cage, tail base thickened	30
Obese	5/5	Rib cage can't be palpated, tail base barely palpable	40

Table 1: Body Condition Scoring for dogs, adapted from Nelson and Couto.

Condition	BCS	Findings
Thin Dog	1	Ribs, lumbar vertebrae, and pelvic bones easily visible, No palpable fat, Obvious waist and abdominal tuck, Prominent pelvic bones
Underweight Dog	3	Ribs easily palpable, Minimal fat covering, Waist easily noted when viewed from above, Abdominal tuck evident
Ideal Dog	5	Ribs palpable, but not visible, Waist observed behind ribs when viewed from above, abdomen tucked up when viewed from side
Overweight Dog	7	Ribs palpable with slight excess of fat covering, Waist discernible when viewed from above, but not prominent, Abdominal tuck apparent
Obese Dog	9	Ribs not easily palpable under a heavy fat covering, Fat deposits over lumbar area and tail base, Waist barely visible to absent, No abdominal tuck; may exhibit obvious abdominal distention

Table 2: Body Condition Scoring for dogs [4].

The major constraints of BCS methods include the subjectivity of the measure, variation in the shape of body among different individuals and breeds and the fact that BCS does not consider lean mass during evaluation [5].

The adipokines are cytokines or signaling proteins synthesized by adipose tissue. Leptin was the first discovered adipokine in 1994. Leptin and adiponectin are the two major fat-derived adipokines. Leptin (composed of 167 amino acids) is a hormone discovered to

be produced by a gene named “Ob gene” located on chromosome number 7. In humans this hormone is produced mainly by the white adipose tissue and binds to a receptor present in brain responsible for controlling appetite [6]. Adiponectin (composed of 244 amino acids) is also a hormone produced mainly by mature adipocytes which contributes to increase insulin sensitivity, involved in glucose homeostasis and beta-oxidation of fatty acids. Relative or absolute deficiency of this hormone in circulation leads to obesity [7].

Various modern techniques like dual x-ray absorptiometry scan, deuterium oxide analysis, bioelectrical impedance analysis, densitometry, computed tomography, dilution methods, magnetic resonance imaging, neutron activation analysis etc. have been discovered to determine whether an animal is obese or not.

Causes of Obesity

Metabolic and endocrine disorder

Leptin and adiponectin are two major endocrine hormones associated with obesity. The fluctuation of leptin above or below the normal level circulating in the body results in uncontrolled feeding and results obesity [8]. Hypothyroidism, hyper-adrenocortism, diabetes mellitus, hypopituitarism, hyper-lipidemia and glucose intolerance can lead to obesity [9].

Effects of medicines

Drug-induced polyphagia caused by glucocorticoids and anticonvulsant drugs also causes obesity. Some chemicals like Gold thioglucose and monosodium glutamate were found to induce obesity in rodents. Most of the drug except antipsychotics doesn't possess any side-effects of inducing obesity. These drugs are believed to impair mitochondrial beta-oxidation of fatty acids, decrease energy expenditure and altered activity of hypothalamic leptin and neuropeptide Y which ultimately results obese condition in dogs [10].

Neutering

Spaying or neutering of dog's results in hormonal alterations that influence appetite, glucose tolerance, and adipose and lipid metabolism. Many studies revealed that the decrease in concentration of sex hormones leads to a decrease (25-30%) in metabolic rate after neutering resulting obesity [11].

Dietary factors and human-animal bond

Diet can also lead to the development of obesity in both dogs and cats due to impaired glucose tolerance, dyslipidemia, and insulin resistance when fed a high-fat, high-sucrose, and high-caloric diet (Levin & Dunn-Meynell, 2002). Diet-induced obesity is associated with insensitivity to leptin with high-circulating leptin levels leading to 'leptin resistance' [12]. Leptin is mainly associated with appetite control. Obesity in dogs is associated with the number of meals and snacks fed by their owners irrespective to their caloric value, the feeding of table scraps, and the dog's presence when its owners prepared or ate their own meal [13].

Genetic factors

Opined that some dog breeds possess [14,15] higher predisposition to obesity. Labrador Retrievers were found to have higher chance of developing obesity. Some other breeds with chances of being obese

includes Cairn terriers, Cocker spaniels, long-haired Dachshunds, Shetland sheepdogs, Basset hounds, Cavalier King Charles spaniels and Beagles. Greyhound is resistant of obesity.

Issues related to obesity

Orthopedic disorder

Osteoarthritis, Fractures (primarily humeral condyles), Cruciate ligament tears/rupture, Intervertebral disk disease are the major disorders associated with obesity in dogs. The increased body weight during obesity exerts excessive pressure on the joint and ligaments leading to degenerative effects and lameness. A number of studies depicted the relation between obesity and occurrence of osteoarthritis [16] and similarly the reduction in body weight can lead to improvement in the degree of lameness in dogs [17].

Diabetes

It is a common endocrinopathy in dogs of today's date resulting due to insulin deficiency. Lower level of adiponectin in obesity contribute to peripheral insulin resistance resembling the type I diabetes mellitus of humans [18]. The decreased level of adiponectin is due to increased production of pro-inflammatory cytokines like TNF and IL-6 [19].

Respiratory distress

Weight gain and rising BMI in human's leads to decrease in lung volume resulting restrictive type of ventilatory pattern on spirometer [20,21] also demonstrated that the incidence of asthma is higher in individual with higher BMI. So, it is also similar to dogs as that of humans. Excessive fat on the body of obese dog hinders the movement of diaphragm (expansion and relaxation) during respiration [22].

Heart diseases

Increased inter-ventricular septal width in diastole to left ventricular internal dimension in diastole ratio, decreased ratios of peak early to peak late left ventricular inflow velocities, and ratios of peak early to peak late mitral annular tissue velocities, and increased fractional shortening and ejection fraction percentages are the major cardiac changes associated with obese dogs over normal ones [23]. The metabolic alterations can result in cardiac dysfunction as a result of altered cardiac mitochondrial metabolism and resulting in intramyocardial lipid accumulation [24]. In the study performed by [25] Body Condition Score (BCS), modified body mass index (MBMI, kg/m²) and abdominal obesity were compared between healthy dogs and dogs affected with heart disease. The average BCS was found to be comparable between healthy dogs and dogs with heart disease. But the average MBMI was significantly higher in dogs with heart disease than in healthy dogs. Increased level of body fat in obese animals leads to increased blood pressure and can cause congestive heart failure [26].

Reproductive disorder

Obesity is associated with multiple reproductive disorders like infertility, ovulation dysfunction, fetal growth disorders and abortion too in some cases [27]. Obese animals possess higher risk of dystocia due to accumulation of fatty tissues around the pelvic cavity reducing the elasticity of pelvic ligaments which is must for parturition [28].

Urinary disorders

Increased retroperitoneal fat in obese dogs causes caudal displacements of urinary bladder leading to difficult and painful micturition. Some researchers have reported the higher incidence of urolithiasis in obese animals than normal ones [29]. Excess body weight in obese dogs causes increased abdominal pressure, which in turn leads to increased urethral mobility and bladder pressure, resulting to stress induced urinary incontinence [30].

Treatment and management

There are no specific pharmacological products for the correction of obesity. It mainly involves dietary management and physical exercise for weight reduction. Control of obesity will subsequently prevent all other effects on heart, urinary bladder, joints etc.

Dietary management

Dietary factors for weight reduction mainly include L-carnitine conjugated linoleic acid (CLA), and high-fiber diets.

- **L-Carnitine** is synthesized by De-novo pathway in the liver and kidneys from lysine and methionine in the presence of ascorbate. L-carnitine (@50–300 ppm) enhances nitrogen retention and reduces fatty tissues from the body. It acts by enhancing fatty acid oxidation and energy availability for protein synthesis during times of need [31].
- **Conjugated linoleic acid** is derived from linoleic acid and discovered to possess anti-adipogenic effect through various researches. It inhibits **Stearyl-CoA desaturase** activity, which inhibits the synthesis of monounsaturated fatty acids involved in triglyceride synthesis, and ultimately suppresses elongation and desaturation of fatty acids into long-chain fatty acids [32].
- In obese dogs the production of mediators of inflammation derived from adipose tissue is increased. So, diets enriched with **omega-3 polyunsaturated fatty acids** can be proven beneficial by reducing the production of lipid inflammatory mediators [33].

Obese dog provided with low-fat diet was found to have decreased level of serum [34]. Decrease in the degree of hindlimb lameness was found in obese dogs with coxofemoral osteoarthritis following diet-induced weight loss. Significant reductions in total serum cholesterol concentrations and systolic, diastolic and mean arterial blood pressures was noticed in dogs made obese with a high-fat diet then placed on a low-fat diet [35].

Exercise and lifestyle management

Dietary therapy used in conjunction with exercise facilitates rapid fat loss. Various exercises for canines include walking, running, hydrotherapy, treadmill, swimming [36] etc. The combined people and pet exercise program conducted by [37] documented the weight loss in both owner and pet where 15% of weight was reduced in case of dogs.

Note: Recently two anti-obesity drugs (Dirlotapide, Mitratapide) containing microsomal triglyceride transfer (MTP) protein inhibitors are formulated [38]. These drugs reduce the packaging of fatty acids and proteins into chylomicrons in the enterocytes of small intestine which is driven by MTP activity. Intracellular accumulation of fat molecules

due to MTP inhibition stimulates the release of peptide YY from the enterocyte of villi. The Peptide YY suppresses the synthesis of satiety hormone essential for signaling hypothalamus to control feed intake.

Conclusion

Obesity associated osteoarthritis and other detrimental effects in dogs can be controlled by exercise and dietary management. High fiber containing diet is to be provided to dogs as it contains lower nutritive value. Strict daily diet plan must be formulated for dogs with optimum energy and protein requirement. BCS of dog must be calculated by every veterinarian during each visit to determine whether an animal is obese or not.

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