



ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(7): 662-667
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www.thepharmajournal.com

Received: 01-05-2022

Accepted: 05-06-2022

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Canine obesity-prevalence, risk factors and management: A review

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Abstract

The canine obesity is a prevalent medical condition in dogs caused by the excess accumulation of fat with negative effects on quality of life, longevity and the risk of developing associated pathologies. Recent studies from several countries have indicated that between 15% to 65% of dogs are overweight or obese. Breed, age, gender, feeding type, neutering, housing, owner awareness, pet-owner relationship and environment all of these identified as potential risk factors for the development of obesity in dog. Obesity causes significant alteration in metabolic and hormonal parameters in dog, and predispose to conditions such as cardiovascular diseases, hypertension, respiratory distress, dermatological disorders, exercise intolerance, lameness and endocrinal diseases like diabetes mellitus and hypothyroidism. The dog obesity prevents by regular exercise and dietary management. The high fiber and low protein diet good for management of dog fobesity. This review paper uses recent scientific literature to discuss various aspects of canine obesity, including its prevalence, risk factors and management in dog.

Keywords: Obesity, prevalence, risk factors, dietary intervention

1. Introduction

Obesity is now a major worldwide non-communicable medical condition of humans and companion animals where the accumulation of excess body fat adversely affects the health of both (Kopelman, 2000) [34]. Obesity as it is a situation where an accumulation of an excessive quantity of fat in the body is takes placed. This is a result of an imbalance between the intake and usages of calories, when the intake is higher and the body stores these extra calories as fat (Markwell *et al.*, 1990) [39]. Dogs to be overweight if weight exceed 10 per cent and considered obese when weight is greater than 20 per cent above ideal weight, respectively (Burkholder and Baurer, 1998) [4]. Obesity is a prevalent medical condition in dogs caused by the excess accumulation of fat with negative effects on quality of life, longevity and the risk of developing associated pathologies (Rolph *et al.*, 2014) [52]. Obesity is officially classed as a disease and sadly it is the most common nutritional problem seen in our companion animals today. It is defined as an accumulation of excess amounts of body fat, to the point where the health of the animal is at risk. obesity has become an emerging challenge at global level to the practicing veterinarians and pet-owners which requires newer methods of diagnosis and treatment approaches for its effective control. Obesity is not a disease itself, but a status of the body/clinical sign, which has various predisposing factors to develop and itself predisposes the animal to other non-specific disorders (Shah *et al.*, 2017) [56]. Canine obesity is a common medical disorder and a known risk factor for obesity-related metabolic dysfunction. It can seriously influence various physiological functions the body, thereby limiting the longevity of the animals (Pereira-Neto *et al.*, 2018) [49]. Body condition score is an established, inexpensive, and non-invasive technique for assessing body fat percentage and is widely used in veterinary practice. A number of BCS charts are available and provide a simplified index (typically a five-point or a nine-point scale) of the amount of muscle and degree of fatness of a particular animal (Ricci and Bevilacqua, (2012) [50]. Obese dogs are more likely to suffer from osteoarticular disorders, heart problems, respiratory problems or skin disease. Obese dogs' owners do not have sufficient knowledge regarding treatment of obesity. The main preventive measures are daily exercise and providing the dog with correct food amount (Antoniou, 2018) [1] This review paper will use recent scientific literature to highlight key features of obesity in dogs, including its prevalence, proposed risk factors, management and associated conditions.

2. Prevalence of obesity in dogs

The results of multiples studies published in the last 15 years

suggest several countries have indicated that between 15% to 65% of dogs are overweight or obese.

Table 1: Prevalence of canine obesity in different countries

Country/place	No. of animals examined	Prevalence (%)	References
United Kingdom	Survey on 8268 dogs	21.4 %	Edney and Smith (1986) ^[15]
Australia	1093 dogs	7.6 %	McGreevy <i>et al.</i> (2005) ^[41]
California, United States	14670 dogs	14.8%	Weeth <i>et al.</i> (2007) ^[60]
Spain	127 dogs	66.1%	Pena <i>et al.</i> (2008) ^[47]
UK.	696 questionnaires	20.4%	Courcier <i>et al.</i> (2010) ^[9]
Span	1379 dogs	1.1%.	Corbee (2013) ^[7]
Great Britain	7847 dogs	3.4%	Courcier (2013) ^[10]
Beijing, China	2391 dogs	44.4%	Mao <i>et al.</i> (2013) ^[38]
Perth metropolitan	860 dogs	25%	Robertson (2003) ^[51]
Portugal mainland	Online questionnaires	40%	Payan-Carreira <i>et al.</i> (2015) ^[46]
Victoria, Australia	Online survey	40%	Howell <i>et al.</i> (2016) ^[26]
Thailand	2401 dogs	42.94%	Tawatsin (2016) ^[57]
Japan	5827 dogs	39.8 %	Usui <i>et al.</i> (2016) ^[59]
European countries	3,185 questionnaires	31.3%	Lavrador <i>et al.</i> (2018)
Manizales	1060 cases	24.40%	Robertson (2003) ^[51]
North Island	24,247 records	2.3%	Gates <i>et al.</i> (2019) ^[18]
Ludhiana, Punjab	500 dogs	14%	Gurpreet (2019) ^[22]

3. Risk factors related with dog obesity

The cause of dog obesity includes both dog and owner factors. The following factors were reported in studies related with dog obesity.

3.1 Dog factors

3.1.1 Age

Most of recent studies showed that dogs of old age were more risk for obesity (Mao *et al.*, 2013) ^[38]. Obesity appeared to peak around the 10th year of age and then gradually declines most probably reason because older dogs start to lose weight because of various diseases processes related to old age or because obese dogs die earlier than lean ones (Kealy *et al.*, 2002) ^[31]. The risk of obesity increases dramatically with age from 2-3 years of age, chances of obesity increased 2.74 folds to for more than 12 years of age, obesity increased 4.65 folds (Colliard *et al.* 2006; McGreevy *et al.* 2005) ^[6, 41]. The body condition score significantly associates with dog age. The height prevalence of dog become overweight or obese between 7.5–9.9 years (71%) (Holmes *et al.*, 2007) ^[24]. Usui *et al.* (2016) ^[59] reported that obesity increases with age and most probabilities of dogs become obese or overweight were between 7 and 9 years of age, with the probabilities then declining as the dogs got older. Some recent study showed that the incidence of obesity increases to a maximum as dogs reach middle age (8-11 years) (Mason, 1970; McGreevy *et al.*, 2005; Payan-Carreira *et al.*, 2015) ^[40,41,46], which can be due to a decrease in metabolic rate as an animal age (Gossellin *et al.*, 2007) ^[21].

3.1.2 Breeds

The certain breeds were more likely to be overweight (Labrador/Cocker Spaniel / Dalmatians / Dachshund / Rottweiler / Golden Retriever / Shetland Sheepdog / Mixed breed) and more likely to be obese (Labrador/Dachshund/Golden retriever (Colliard *et al.* 2006; Lund *et al.* (2006) ^[6,37]. Breeds of dogs viz Labrador Retrievers - Cavalier King Charles spaniels - Cocker spaniels - Beagles had higher prevalence of obesity in canine (German, 2010; Payan-Carreira *et al.*, 2015). Corbee (2013) ^[19, 46, 7] reported that there were significant differences in obesity between breeds. Some groups of breeds had a significant

higher BCS (Molossoid breeds, Swiss Mountain and Cattle dogs, Asian spitz and related breeds, Scent hounds, Retrievers, Water dogs, Bichons), whereas some breed groups had a significantly lower BCS (i.e. Sight hounds). German *et al.* (2017) ^[20] found high prevalence of obesity was Beagle, Cavalier King Charles spaniel, golden retriever, Labrador retriever and pug. The medium sized dogs were also associated with high probability of obesity like Beagle and Corgis were 1.4 times more obese than toy breed dogs. There was a difference of level of energy expenditure regards of breeds (Usui *et al.* 2016) ^[59]. Antoniou (2018) ^[1] studied on 249 dogs took part in the survey including pure breed dogs as well as crossbred ones and found that most obese dogs belong to these breeds: Beagles, Labrador Retrievers, Pekingese, Dachshund, as well as crossbreed dogs. Gurpreet (2019) ^[22] reported that highest prevalence was recorded in Labrador Retriever, Pug, Beagle, Spitz, German Shepherd, Toy Pom, Boxer, Dachshund, Cocker Spaniel, and mixed breed.

3.1.3 Gender

The highest prevalence of dog obesity found in female than in male dogs. The dog obesity increases with age, there was increase in incidence of canine obesity in both sexes (Colliard *et al.* 2006) ^[6]. Payan-Carreira *et al.* (2015) ^[49], Daija (2017) ^[12], Honrado (2018) ^[25] who found higher prevalence of obesity in female dogs than male dogs.

3.1.4 Neutering

Jeusette *et al.* (2004) ^[29] and Mc Greevy *et al.* (2005) ^[41] documented that higher incidence of obesity in neuter dogs of either sex was due to reduced metabolic rate. Colliard *et al.* (2006) ^[6] observed that risk of obesity increased 2.23-fold in neutered dogs than normal dogs. Mao *et al.* (2013) ^[38] observed that obesity rate was higher in spayed female dogs (67.3%) than in neutered males (52.7%). BSC significantly positively correlated with neutered status of dog. Payan-Carreira *et al.* (2015) ^[49] and Usui *et al.* (2016) ^[59] reported that obesity was more frequent in females than males and in spayed dogs. The feeding behaviour and metabolic rate of a neutered dog changes and the dog begins to consume more food than before and in association with decreased metabolic activity the animal is susceptible in ending up obese (Kawauchi *et al.*, 2017) ^[30].

3.2 Owner factors

3.2.1 Type of food

The improper feeding frequency and diet selection, ad-libitum feeding, supplementation, feeding homemade meals and feeding behaviour lead to excess calorie consumption. Begging, competitive eating with other pets and specific food addictions are problems in some homes and are identifiable risk factors. The number of meals and snacks was greater in obese dogs than in normal dogs. Obese dogs were more often fed kitchen scraps in addition to their meals (Crane, 1991; Kienzle *et al.*, 1998) ^[11,33]. The obese cats more commonly have a free choice of food intake. Even dogs fed according to the label instructions of commercial foods can gain weight as the energy recommendations for dogs provided by Nutrient Requirement of Dogs (NRC, 2006) ^[42] seems to be excessive. (Kienzle, 2002; Center, 2003) ^[32]. Obese dogs were fed a greater number of treats or snacks and fed different pattern from the owners of normal weight dogs and dogs fed only one meal or more than three meals were at greater risk of obesity (Bland *et al.*, 2009) ^[3]. The dogs are perceived to have good or very good appetite had 3.42-fold greater odds for obesity than individuals with bad or very bad appetite. Dogs fed table foods or home-made diets had 2.06-fold greater odds of obesity than those that were not given these food items. Courcier (2013) ^[10] found that dogs whose owners reported feeding table scraps monthly were more likely to be classed as obese rather than ideal and dogs who received any frequency of snacks and treats were significantly more likely to be overweight than ideal. Yam *et al.* (2017) ^[61] reported that owners could not correctly estimate how much wet and dry food to feed. Owner education to improve these skills is needed if dogs are to be fed correctly.

3.2.2 Feeding frequency

The obese dogs where several feeding times were associated with higher rates of obesity in dogs. Robertson (2003) ^[51] reported that feeding frequency once a day was more obese. Pak (2014) ^[45] and German (2010) ^[19] reported that feeding frequency was significantly effect on obesity in dogs. Mao *et al.* (2013) ^[38] reported that obese dogs were several feeding times were associated with higher rates of obesity in dogs.

3.2.3 Exercise

The higher energy food intake with short duration of exercise led to positive energy balance leading to excessive fat accumulation in dogs (Mao *et al.*, 2013) ^[38]. Fisher *et al.* (2013) ^[17] reported that exercise is beneficial for weight loss if the exercise programme is adhered to. However, we do not disagree with the contention that exercise recommendations may be difficult to complete for individuals who are already overweight or obese. We also feel there is a need for larger supervised exercise training studies with more sophisticated techniques (such as doubly labelled water) to assess energy expenditure. Bland *et al.* (2009) ^[3] reported that animals exercised less were more prone to obesity. normal weight dogs being exercised daily compared to weekly for overweight or mixed weight dogs. Owners who indicated that their dog was confined to a yard as its exercise regime rather than walked were also significantly more likely to be an obese or mixed weight household.

3.2.4 Housing

The type of housing has also been significantly associated with canine overweight/obesity. Dogs in apartments being at

greater risk of overweight/obesity. 62.2 % of obese dogs lived in apartment buildings, while 37.7% lived in houses (Colliard *et al.*, 2006) ^[6]. Bland *et al.* (2009) ^[3] reported that dogs reared in houses with a greater number of people was less prone to obesity as a greater number of people lead to playful environment resulting in greater expenditure of energy. Lorin (2016) ^[36] and Tawatsin (2016) ^[57] reported that canine obesity depended on owner age, sex, household person, feeding, exercise duration. Antoniou (2018) ^[1] conducted a survey on 249 purebred and crossbred dogs and found that 62.50 % of owners who keep more than one dog in the household indicate a lack of attention to each of their dog's health and weight statuses as well as 57.45 % of owners are not aware of preventive measures for obesity.

3.2.5 Owner awareness

The risk factors associated with obesity prevention and early detection of obesity leads to better health care. Many owners do not know if the dog is obese, or do not know why it is dangerous. One way to prevent obesity may therefore be to increase the owners' awareness and knowledge about obesity and how the dog is kept at normal body condition. The owner misperception of canine body shape was widespread within our study population. Under estimation seemed to follow owner demographic and socioeconomic lines. Understanding the complexity of factors that lead to misperception may be instrumental in canine obesity prevention and treatment (Courcier *et al.*, 2009; Nilsson, 2012) ^[8, 43]. Canine obesity is a prevalent disease, but many owners are unaware of it, partly due to misperception of their dog's body shape. Most owners incorrectly estimated their dog's body condition, both with (64 %) and without (65 %) the chart. Eastland-Jones *et al.* (2014) ^[14] reported that canine obesity is a prevalent disease, but many owners are unaware of it, partly due to misperception of their dog's body shape. Most owners incorrectly estimated their dog's body condition, both with (64 %) and without (65 %) the chart. Howell *et al.* (2016) ^[26] reported that some owners are unaware of what an ideal body condition looks like. 85% of owners indicate that their dog is neither overweight nor underweight, even though research suggests that up to 40% of dogs are obese.

The owners are not aware of preventive measures for obesity. Dogs whose owners provide them dry food once a day or constantly, do not estimate their feed amount, giving table scraps and treats are more likely to be obese. obesity is related to dog owner's attitude while 69.83% of dog owners who own obese dogs aren't aware of their dog's weight (Antoniou, 2018) ^[1].

4. Obesity related disorders

Canine obesity as a condition that leads to serious alterations in various body functions and limits the longevity of the animals (Kealy *et al.*, 2002) ^[31]. Overweight or obesity are also associated with serious medical diseases, including cardiovascular and musculoskeletal disease. Most significantly, dogs that are overweight or obese have a significantly reduced lifespan compared to dogs that maintain a healthy body condition over the course of their life (Hurley *et al.*, 2011) ^[27]. Handl and Iben (2012) ^[23] reported that a number of diseases have been associated with obesity, including orthopaedic disorders, skin disorders, heart disease, diseases of the urinary tract, diabetes mellitus and cancer. Obesity lowers exercise tolerance as well as reduces quality of life and longevity. Nilsson (2012) ^[43] reported that the

consequences of obesity are believed to be metabolic and hormonal changes, as well as cardiovascular and respiratory diseases, orthopedic problems, tumors and premature death. The obese dogs are more likely to suffer from osteoarticular disorders, heart problems, respiratory problems or skin disease. Obese dogs' owners do not have sufficient knowledge regarding treatment of obesity. The main preventive measures are daily exercise and providing the dog with correct food amount (Antonίου, 2018) ^[1].

5. Therapeutic and management of canine obesity

5.1 Dietary intervention

A restricted energy supply with a low-energy and high protein: energy-ratio diet allowed a very satisfactory weight loss in obese dogs, quantitatively and qualitatively, because dogs returned to their basal weight and fat-free mass. However, in the obese state the fat mass increased much more, and the percent of the fat-free mass diminished significantly, representing ~67% vs. 83% in the dogs with ideal body weight (Blanchard *et al.* (2004) ^[2]). The high protein low carbohydrate diet use in obese dogs was reducing body fat content and body weight. The BCS and both thoracic and pelvic circumferences were significantly and positively correlated with excess body weight (Diez *et al.*, 2002) ^[13]. The high fiber diet can be used to dilute or reduce the calorie density of foods, which can aid in calorie restriction for weight loss (Fekete *et al.* (2001) ^[16]). Jena *et al.* (2002) ^[28] studied that (-) Hydroxycitric acid is the principal acid of fruit rinds of *Garcinia cambogia*. HCA exerts its anti-obesity effect by inhibiting ATP citrate lyase, consequently inhibiting the cleavage of citrate to oxaloacetate and acetyl-CoA, a key molecule, which plays a critical role in energy storage as fat. Now, instead of wasting energy to synthesize fat, the energy is diverted to the production of glycogen in the liver and muscles. This slows the production of fatty acids, cholesterol, and triglycerides with the net effect of reduced fat production and storage. Oluyemi *et al.* (2007) ^[44] conducted an experimental study to investigate the anti-obesity and erythropoietic effects of crude ethanolic extracts of *Garcinia cambogia* (bitter kola) seeds on Wistar rats (*Rattus norvegicus*). The result showed a significantly increase in RBC counts in both test groups and a decrease in weights of experimental animals. There was a dose-dependent decrease in the plasma level of very-low-density lipoprotein and a dose-dependent increase in the level of chylomicrons. There was a significantly, decrease in the level of high-density lipoprotein and a significantly increase in the level of LDL (low-density lipoprotein). There was significantly dose dependent decrease in the TAG (triacylglycerol) pool of adipose tissue and the liver of the test groups, but a significantly increase in the TAG pool of the gastrointestinal system. The increase in the TAG pool of the gastrointestinal system is possibly compensatory. The results therefore confirm that ethanolic extracts of *G. cambogia* seeds have both anti-obesity and erythropoietic effects. The decrease in the high-density-lipoprotein level and an increase in the LDL level may play an important role in cardiovascular disease. Toromanyan *et al.* (2007) ^[58] reported that HCA increases the release or availability of serotonin in the brain, thereby leading to appetite suppression. Roudebush *et al.* (2009) ^[58] found that High-fiber and protein diets which are lower in fat content have been shown to effectively promote weight loss while maintaining lean tissue mass.

The *Garcinia cambogia* is a rich source of hydroxycitric acid

(HCA), the active agent that aids in weight loss by inhibiting fat production and suppressing appetite. Hydroxycitric acid (HCA) inhibits an enzyme that helps the body synthesize fat for storage in adipose tissue. HCA promotes energy, inhibits lipogenesis, lowers the production of cholesterol and fatty acids, increases the production of glycogen in the liver, suppresses appetite, and increases the body's production of heat by activating the process of thermogenesis (Sethi, 2011) ^[55].

Pena *et al.* (2014) ^[48] planned a study to compare the impact on blood pressure and different metabolic parameters of a weight-loss program on obese dogs fed on a low-fat high-fibre diet and treated with and without mitratapide. Observation revealed that at the end of treatment (85 day) all parameters viz; body condition score, body weight, heart rate, systolic and diastolic blood pressures; total cholesterol, triglycerides and glucose levels; alanine aminotransferase and alkaline phosphatase activity had decreased in both groups but diastolic blood pressure, total cholesterol and alanine aminotransferase, significantly lower in dogs treated with mitratapide. The use of mitratapide in addition to low-fat high-fibre diet does not seem to offer any further useful effect in the loss of weight during the treatment of canine obesity. Whereas, mitratapide seems to present certain beneficial effects on pathologies associated with obesity, these being mainly related to blood pressure, lipids and hepatic parameters. The extracts as well as hydroxy citric acid (HCA), a main organic acid component of the fruit rind exhibited anti-obesity activity including reduced food intake and body fat gain by regulating the serotonin levels related to satiety, increased fat oxidation and decreased de novo lipogenesis. HCA is a potent inhibitor of adenosine triphosphate-citrate lyase, a catalyst for the conversion process of citrate to acetyl-coenzyme A, which plays a key role in fatty acid, cholesterol and triglycerides syntheses. The crude extract or constituents from the plant also exerted hypolipidemic, antidiabetic, anti-inflammatory, anticancer, anthelmintic, anticholinesterase and hepatoprotective activities *in vitro* and *in vivo* models (Semwal *et al.*, 2015) ^[54].

6. Conclusions

The present study concluded that canine obesity is most prevalent condition in companion animals, with recent epidemiological studies indicating that between 15% to 65% of dogs are overweight or obese. The potential risk factors associated with obesity in dogs were gender, middle age, less awareness about obesity and body condition score among owner, numbers of pets, homemade diets, and several time feeding. Duration and status of exercise, feeding person have major role in development of obesity. Dogs that lived in apartments or double story buildings or those reared by families having member's 1-2 persons were at higher risk of obesity. Breeds like Labrador Retriever, cross bred, Pug, Beagle and German Shephard were more prone to obesity. Skin diseases, bone problem, respiratory distress and hypothyroidism were more associated with obesity in dogs. Evaluation of therapeutic response of dietary interventions on obesity was estimated on the basis of reduction in initial body weight. Body weight and BSC are the best techniques commonly used in small animal practice. It is recommended that estimation of body weight, body condition score, should be part of routine health assessments for dogs so that obesity can be identified and management.

7. Acknowledgements

The authors acknowledge the help and permission provided by the Head of Department of Veterinary Clinical Medicine, College of Veterinary and Animal science, Bikaner also the permission and help by the Dean, College of Veterinary and Animal science, Bikaner is thankfully acknowledged.

9. Conflict of interest: Authors are thankful to Dean, CVAS Bikaner for financial support and provided facility.

10. Authors Contribution: Part of M.V.Sc research work carried out by Yogendra Kumar Meena under the guidance of Assistant Professor Sitaram Gupta.

11. References

- Antoniou N. Analysis of dog obesity in Cyprus Paphos X small animal clinic. Master thesis submitted to Lithuanian University of Health Sciences, Kaunas, Luthiana, 2018.
- Blanchard G, Nguyen P, Gayet C, Leriche I, Siliart B, Paragon BM. Rapid weight loss with a high-protein low-energy diet allows the recovery of ideal body composition and insulin sensitivity in obese dogs. *The Journal of Nutrition*. 2004;134(8):2148S-2150S.
- Bland IM, Guthrie-Jones A, Taylor RD, Hill J. Dog obesity: Owner attitudes and behaviour. *The Preventive Veterinary Medicine*. 2009;92(4):333-340.
- Burkholder WJ, Bauer JE. Foods and techniques for managing obesity in companion animals. *Journal of America Veterinary Medicine Association*. 1998;212(1):658-662.
- Center S. Obesity prevention. *Pet Food Industry*. 2003;45:12-17.
- Colliard L, Ancel J, Benet JJ, Paragon BM, Blanchard G. Risk factors for obesity in dogs in France. *The Journal of Nutrition*. 2006;136(7):1951-1954.
- Corbee RJ. Obesity in show dogs. *Journal of Animal Physiology and Animal Nutrition*. 2013;97(5): 904-910.
- Courcier E, Yam PS, Thomson RM, Mellor DJ. Owner misperception of canine body shape: An important determinant of canine obesity. In *International Symposia on Veterinary Epidemiology and Economics*, Durban, Africa. do Sul. Theme, 2009.
- Courcier EA, Thomson RM, Mellor DJ, Yam PS. An epidemiological study of environmental factors associated with canine obesity. *Journal of Small Animal Practice*. 2010;51(7):362-367.
- Courcier Emily. Investigating the epidemiology of companion animal overweight/obesity in Great Britain. Ph.D. thesis submitted to University of Glasgow, 2013.
- Crane SW. Occurrence and management of obesity in companion animals. *Journal of Small Animal Practice*. 1991;32(6):275-282.
- Daija N. Obesity in dogs and its impact on diabetes mellitus. *Anglisticum Journal*. 2017;6(4):50-54.
- Diez M, Nguyen P, Jeusette I, Devois C, Istasse L, Biourge V. Weight loss in obese dogs: Evaluation of a high-protein, low-carbohydrate diet. *The Journal of Nutrition*. 2002;132(6):1685-1687.
- Eastland-Jones RC, German AJ, Holden SL, Biourge V, Pickavance LC. Owner misperception of canine body condition persists despite use of a body condition score chart. *Journal of Nutritional Science*. 2014;3(45):1-5.
- Edney ATB, Smith PM. Study of obesity in dogs visiting veterinary practices in the Kingdom. *Veterinary Record*. 1986;118:391-396.
- Fekete S, Hullar I, Andrasofszky E, Rigo Z, Berkenyi T. Reduction of the energy density of cat foods by increasing their fibre content with a view to nutrients digestibility. *Journal of Animal Physiology and Animal Nutrition*. 2001;85(7-8):200-204.
- Fisher G, Hunter GR, Allison DB. Commentary: Physical activity does influence obesity risk when it actually occurs in sufficient amount. *International Journal of Epidemiology*. 2013;42(6):1845-1848.
- Gates MC, Zito S, Harvey LC, Dale A, Walker JK. Assessing obesity in adult dogs and cats presenting for routine vaccination appointments in the North Island of New Zealand using electronic medical records data. *New Zealand Veterinary Journal*. 2019;67(3):126-133.
- German A. Obesity in companion animals. *British Medical Journal (In Practice)*. 2010;32(2):42-50.
- German AJ, Blackwell E, Evans M, Westgarth C. Overweight dogs exercise less frequently and for shorter periods: Results of a large online survey of dog owners from the UK. *Journal of Nutritional Science*. 2017;6(11):1-4.
- Gossellin J, Peachey S, Sherington J, Rowan TG, Sunderland SJ. Evaluation of dirlotapide for sustained weight loss in overweight Labrador retrievers. *Journal of Veterinary Pharmacology and Therapeutics*. 2007;30:55-65.
- Gurpreet. Risk factors and diagnosis of obesity in companion dogs. M.V.Sc Thesis submitted to Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana, 2019.
- Handl S, Iben C. The current situation of obesity in the dog and cat. I: Risk factors, associated diseases and pathophysiological background. *Kleintierpraxis*, 2012;57(4):196-207.
- Holmes KL, Morris PJ, Abdulla Z, Hackett R, Rawlings JM. Risk factors associated with excess body weight in dogs in the UK. *Journal of Animal Physiology and Animal Nutrition*. 2007;91(3-4):166-167.
- Honrado SA. Risk factors for the development of overweight and obesity in dogs. Doctoral thesis submitted to University of Lisbon Veterinary Medicine College, 2018.
- Howell TJ, Mornement K, Bennett PC. Pet dog management practices among a representative sample of owners in Victoria, Australia. *Journal of Veterinary Behavior*. 2016;12:4-12.
- Hurley KJ, Elliott DA, Lund E. *The Health Benefits of Dog Walking for Pets and People: Evidence and Case Studies*. 1st ed. Purdue University Press, West Lafayette, USA, 2011, 125-146.
- Jena BS, Jayaprakasha GK, Singh RP, Sakariah KK. Chemistry and biochemistry of (-)-hydroxycitric acid from *Garcinia*. *Journal of Agricultural and Food Chemistry*. 2002;50(1):10-22.
- Jeusette I, Detilleux J, Cuvelier C, Istasse L, Diez M. Ad libitum feeding following ovariectomy in female Beagle dogs: Effect on maintenance energy requirement and on blood metabolites. *Journal of Animal Physiology and Animal Nutrition*. 2004;88(3-4): 117-121.
- Kawauchi IM, Jeremias JT, Takeara P, de Souza DF, de Carvalho Balieiro JC, Pfrimer K, *et al.* Effect of dietary protein intake on the body composition and metabolic

- parameters of neutered dogs. *Journal of Nutritional Science*. 2017;6(40):1-5.
31. Kealy RD, Lawler DF, Ballam JM, Mantz SL, Biery DM, Greeley EH, *et al.* Effect of diet restriction on lifespan and age-related changes in dogs. *Journal of Animal Veterinary Medicine Association*. 2002;220(9):1315-1320.
 32. Kienzle E. Calculation of gross energy in pet foods: Do we have the right values for heat of combustion. *The Journal of Nutrition*. 2002;132(6):1799-1800.
 33. Kienzle E, Bergler R, Mandernach A. A comparison of the feeding behavior and the human-animal relationship in owners of normal and obese dogs. *The Journal of Nutrition*. 1998;128(12):2779-2782.
 34. Kopelman PG. Obesity as a medical problem. *Nature*. 2000;404(6778):635.
 35. Lavrador C, Lamy E, Capela F, Lucena S. European dog owner perceptions of obesity and factors associated with human and canine obesity. *Scientific Reports*. 2018;8(13353):1-10.
 36. Lorin M. The role of dog owners' behaviour in canine obesity. Doctoral thesis submitted to University Of Veterinary Medicine, Budapest Department of Animal Breeding, Nutrition and Laboratory Animal Science, Department of Biomathematics and Informatics, Budapest, Hungary, 2016.
 37. Lund EM, Armstrong PJ, Kirk CA, Klausner JS. Prevalence and risk factors for obesity in adult dogs from private US veterinary practices. *International Journal Application Research of Veterinary Medicine*. 2006;4:177-186.
 38. Mao J, Xia Z, Chen J, Yu J. Prevalence and risk factors for canine obesity surveyed in veterinary practices in Beijing, China. *Preventive Veterinary Medicine*. 2013;112(3-4):438-442.
 39. Markwell PJ, Van Erk W, Parkin GD, Sloth CJ, Shantz-Christienson T. Obesity in the dog. *Journal of Small Animal Practice*. 1990;31(10): 533-537.
 40. Mason E. Obesity in pet dogs. *Veterinary Record*. 1970;86(21):612-613.
 41. McGreevy PD, Thomson PC, Pride C, Fawcett A, Grassi T, Jones B. Prevalence of obesity in dogs examined by Australian veterinary practices and the risk factors involved. *Veterinary Record*. 2005;156:695-702.
 42. National Research Council. *Nutrient requirements of dogs and cats*. National Academies Press. Washington, USA, 2006, Pp 424.
 43. Nilsson J. Obesity in dogs-proportion obese, risk factors, consequences, and how obesity can be prevented and the incidence reduced. A student report submitted to Swedish University of Agricultural Sciences, Department of Animal Environment and Health Veterinary Nurse Programme, 2012.
 44. Oluyemi KA, Omotuyi IO, Jimoh OR, Adesanya OA, Saalu CL, Josiah SJ. Erythropoietic and anti-obesity effects of *Garcinia cambogia* (bitter kola) in Wistar rats. *Biotechnology and Applied Biochemistry*. 2007;46(1):69-72.
 45. Pak SI. A cross-sectional study on the prevalence of canine obesity and associated risk factors in Chuncheon, Kangwon Province. *Journal of Veterinary Clinics*. 2014;31(1):31-35.
 46. Payan-Carreira R, Sargo T, Nascimento MM. Canine obesity in Portugal: Perceptions on occurrence and treatment determinants. *An international journal of Scandinavian Studies*. 2015;57(1):8.
 47. Pena C, Suarez L, Bautista I, Montoya JA, Juste MC. Relationship between analytic values and canine obesity. *Journal of Animal Physiology and Animal Nutrition*. 2008;92(3):324-325.
 48. Pena C, Suarez L, Bautista-Casta no I, Juste MC, Carretón E, Montoya-Alonso JA. Effects of low-fat high-fiber diet and mitratapide on body weight reduction, blood pressure and metabolic parameters in obese dogs. *Journal of Veterinary Medical Science*. 2014.76(9):1305-1308.
 49. Pereira-Neto GB, Brunetto MA, Oba PM, Champion T, Villaverde C, Vendramini TH, *et al.* Weight loss improves arterial blood gases and respiratory parameters in obese dogs. *Journal of Animal Physiology and Animal Nutrition*. 2018;102(6):1743-1748.
 50. Ricci R, Bevilacqua F. The potential role of leptin and adiponectin in obesity: A comparative review. *The Veterinary Journal*. 2012;191(3):292-298.
 51. Robertson ID. The association of exercise, diet and other factors with owner-perceived obesity in privately owned dogs from metropolitan Perth, WA. *Preventive Veterinary Medicine*. 2003;58(1-2):75-83.
 52. Rolph NC, Noble PJM, German AJ. How often do primary care veterinarians record the overweight status of dogs? *Journal of Nutritional Science*. 2014;3(58):1-5.
 53. Roudebush 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. *American Veterinary Medical Association*. 2009;233(5):717-725.
 54. Semwal RB, Semwal DK, Vermaak I, Viljoen A. A comprehensive scientific overview of *Garcinia cambogia*. *Fitoterapia*. 2015;102:134-148.
 55. Sethi A. A review on *Garcinia cambogia*- A weight controlling agent. *International Journal of Pharmaceutical Sciences Review and Research*. 2011;3(10):13-24.
 56. Shah B, Jani R, Bhadesiya C. Obesity in dogs-A mini review. *Biosciences*. 2017;10(10):1865-1867.
 57. Tawatsin A. Prevalence, perception and risk factors of canine obesity in Thailand. Doctoral thesis submitted to Chulalongkorn University, 2016.
 58. Toromanyan E, Aslanyan G, Amroyan E, Gabrielyan E, Panossian A. Efficacy of Slim339® in reducing body weight of overweight and obese human subjects. *Phytotherapy Research: An International Journal Devoted to Pharmacological and Toxicological Evaluation of Natural Product Derivatives*. 2007;21(12):1177-1181.
 59. Usui S, Yasuda H, Koketsu Y. Characteristics of obese or overweight dogs visiting private Japanese veterinary clinics. *Asian Pacific Journal of Tropical Biomedicine*. 2016;6(4): 338-343.
 60. Weeth LP, Fascetti AJ, Kass PH, Suter SE, Santos AM, Delaney SJ. Prevalence of obese dogs in a population of dogs with cancer. *American Journal of Veterinary Research*. 2007;68(4): 389-398.
 61. Yam PS, Naughton G, Butowski CF, Root AL. Inaccurate assessment of canine body condition score, bodyweight, and pet food labels: A potential cause of inaccurate feeding. *Veterinary Sciences*, 2017.