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Clinical, Behavioral, and Laboratory Changes Associated with Overweight and Obesity in Dogs

Alterações Clínicas, Comportamentais e Laboratoriais em Cães com Sobrepeso e Obesidade

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Abstract

Canine obesity is a prevalent condition in veterinary medicine, associated with comorbidities such as *diabetes mellitus*, osteoarthritis, and cardiovascular diseases, directly impacting health and quality of life. This cross-sectional study aimed to analyze complications of excess weight in dogs, correlating it with dietary patterns, physical activity, owner-animal interaction, and evaluating its association with clinical, laboratory, and cardiological parameters. Twenty-five overweight dogs (aged 1 to 12 years; 88% neutered) were included. The methodology encompassed clinical evaluation, laboratory tests (lipid and biochemical profiles), electrocardiogram, systolic blood pressure measurement, and a structured questionnaire administered to owners. Results revealed a predominance of body condition scores 7-8 (9-point scale), increased appetite (68%), and lack of dietary control by owners (48%). Neutering showed a positive correlation with post-procedure weight gain. Although 55% of dogs exercised, 84% exhibited exercise intolerance, more prevalent in individuals with higher body condition scores. A gradual increase in systolic blood pressure was observed with higher body condition scores. Electrocardiographic

alterations (52%) and hypertriglyceridemia (64%) emerged as significant findings. It is concluded that factors such as neutering, inadequate diet, and sedentary behavior contribute to canine obesity, with significant metabolic and cardiovascular repercussions. Multidisciplinary strategies, including nutritional education, strict dietary control, and exercise adapted to individual tolerance, are essential to mitigate risks and promote animal welfare.

Keywords: Electrocardiographic Alterations. Exercise Intolerance. Hypertriglyceridemia. Neutering. Systolic Blood Pressure.

Resumo

A obesidade canina configura-se como uma condição prevalente na medicina veterinária, associada a comorbidades como *diabetes mellitus*, osteoartrite e doenças cardiovasculares, com impacto direto na saúde e qualidade de vida. Este estudo transversal objetivou analisar complicações do excesso de peso em cães, correlacionando-o a padrões alimentares, atividade física, interação tutor-animal, e avaliar sua associação com parâmetros clínicos, laboratoriais e cardiológicos. Foram incluídos 25 cães com sobrepeso (idade entre 1 e 12 anos; 88% castrados). A metodologia abrangeu avaliação clínica, exames laboratoriais (perfil lipídico e bioquímico), eletrocardiograma, mensuração da pressão arterial sistólica e aplicação de questionário estruturado aos tutores. Os resultados evidenciaram predominância de escore corporal 7-8 (escala de nove pontos), aumento de apetite (68%) e ausência de controle alimentar pelos tutores (48%). A castração apresentou correlação positiva com ganho de peso pós-procedimento. Apesar de 55% dos cães praticarem exercícios, 84% exibiram intolerância à atividade física, mais prevalente em indivíduos com maior escore corporal. Observou-se incremento gradativo da pressão arterial sistólica conforme à elevação do escore corporal. Alterações eletrocardiográficas (52%) e hipertrigliceridemia (64%) emergiram como achados relevantes. Conclui-se que fatores como castração, dieta inadequada e sedentarismo contribuem para a obesidade canina, com repercussões metabólicas e cardiovasculares significativas. Estratégias multidisciplinares, incluindo educação nutricional, controle alimentar rigoroso e exercícios adaptados à tolerância individual, são fundamentais para mitigar riscos e promover o bem-estar animal.

Palavras-chave: Alterações Eletrocardiográficas. Castração. Hipertrigliceridemia. Intolerância ao Exercício. Pressão Arterial Sistólica.

1 Introduction

Canine obesity has become an increasingly common condition, with prevalence rates ranging between 20% and 50% in different populations (Blanchard *et al*., 2024; Cita *et al*., 2024; German, 2006; Montoya *et al*., 2025). This condition is directly associated with various comorbidities, such as diabetes mellitus, osteoarthritis, and cardiovascular diseases like systolic arterial hypertension, which significantly impair the health and quality of life of dogs. Due to the physical and emotional impacts, canine obesity requires continuous attention from both veterinary professionals and owners (Laflamme, 2012).

The factors contributing to the development of canine obesity are multifactorial, involving genetic, environmental, and behavioral aspects. Certain breeds, such as the Labrador Retriever and the Beagle, have a greater genetic predisposition to weight gain, which can make these dogs more vulnerable to obesity (Raffan *et al.*, 2016). A sedentary lifestyle and inadequate nutrition, characterized by obesogenic

diets rich in calories and poor in nutrients, are aggravating factors that promote energy imbalance, the primary cause of fat accumulation (Bland *et al*., 2009).

In addition to the physical complications, canine obesity negatively affects the animals' emotional well-being, reducing their willingness to engage in physical activities and social interactions, which can lead to signs of depression and a diminished quality of life (Kealy *et al*., 2002). The burden of veterinary treatments necessary to manage the diseases associated with obesity also represents an economic challenge for owners (Marshall *et al.*, 2010). These factors make canine obesity a complex condition that affects both the animal's health and its bond with the owner.

Although advances have been made in understanding canine obesity, challenges persist in implementing effective management strategies. The lack of owner adherence to nutritional education programs and to increasing their dogs' physical activity continues to be a major obstacle (Courcier *et al*., 2010). Therefore, it is essential to adopt multidisciplinary approaches that involve veterinary professionals, nutritionists, and owners for the prevention and treatment of obesity, aiming not only for weight control but also for the overall improvement of the health and well-being of dogs.

Just like human obesity, canine obesity is a complex and multifactorial disease, requiring a multidisciplinary and patient-centered approach for its management. Given the large number of available articles on this topic, this study sought to analyze patients with obesity by considering and relating not only their clinical, laboratory, and cardiological parameters but also their dietary patterns and physical activity based on interaction with their respective owners, aiming to broaden the management strategies for this important clinical condition.

2 Material and Methods

The cross-sectional study was approved by the Animal Use Ethics Committee of Universidade Anhanguera Pitagoras Unopar (CEUA) under protocol No. 01/24 and was developed in partnership between the institution's veterinary clinic of university (Arapongas, Parana, Brazil) and a private veterinary clinic at Maringa (Parana, Brazil).

Twenty-five dogs of both sexes, aged between one and twelve years, with a body condition score (BCS) between six and nine according to the Laflamme scale (1997) where animals with BCS 6 were considered above ideal weight, BCS 7 overweight, and BCS 8 and 9 obese—were included. The dogs were either spayed/neutered or intact, with a gentle temperament and in good general health. The physical parameters evaluated at the initial stage included body weight (measured using a TCS® digital scale with a capacity of 150 kg), heart rate (average beats during electrocardiographic recording), respiratory rate (observation of thoracic movements for one minute), rectal temperature (measured with a digital thermometer), and body condition score (determined by a single evaluator according to the Laflamme scale).

Blood samples were collected after a 12-hour fast via jugular vein puncture using a 0.7x25 mm needle and a five mL syringe, following local antisepsis with 70% alcohol. The complete blood count was performed using a Celltac MEK 6550J/K veterinary analyzer, while the biochemical profile (ALT, ALP, creatinine, urea, albumin, total proteins, glucose, triglycerides, total cholesterol, and HDL) was analyzed using a BioPlus 2000 instrument after centrifugation to obtain serum.

The cardiological evaluation consisted of measuring systolic blood pressure using a non-invasive method with a Deltalife Dl330 vascular Doppler on the left thoracic limb, with the animal in a standing position and five consecutive measurements. The electrocardiographic exam was conducted using an Inpulse ECG device. Monitoring was carried out for a period of five minutes, with the animal positioned in right lateral recumbency. Standard limb electrocardiographic leads were recorded, including the bipolar leads (I, II, and III) and the augmented unipolar leads (aVR, aVL, and aVF), to assess the heart's electrical activity in multiple planes.

The owners answered a structured questionnaire with 21 questions about feeding management, physical activity, behavior, and the animals' routine. The data obtained were tabulated and submitted to descriptive statistical analysis using Microsoft Excel® software. For the comparison of hematological variables between the groups of animals with different BCS, the Kruskal-Wallis test was applied, adopting a significance level of 5%.

3 Results and Discussion

A total of 25 overweight dogs were included in the study. The age of the animals ranged from one to twelve years, with a body weight between 3.2 kg and 42.5 kg. The sex distribution was five males (20%) and twenty females (80%).

The Body Condition Score of the animals ranged from six to nine according to the Laflamme scale, with the majority presenting a score of eight or seven, as shown in Table 1.

Table 1 - Distribution of Body Condition Score (BCS), according to the Laflamme scale, of 25 animals presenting excess weight

BCS	Percentage (%)	Number of Animals (n)
BCS 6	8%	2/25
BCS 7	28%	7/25
BCS 8	40%	10/25
BCS 9	24%	6/25

Source: research data.

Regarding reproductive status, the majority of animals (88%) were neutered, with half undergoing surgery 12 months of age and the other half after this period. When asked about the impact of neutering

on the development of overweight, 72% developed overweight within the first six months after surgery, while 16% of the animals showed weight gain after six months of the surgical procedure.

Regarding eating habits, the majority of animals (68%), according to the owners, showed an increased appetite. Regarding food provision, 48% (12/25) received food ad libitum, while 52% (13/25) had controlled feeding, following each pet food manufacturer's guidelines to provide the stipulated daily food quantity.

The owners were asked to detail the categories of pet food provided to their animals. Most received super premium food, as detailed in Table 2, followed by premium food. Of the total of 25 animals, only five were fed a therapeutic diet for weight control.

Table 2 - Distribution of animals according to the categories of pet food received

Type of Pet Food	Percentage (%)
Standard food	12% (3/25)
Premium food	28% (7/25)
Super premium food	40% (10/25)
Weight control food	20% (5/25)

Source: research data.

The provision of treats was reported by all owners when responding to the questionnaire. Of the 25 animals, 18 (72%) received food shared from the owners' diets, in addition to processed meat snacks (52% of animals), vegetables and greens (32%), fruits (20%), and commercial biscuits (16%).

The practice of physical activity, according to BCS, is detailed in Table 3. Physical activity was considered as walks of at least 15 minutes, once or twice a day. Of the total 25 animals, 11 (55%) engaged in it. On the other hand, exercise intolerance was prevalent in 84% of the animals (21/25), which were unable to sustain 15 minutes of constant physical activity, a finding especially evident in those with an increased BCS.

Table 3 - Frequency of physical activity and exercise intolerance according to body condition score in 25 overweight dogs

Parameters	BCS 6 (n=2)	BCS 7 (n=7)	BCS 8 (n=10)	BCS 9 (n=6)
With physico activity	50% (1/2)	57% (4/7)	50% (5/10)	16% (1/6)
Exercise intolerance	50% (1/2)	52% (4/7)	100% (10/10)	100% (6/6)

Source: research data.

Regarding clinical/cardiological parameters, normothermia was observed in all animals, with an average respiratory rate of 40 bpm and an average heart rate of 120 bpm. Electrocardiographic alterations were detected in 52% (13/25) of the animals.

Electrocardiographic changes related to P and T waves were analyzed in 25 overweight dogs. It was observed that 1/25 (4%) of the animals had a P wave amplitude greater than 0.4 mV, while 7/25 (28%) showed an increase in P wave duration. Regarding the T wave, 9/25 (36%) of the dogs demonstrated an amplitude above 1.0 mV. For context, the reference values for P wave duration, according to Tilley (2008), are up to 40 ms for small-breed dogs and up to 50 ms for large-breed dogs.

The mean systolic blood pressure of the 25 animals was 140 mmHg, and the mean respiratory rate was 40 bpm. It is observed that, as shown in Table 4, the animals with a higher BCS presented the highest values for SBP.

Table 4 - Relationship between body condition score (BCS) and mean systolic blood pressure values in overweight

Groups	Mean Systolic Blood Pressure (mmHg)
BCS 6	125
BCS 7	140
BCS 8	140
BCS9	160

Source: research data.

Regarding laboratory tests, the results demonstrated alterations in some biochemical parameters, with an emphasis on increased triglycerides in 64% of the animals, as evidenced in Table 5.

Table 5 - Prevalence of alterations in biochemical parameters in overweight dogs

Biochemical parameters	Percentage(%)
ALT > 73 mg/dl	12% (03/25)
FA > 156 U/l	20% (05/25)
Blood glucose > 110 mg/dl	36% (09/25)
Triglycerides > 112 mg/dl	64% (16/25)
Total cholesterol > 270 mg/dl	20% (05/25)
Hemoglobin > 18 g/dl	76% (19/25)
Albumin > 3.3 g/dl	64% (16/25)
Total proteins > 7.1 g/dl	76% (19/25)

Source: research data.

To assess potential metabolic alterations associated with excess adiposity, the dogs were separated according to body condition score. The hematological and serum biochemical parameters were compared between these groups using the Kruskal-Wallis test. As shown in Table 6, no statistically significant differences ($p > 0.05$) were observed in any of the analyzed variables between the groups.

Table 6 – Statistical analysis of hematological variables between groups of animals with different BCS (Kruskal-Wallis)

Variables		BCS				
		6	**7**	**8**	**9**	**p-valor**
ALT	Median	38.5	43	51	47.5	0.9158
	IQR	4.5	63.5	30.5	19.5	
ALP	Median	33	113	49.5	88	0.2093
	IQR	0	82	136	19.5	
Albumin	Median	3.55	3.56	3.8	3.435	0.617
	IQR	0.65	0.7	1.6	0.468	
Total Proteins	Median	7.95	8.1	7.8	8.6	0.7543
	IQR	0.35	1.25	2.05	1.27	
Blood Glucose	Median	77.5	97	120	86	0.1123
	IQR	6.5	15.5	24.5	23	
Triglycerides	Median	83.5	153	254	170	0.3582
	IQR	3.5	439	549	230	
Total cholesterol	Median	197	207	184	219	0.5017
	IQR	45	55.5	55.5	95	
Hemoglobin	Median	19	18.5	22.05	19.5	0.1197
	IQR	1	3.55	2.7	1.32	

Source: research data.

This study presents relevant data on the impact of excess weight on clinical, behavioral, and laboratory parameters in dogs. When comparing the obtained results with the available literature, it is observed that canine overweight and obesity are prevalent conditions that affect not only the metabolic health of the animals but also their quality of life and longevity (Laflamme, 1997). The prevalence of overweight and obesity in dogs has been increasing, with neuter status, inadequate nutrition, and lack of physical exercise being determining factors, as discussed in various studies (Blanchard *et al*., 2024; Cita *et al*., 2024; German, 2006; Montoya *et al*., 2025).

In the present study, 88% of the animals were neutered, a finding that corroborates previous evidence on the association between neutering and weight gain, attributed to hormonal and metabolic dysregulations (Yang *et al*., 2023). The predominance of females (68%) in the sample is also aligned with the literature, which indicates a greater predisposition to excess weight in female dogs, possibly due to the interruption of sex hormone secretion and its implications for energy homeostasis (Laflamme, 1997). The suppression of estrogen and testosterone, for example, compromises the neuroendocrine modulation of appetite and reduces motivation for physical activity, promoting a positive energy balance. These endocrine mechanisms, associated with increased caloric intake and a reduced metabolic rate, reinforce the causal relationship between neutering and canine obesity (Silva *et al*., 2016).

The data obtained on eating habits and physical activity practices show that 68% of dogs exhibited an increased appetite, which is a common response in neutered animals (McKenzie, 2010). This change in appetite, combined with the absence of dietary control in 48% of the animals, may explain the weight

gain observed in 72% of the dogs within six months after neutering. The lack of dietary restriction and the high provision of treats can exacerbate the overweight problem (McGreevy *et al*., 2005). Furthermore, 84% of the animals demonstrated exercise intolerance, which is related to increased body fat and reduced physical stamina, a finding commonly observed in overweight dogs (German, 2006).

The mean heart rate of the dogs in the study was 120 bpm, with abnormalities in the electrocardiographic examination in 52% of the animals. Prolongation of the P wave and ventricular repolarization abnormalities, characterized by an increase in T wave amplitude and its amplitude relative to the R wave, as described by Partington *et al*. (2022), were observed. These findings, although not confirming morphological changes, indicate possible cardiac adaptations associated with obesity. Excess weight promotes hemodynamic overload that can culminate in left ventricular hypertrophy and atrial enlargement, conditions that increase the risk of cardiac remodeling and arrhythmias (Boon, 2011; Cunha, 2004). Such findings are concerning, as they suggest that overweight may have adverse effects on cardiovascular function, which could increase the long-term risk of heart disease.

The mean blood pressure of the animals was 140 mmHg, with variation among the groups, as animals with a BCS of 9 were considered pre-hypertensive at 160 mmHg, according to the scale by Acierno *et al*. (2018). These data align with studies suggesting that obesity in dogs can lead to hypertension due to increased circulating volume and cardiac output, as well as elevated peripheral vascular resistance (Chandler, 2016). Hypertension in overweight dogs may contribute to the development of renal diseases, cardiac conditions, and other systemic issues (Hall *et al*., 2022).

The laboratory tests performed showed that 36% of the animals had elevated blood glucose and 64% had elevated triglycerides, common factors in obese canines and related to an increased risk of metabolic diseases such as diabetes mellitus and pancreatitis (Jericó; Andrade Neto; Kogika, 2015). Additionally, 76% of the animals showed elevated levels of hemoglobin and total proteins, which may indicate dehydration or chronic inflammation, conditions frequently observed in overweight dogs (Hernandez *et al*., 2018).

The increased serum concentrations of ALT and ALP in 12% and 20% of the animals, respectively, may indicate hepatic alterations, which are more prevalent in obese dogs due to fat accumulation in the liver (Fernandes *et al*., 2022). These findings are consistent with studies reporting that obesity may be associated with the development of hepatopathies in dogs (Tribuddharatana *et al*., 2011, 2019).

However, when submitted to comparative statistical analysis between the BCS groups using the Kruskal-Wallis test, the altered biochemical variables showed no significant differences ($p > 0.05$). This absence of statistical significance may be attributed to the high individual variability of the parameters, the multifactorial nature of the metabolic alterations, and the limited sample size of each subgroup, which may have reduced the test's power to detect intergroup differences.

This study sought to address canine obesity from different perspectives, highlighting not only the

intrinsic factors of the animals but also the influence of the human factor in their dietary management and physical activity, which has a direct influence on adiposity. It is possible that the owners' obesogenic management of their dogs is associated with the contemporary lifestyle, characterized by a fast-paced routine, which prevents dedicating time for longer walks and active interactions with the animal. This contributes to a lack of stimuli for walks, play, or any type of energy expenditure aimed at increasing metabolism and reducing the risk of obesity. It is worth remembering that, under these circumstances, the way found to calm or reward the animal is by offering treats, which, coupled with low exercise levels, contributes to body fat accumulation. Such reflections are important as they contribute to raising owner awareness about this significant condition that contributes to a lower quality and expectancy of life for those now considered members of multispecies families.

4 Conclusion

The results of this study corroborate the scientific literature that associates overweight and obesity in dogs with a series of metabolic, clinical, and behavioral alterations. Weight gain after neutering, lack of dietary control, and insufficient physical exercise were the main contributing factors to the overweight condition of the animals. Furthermore, the alterations in clinical and laboratory parameters reinforce the need for management strategies for weight control, with an emphasis on owner education about balanced nutrition, exercise practices, and monitoring of the animals' cardiovascular and metabolic health. This study highlights the importance of preventive and therapeutic approaches to canine obesity, aiming to improve the quality of life and reduce the risks associated with the condition.

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