

Presence of overweight and obesity in canines (*Canis lupus familiaris*) and its risk factors in the North of Bogotá

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ABSTRACT

Canine obesity, a prevalent global health concern, is also on the rise in Colombia. However, there is limited data available on this issue. This study aimed to assess the prevalence of overweight and obesity among dogs in Northern Bogotá, Colombia, and to identify key risk factors associated with this condition. A sample of 194 dogs was used. They were weighed, their body condition was evaluated, and their owners were surveyed about the habits of the dog. Results revealed 23.2% of dogs were overweight and 1.6% were obese. Through a logistic regression model, it was determined that the variables significantly related to this disease were daily physical activity and the condition of being neutered or spayed.

Keywords: overweight, obesity, body condition, canines.

Presencia de sobrepeso y obesidad de caninos (*Canis lupus familiaris*) y factores de riesgo en el norte de Bogotá

RESUMEN

La obesidad canina es una enfermedad y un trastorno nutricional en aumento a nivel mundial y Colombia no es la excepción; sin embargo, los reportes sobre esta condición son escasos. Este estudio buscó determinar la presencia de sobrepeso y obesidad en caninos en el norte de la ciudad de Bogotá, Colombia, y determinar los principales factores de riesgo que predisponen esta condición. Se utilizó una muestra de 194 perros, los cuales se pesaron, se evaluó su condición corporal y se hizo una encuesta a los propietarios para indagar sobre los hábitos del canino. El estudio encontró un 23,2% de perros con sobrepeso y un 1,6% con obesidad. Por medio de un modelo de regresión logístico dicotómico, se pudo determinar que las variables que tuvieron una relación significativa frente a esta enfermedad fueron la actividad física diaria y la condición de estar castrado o esterilizado.

Palabras claves: sobrepeso, obesidad, condición corporal, caninos.

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INTRODUCTION

In recent years, overweight and obesity rates in canines have noticeably increased, posing a health risk to pets that compromises their quality of life and longevity (Chiang *et al.* 2022). Currently, obesity is presenting a substantial health concern due to its association with shared lifestyles between humans and their pets, and its prevalence is exponentially increasing (Chandler *et al.* 2017). This nutritional disorder causes a series of changes in bodily functions and limits longevity in animals (Palatucci *et al.* 2018), affecting approximately 30% to 40% of the population (Devito *et al.* 2020).

Research conducted in the United Kingdom suggests that overweight or obesity affects between 25% and 59.3% of companion dogs (Bjørnvad *et al.* 2019; Yam *et al.* 2016). Furthermore, studies have demonstrated that multiple factors associated with lifestyles of owners in industrialized nations contribute to nutritional imbalances in pets (Palatucci *et al.* 2018), as owners and their pets share both lifestyle and environment (Yamazaki *et al.* 2021).

Chiang *et al.* (2022) found a prevalence of overweight and obesity at 21% and 20%, respectively, with the most frequently associated variables being the consumption of homemade and semi-moist food, as well as the age range of six to ten years (Chiang *et al.* 2022; Agudelo & Narváez 2019; Petro *et al.* 2018). This persistent issue demonstrates a high incidence, with 80% of US veterinarians predicting that, within five years, there will be more pets classified as overweight than healthy animals (Yam *et al.* 2016). Furthermore, in Colombia, Agudelo and Narváez (2019) highlight obesity as the seventh most prevalent disease in veterinary clinics in Bogotá among a group of 30 pathologies (Agudelo & Narváez 2019).

OBESITY

Malnutrition is recognized as one of the most common clinical conditions that alters the function of organs and the immune system in pets (Abood & Wara 2020). Within this category lies obesity, a nutritional disorder defined by the excessive accumulation of body fat, occurring due to the enlargement of adipose cells from fat buildup in the cytoplasm of adipocytes (Chan *et al.* 2021; Chandler *et al.* 2017). Clinically, a canine patient is categorized as obese when their body weight exceeds at least 15% of their optimal weight, considering their body size (Palatucci *et al.* 2018; Endenburg *et al.* 2018).

In dogs, excess adiposity significantly impacts the development of degenerative diseases, insulin resistance, and diabetes mellitus, as well as the propensity for non-allergic skin diseases (Weeth 2016), osteoarthritis, respiratory difficulties, dyslipidemia, renal diseases, and/or metabolic disorders, thereby reducing the lifespan of animals (Bjørnvad *et al.* 2019; Palatucci *et al.* 2018).

Adipose tissue plays an active role in carbohydrate and lipid metabolism, inflammatory and coagulation cascades, and responds to metabolic signals from various organs to coordinate energy storage and utilization. This is facilitated by its secretion of various active substances, including steroid hormones, growth factors, proteins, cytokines, and metabolism regulators (Clark & Hoenig 2016; Hamper 2016). These active substances, known as adipokines, operate through autocrine, paracrine, or endocrine mechanisms. However, excessive fat accumulation disrupts their secretion profile, impacting peripheral tissues and the central nervous system, leading to complications such as inflammation and oxidative stress (Hamper 2016; Bayliak *et al.* 2019).

Oxidative stress is characterized by an imbalance between oxidant molecules and antioxidants, leading to cellular damage through free radicals (Petro *et al.* 2018). The evidence supports the notion that oxidative stress plays a role in the progression of obesity and represents one of its primary molecular mechanisms (Bayliak *et al.* 2019). When adipose tissue undergoes heightened oxidative stress, protective mechanisms are activated in response to increased oxidation rates resulting from elevated production of reactive oxygen species (ROS), nitrogen, and carbonyl compounds (Bayliak *et al.* 2019; Carvajal 2019).

RISK FACTORS

Various factors predispose pets to obesity, including genetics, low or decreased levels of physical activity, breed-specific predispositions (Labradors and Golden Retrievers, for instance, show a higher tendency), diets high in fats or energy, and increased food intake (Hamper 2016). Additionally, age, sex, and the impact of spaying or neutering play significant roles in weight gain. For example, spayed females often become overweight because their energy requirements decrease after the procedure (Chandler *et al.* 2017).

The correlation between obesity in humans and dogs has been documented. Therefore, reviewing the reports from the World Health Organization on human obesity is important for understanding the extent of this issue. For example, the United States has the highest global rate of human obesity, and a 5-year study demonstrates a 37% increase in obesity among its canine population (Bayliak *et al.* 2019; Chandler *et al.* 2017). This relationship arises from the fact that owners control food intake and

can moderate energy expenditure through physical activity (Webb *et al.* 2020).

Currently, there is a lack of information or reports on canine obesity in Bogotá, compared to other cities worldwide. Therefore, the aim of this study was to demonstrate the presence of this nutritional disorder in dogs in Bogotá and to identify the factors influencing or predisposing this condition.

MATERIALS AND METHODS

Population sample and data collection

194 dogs participated in the study with the authorization of the owners, voluntarily accessing nutritional counseling services at a veterinary clinic in the Northern area of Bogotá from 2018 to 2020. A comprehensive and detailed anamnesis was conducted to gather information through a structured document comprising three sections: the first section collected basic information about the pet, including name, breed, sex, age, and weight. The second section focused on dietary information, querying the type of food provided, portion measurement practices, quantity given to the pet, consumption of wet food, homemade food, or snacks, cohabitation with other animals and their number, daily physical activity level (mild: >30 min, moderate: 30 min to 1 hour, high: <1 hour), sterilization status (spayed, neutered, or none), and body condition. The final section addressed medical history, encompassing gastrointestinal, oncological, respiratory, ophthalmological, auditory, and other health issues.

All owners provided verbal consent to participate in the study, and the study is endorsed by the Ethics Committee

of Facultad de Medicina Veterinaria y de Zootecnia, Universidad Nacional de Colombia, as stated in the act of meeting 11 of the year 2021.

Body condition scoring

Due to the variability among breeds and ages, measuring overweight and obesity is complex. Therefore, body condition scoring (BCS) was employed, which is a standardized, globally accepted, and endorsed technique by the World Small Animal Veterinary Association (WSAVA). This method involves visual assessment and physical palpation of the ribcage to determine the amount of fat deposition. According to WSAVA, BCS operates on a 9-point scale, where a score of 1 to 3 corresponds to an underweight dog, 4 to 5 to an ideal condition dog, and 6 to 9 to an overweight dog. For the presence of canine overweight and obesity, patients were classified with a BCS of 6 to 7 as overweight and between 8 and 9 as obese.

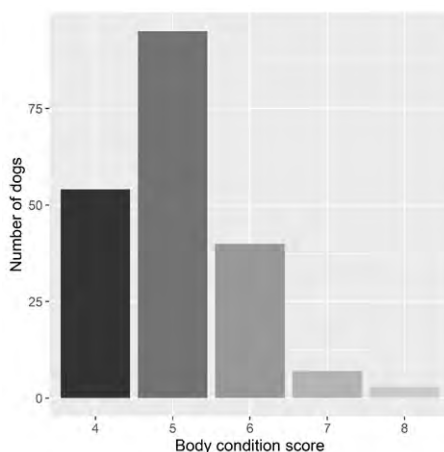
Statistical analysis

A univariate and multivariate descriptive analysis was conducted for both qualitative and quantitative variables. To evaluate factors associated with the likelihood of overweight/obesity occurrence, association tests were performed between different variables and the presence of overweight or obesity. Additionally, a logistic regression model was formulated, relating potential explanatory variables of the dog (sex, age, breed, type of food, brand of concentrated food, whether food measurement is performed or not, daily physical activity, being neutered or spayed, and amount of food) to the presence or absence of overweight or obesity. Statistical analysis of the data was performed using R statistical software (version 4.0.2).

RESULTS

A 27.3% of the dogs were found with a BCS of 4 (ideal), 47.5% with a BCS of 5 (optimal weight), 19.1% were classified with a BCS of 6 (overweight), 4.1% with a BCS of 7 (overweight), and 1.6% with a BCS of 8 (obese). Accordingly, 23.2% of the evaluated dogs presented overweight, 1.6% presented obesity, and collectively, 24.7% of the dogs had a BCS greater than ideal (figure 1).

FIGURE 1. Distribution of the body condition of evaluated canines.



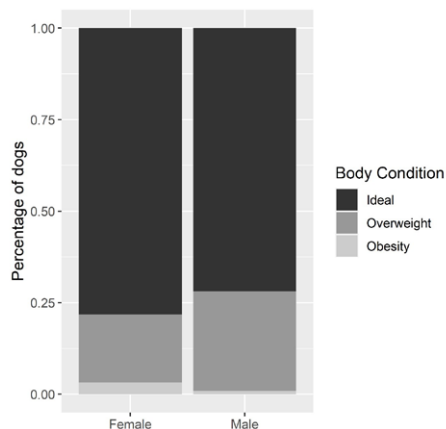
Source: own elaboration.

The assessment of body condition in canines differentiated by sex showed that, in the group of female canines, 18.4% were overweight and 2.3% were obese. In the case of males, 27.1% were overweight and 0.9% were obese (figure 2). When performing the association test (chi-square), no association was found between sex and the presence of overweight or obesity ($p=0.3912$).

Regarding food portion measurement, 55.6% of owners of overweight animals and 66.7% of owners of obese canines reported not measuring the food portion

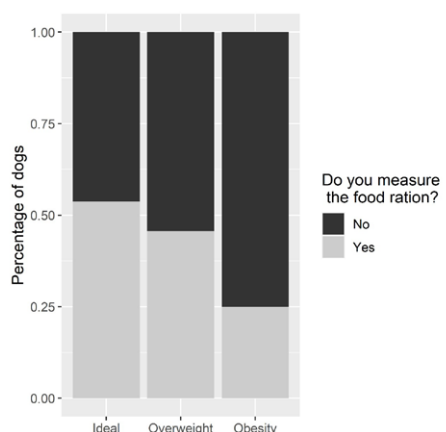
to be provided. Likewise, in the group of animals without overweight or obesity, 45.2% of owners reported not measuring the portion (figure 3). Therefore,

FIGURE 2. Percentage of canines with overweight and obesity according to body condition classification, differentiated by sex.



Source: own elaboration.

FIGURE 3. Percentage of owners who measure or do not measure the portion of their pets according to ideal, overweight, and obesity condition.



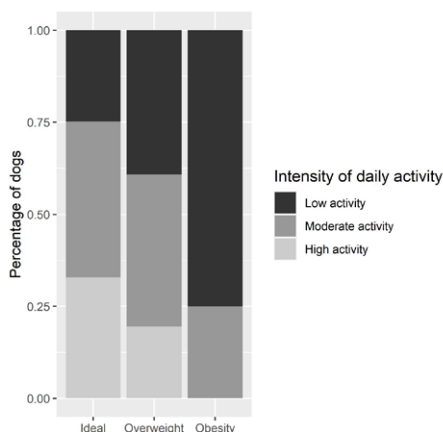
Source: own elaboration.

no association was found between food portion measurement and the presence of overweight or obesity ($p = 0.3064$).

In the analysis of physical activity, it was observed that among overweight canines, 42.2% of owners reported their pets engage in mild daily physical activity, while 37.8% stated they perform moderate daily physical activity, and 20% reported high daily physical activity levels. Regarding obese canines, 66.7% were reported to engage in mild daily activity, and 33.4% perform moderate physical activity (figure 4).

In the case of canines without overweight or obesity, 25.3% of owners reported that the canines engage in mild daily physical activity, 41.1% moderate daily physical activity, and 33.6% of owners reported high daily physical activity. Upon conducting the association test (chi-square), a significant association was found between the intensity of physical activity and the presence of overweight or obesity ($p = 0.03546$).

FIGURE 4. Level of physical activity performed by canines in ideal, overweight, and obesity conditions.



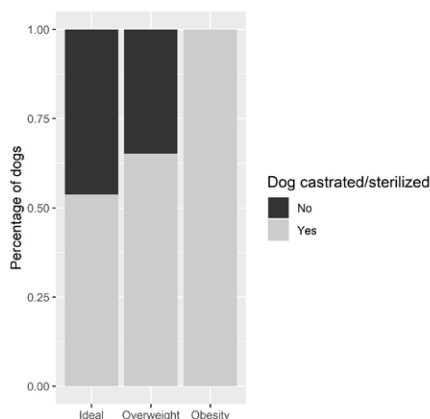
Source: own elaboration.

When examining the potential relationship between neutering and spaying individuals and the occurrence of overweight and obesity, it was observed that among non-neutered or non-spayed animals, 18.6% exhibited overweight, with none displaying obesity. In contrast, among neutered or spayed animals, 26.8% showed overweight, while 2.8% manifested obesity (figure 5). Subsequently, conducting the association test (chi-square) revealed a significant 10% association between these variables ($p = 0.0946$).

The logistic regression analysis showed that daily physical activity and being neutered or spayed were the variables that best explained the presence of overweight in the canines included in this study. The other variables were not significant (table 1).

In an initial model, with a 95% confidence level, only the variable of daily physical activity was significant, with the *high* category as an explanatory variable for the presence or absence of overweight or obesity. This means that dogs with high

FIGURE 5. Percentage of neutered/spayed and intact canines according to ideal, overweight, and obesity conditions.



Source: own elaboration.

physical activity have approximately 3.09 (1/0.32) times less probability of suffering from overweight or obesity than those with low or moderate activity (table 2).

TABLE 1. Results of the logistic regression model with a 95% confidence level of non-significant variables

Variable	Coefficient (95% CI)	OR (95% CI)	p
Sex	0.338 (-0.307, 0.998)	1.403 (0.736, 2.717)	0.308
Neutered	0.606 (-0.06, 1.301)	1.833 (0.944, 3.675)	0.0790
Age	0.045 (-0.037, 0.125)	1.046 (0.964, 1.133)	0.273
Feed measurement	0.002 (-0.003, 0.007)	1.002 (0.997, 1.007)	0.445
Breed	None of the breeds were significant in the model		Between 0.184 and 0.998
Feed brand	No feed brand was significant in the model		Between 0.995 and 0.997

Source: own elaboration.

TABLE 2. Results of the logistic regression model with a 95% confidence level.

Variable	OR (95% CI)	p
High daily physical activity	0.32 (0.13-0.77)	0.0130

Source: own elaboration.

In a subsequent model, significance was established at a 90% confidence level for the variable of neutering or spaying. This suggests that dogs engaging in high daily physical activity have roughly 3.05 times lower odds of experiencing overweight or obesity than those with low or moderate daily activity levels. Likewise, neutered dogs are approximately 1.8 times more likely to exhibit overweight or obesity compared to intact ones (table 3).

DISCUSSION

In this study, a prevalence of 23.2% overweight and 1.6% obesity was observed among canines. These findings are consistent with those reported by Bjørnvad *et al.* (2019), who noted 16.4% of dogs as overweight and 4.1% as obese in Denmark (Bjørnvad *et al.* 2019). Similarly, Montoya *et al.* (2017) identified a 22.6% overweight population in Spain, while Chiang *et al.* (2022) reported a global prevalence of 21.1% for overweight and 20.2% for obesity, totaling 41.3% of canines with elevated body condition scores in the United States (Montoya *et al.* 2017; Chiang *et al.* 2022). Likewise, Colombia has seen a recorded prevalence of 24% of animals exhibiting some degree of obesity (Agudelo & Narváez 2019).

It was observed that 47.9% of owners do not measure the food portion due to a lack of awareness regarding its importance. Although this variable did not yield statistical

significance, previous studies aimed at understanding the primary causes of this nutritional disorder have revealed that many owners fail to recognize the status of overweight or obesity of their pets and struggle to determine the appropriate food quantity and calorie intake. Consequently, they tend to provide a larger food portion than recommended, leading to an increase in the body condition score (Spence 2022). Additionally, it is necessary to consider the feeding frequency. In this respect, Agudelo and Narváez (2019) have pointed out that a higher frequency of feeding correlates with a greater risk of obesity (Agudelo & Narváez 2019).

Regarding gender, a higher predisposition to overweight and obesity was observed in males than in females, although it was not statistically significant. These findings diverge from those reported by other authors, who have noted a higher prevalence of these conditions among females, irrespective of their reproductive status (Montoya & Alonso 2017). When considering neutered or intact status, Agudelo and Narváez (2019) indicated that, in neutered canines, the prevalence of overweight and obesity is higher in females, while in intact animals, males tend to have a higher prevalence of overweight. However, this study revealed a greater tendency for overweight and obesity in males, both neutered and intact (Agudelo & Narváez 2019).

In recent years, it has been demonstrated that the loss of gonadal hormones following the castration or sterilization

TABLE 3. Results of the logistic regression model with a 90% confidence level.

Variable	OR (90% CI)	p
High daily physical activity	0.33 (0.15-0.68)	0.0147
Neutered/spayed	1.80 (1.02-3.24)	0.0938

Source: own elaboration.

procedure results in weight gain (Brent *et al.* 2021). The findings of this study support this fact, revealing that 29.6% of canines showed weight gain after the procedure. As asserted by Kutzler (2020), this may be due to the lack of negative feedback from the removed gonadal hormones on the pituitary and hypothalamus, leading to supra-physiological levels of luteinizing hormone (LH). Furthermore, Schauf *et al.* (2016) state that sterilization reduces physical activity in female dogs, resulting in overweight or obesity (Schauf *et al.* 2016).

According to Yam *et al.* (2016), dogs that exhibit an increase in their body condition score (BCS) are those with reduced physical activity and low energy levels compared to dogs with an optimal weight, negatively impacting health-related quality of life (Yam *et al.* 2016). Similarly, Alemán *et al.* (2017) found that dogs with overweight or obesity demonstrate lower frequency and duration of exercise or daily physical activity compared to those with ideal BCS (Alemán *et al.* 2017). These findings are consistent with the results of this study, which revealed a statistically significant relationship between dogs with a favorable body condition and those participating in high levels of physical activity.

CONCLUSION

A presence of overweight of 23.2% and obesity of 1.6% was found in dogs located in the northern area of Bogotá. The variables that had a significant association with obesity and overweight were physical activity and the status of being neutered or spayed. The other variables (age, breed, type of food, feed brand, whether food measurement is done or not, amount of

food, and type of food) did not show a significant association with obesity or overweight. Although gender did not show a significant association, a trend towards higher rates of overweight and obesity in males compared to females was observed, contradicting existing literature.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest regarding the publication of this manuscript.

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ARTIFICIAL INTELLIGENCE USAGE STATEMENT

We declare that no artificial intelligence was used in the completion of this work.

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