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Original Research

Risk Factors Associated with Obesity in Dogs

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Abstract

This study aimed to investigate the prevalence and risk factors for obesity of dogs presented to the clinics of GADVASU in which healthy adult dogs were screened for obesity on a 5-point scale of Body Condition Score. Detailed information was obtained through a questionnaire of 70 normal dogs and 180 overweight/obese dogs to evaluate the risk factors associated with obesity in companion dogs. Obesity rates were analyzed concerning breed, age, sex, neutering, duration of owning food control, feeding frequency, food type, nutritional supplements, owner age, and health, number of persons per household, number of pets per household, feeding type, and frequency, table scraps, treats, exercise duration, exercise status, exercise type, living environment, vaccination, and deworming. The overall canine obesity rate in clinics was 36%. The risk factors for dog obesity were middle age group, neutering, owner awareness, duration of owning, feeding type, table scraps, treats, feeding frequency, exercise status, regularity, duration and type of exercise, owner health, owner age, number of family members, living environment. By dog breed, the prevalence of obesity was high in Labrador Retrievers (55.55%), followed by Pug (18.89%), and Beagle (8.33%).

Keywords: Dogs, Obesity, Prevalence, Risk Factors.

Introduction

Obesity is a lifestyle disease that is widespread across the world. It is described as "a state of increased body fat percentage to a degree that affects health and well-being" (Preet *et al* 2021a). The WHO called the dramatic rise in obesity prevalence a "world epidemic" and accepted its status as a "disease" in 2000 (WHO 2000). Overweight and obesity in both humans and companion pets are major health concerns. Many adverse health issues as well as reduced life expectancy are correlated with increased weight problems (Salt *et al* 2019). Previous research reported a variety of causes that tend to raise the dogs' chance of obesity. Such contributing factors cover dog and human traits, feed preparation, and exercise. Female dogs are more prone to become obese than male dogs. Neutering and increasing age have been recognized as other factors responsible for obesity in canine population (Mao *et al* 2013; German *et al* 2017; Preet *et al* 2019). Based on previous research, Sandøe *et al* (2014) stated that besides social, genetic and physical theories, the essence of the human-animal relationship is a significant factor in the possible association between obesity in humans and their dogs (Courcier *et al* 2010).

Since most researchers have focused on single or individual risk variables, there is a compelling reason to pay attention to how those risk factors combine. Our study aimed to investigate risk factors responsible for obesity in adult canine population (more than 1 year). The key objectives of the research are to establish the incidence of obesity in the canine population and to elucidate specific risk factors for overweight and obesity in dogs like 1) dog characteristics 2) owner awareness, 3) feeding practices 4) exercise and activity 5) interactions between owner and dog characteristics 6) living environment and home demography. Furthermore, we studied 6) preventive health measures and breed types. These contributing/risk factors are critical when recognizing dogs at risk of obesity.

Materials and Methods

This study was conducted on a total of 500 healthy adult dogs of different breeds presented at the multispecialty hospital of Guru Angad Dev Veterinary and Animal Sciences University, Ludhiana for general checkup or vaccination, having no other clinical abnormality and dogs were screened for obesity on 5point scale of Body Condition Score (BCS) as designed by Dorsten and Cooper 2004 and graded as 1: thin, 2: underweight, 3: ideal, 4: overweight, 5: obese (Preet *et al* 2021b).

Healthy dogs above 1 year of age were only included in this study. Dogs having ascites or intra-abdominal masses that might impact their appetite or BCS were also eliminated from the study to avoid enrolling dogs whose body condition was caused by causes other than feed management.

In this study, the dogs were divided into three categories based on their BCS: Normal/Ideal weight (3), overweight (4), and obese (5).

Statistical Method: In this study, the Chi-square test was employed to evaluate the association between categorical variables (risk factors) and the presence of obesity in companion dogs.

Observations Recorded

Client Information- The **n**ame and address of the pet owner were recorded and documented in the “clinical case record”.

Detailed information was obtained through a questionnaire of 70 normal dogs and 180 overweight/obese healthy dogs to evaluate the risk factors associated with obesity in companion dogs. Patient-specific data i.e. age, breed, sex, duration of owning, weight, and reproductive status was appropriately recorded in the questionnaire.

Owners were interrogated for awareness about canine obesity, its ill effects, and BCS. Dog owners assessed their weight status and obesity using an image-based body condition score (BCS) chart (Figure 2) that was accompanied by a verbal description. Respondents were shown five options reflecting a five-point scale (BCS) (Figure-1 and 2).

We divided the images of dogs of different BCS scales into four groups for this analysis: underweight (corresponding to BCS 1-2); ideal (corresponding to BCS 3); overweight (corresponding to BCS 5); and obese (corresponding to BCS 5). (Figure 2). Owners were asked to evaluate their dogs for obesity and provide an opinion

on BCS after being adequately informed about its usage, and their views were recorded accordingly.

Complete history for feeding like feeding control, feeding frequency, food type, table scraps, nutritional supplements, treats and snacks, exercise history like exercise status (yes or no), regularity, duration and type of exercise were recorded.

Interactions between owner and dog characteristics like age, gender and health status of owners, number of people who stay with the dog, number of pets in the home. Living environment and home demography, such as house type and area of the house, preventive health measures like deworming, vaccination status, and breed types, were also recorded in the questionnaire.

Results

Prevalence of Obesity

The overall prevalence of obesity among screened dogs was 36%. They were further subdivided into 2 categories overweight (n=111, 61.67%) and obese (n=69, 38.33%).

Descriptive Analysis of Potential Risk Factors

Gender Predisposition- The prevalence of obesity (Table-1) was higher in male dogs (n=126, 70%) as compared to females (n=54, 30%). Chi-square analysis revealed no significant difference in obesity levels in both males and females.

Purebred Vs Cross-bred- Out of a total of 180 overweight or obese dogs, 154 dogs (85.56%) were purebred and 26 dogs (14.44%) were cross-bred (Table 1). Chi-square analysis (**X^2=0.28)** did not reveal any significant difference in the prevalence of obesity in purebred or cross-bred dogs.

Reproductive Status- In the surveyed population of 180 overweight and obese dogs, 158 dogs were intact (87.78%) while 22 dogs were neutered or spayed (12.22%) and the prevalence of obesity was equal in neutered males (n= 11, 50%) and spayed females (n= 11, 50%). There was a significant difference in the reproductive status of overweight and obese dogs in comparison to normal weight dogs (**X^2=8.88, p<0.05**) (Table 1).

Duration of ownership- Out of a total of 250 healthy adult dogs, 165 (91.67%) overweight/obese dogs and 61 normal-weight dogs were purchased or adopted at an early age, 9 overweight/obese dogs in adult age (5%) and 6 (3.33%) overweight/obese dogs and 9 normal-weight dogs were owned since birth. Prevalence of obesity was highest in dogs that were adopted at an early age followed by adult age and least in those kept since birth (Table 1) and Chi-square analysis (**X^2=15.38, p<0.01**) also revealed a significant difference in time of adoption with obesity with maximum obesity in dogs adopted during early age.

Age Group- In the present study, the age of the dogs that were included for the evaluation of risk factors in obesity ranged from 1 to 13 years. All the dogs incl;uded in the study were >1 yeasr age. They were divided into 5 age groups i.e. >1-3 years, >3-5 years, >5-7 years, >7-9 years and more than 9 years and the number of overweight /obese dogs in each group was 23%, 44%, 46%, 46 % and 21% respectively (Table 1). Different age groups significantly affected obesity (**X^2=55.75, p<0.0001**).

Obesity and BCS Awareness- Regarding awareness of obesity and its ill effects, only 50% (n=90) of owners understood obesity, while the remaining 50% were unaware of obesity and its ill effects (Table 1). A significant difference was recorded in awareness among owners about obesity of overweight and obese dogs versus owners of normal weight dogs (X2=12.27, p<0.01). Owners of overweight and obese dogs were overall less aware of obesity and its ill effects.

Owners of obese dogs were explained about 5 point BCS scoring to assess overweight and obese dogs. Even then, 101 owners (56.11%) still considered their pets to be in an ideal body weight category while 79 owners (43.89%) considered their dogs either overweight or obese (Table 1). There was a highly significant difference between BCS by owners of overweight and obese dogs with that of normal weight dogs (**X^2=68.21, p<0.0001**).

Perception of Owner- When owners were asked to give their opinion on BCS charts after a proper demonstration, only 6 owners (3.33%) said that BCS is not useful. In contrast, the remaining owners, 174 (96.67%) of overweight/obese dogs and 100 % of owners of normal weight dogs considered BCS useful and were convinced (Table 1). They considered BCS an easy, handy and useful tool for evaluating obesity in dogs at field levels as opined by German (2006). Chi-square value did not show a significant difference in the opinion of owners on BCS charts in different weight groups.

Feeding History

Access to Feed- Only 20 dogs (11.11%) had an access to free feeding and the rest 160 overweight or obese dogs (88.89%) had controlled feeding (Table 1). Control Vs free feeding had highly a significant effect on obesity (**X^2=9.53, p<0.01**).

Types of Feeding- The majority of the overweight and obese dogs (n=100, 55.55%) were those that were fed only home-cooked food followed by 76 dogs (42.22%) that were fed a combination of both home-cooked and commercial diets and only 4 dogs (2.22%) were being fed commercial dog foods alone (Table 1). There was a very significant difference in obesity amongst dogs fed on home-cooked food Vs Commercial Vs Both (**X^2=26.00, p<0.0001**).

Table Scraps- Out of 180 overweight and obese dogs, 113 dogs (62.77%) had an access to table scraps or leftover foods while 67 dogs (37.22%) did not have access to table scraps while in normal-weight dogs only 3 out of 70 (4.29%) were given table scraps. Similarly, 161 overweight and obese dogs (89.44%) were given treats and snacks regularly in addition to their normal feed and only 19 dogs (10.56%) did not receive any treats or snacks (Table 1), when compared to normal dogs only 11 out of 70 (15.71%) were given treats and snacks. There was a highly significant difference in obesity due to easy access of table scrap or leftover (**X^2=70.61, p<0.0001**) and snack/ treats (**X^2=128.34, p<0.0001**).

Frequency of Feeding- Only 3 obese or overweight dogs (1.66%) were fed only once a day, 50 dogs (27.77%) were fed meals 2 times in a day and the remaining all 127 dogs (70.55%) were fed meals several times in a day (Table 1). Various frequencies of feeding had a highly significant effect on obesity (**X^2=72.83, p<0.0001**).

Nutritional Supplements- Out of 180 obese/overweight dogs, only 17 dogs (9.44%) were being given nutritional supplements while the rest 163 dogs (90.56%) did not receive any nutritional supplementations (Table 1) and accordingly, the prevalence of obesity was higher in dogs that were not given any nutritional supplementations. However, chi-square analysis found no significant difference in the incidence of obesity between the two groups.

Exercise and Activity (Exercise Status, Regularity, Duration and Type of Exercise)

Among 180 overweight and obese dogs, 56 dogs (31.12%) were not taken for exercise at all, were mostly kept indoors, and preferred to stay at one place all the time while 124 dogs (68.88%) were taken out for exercise. Out of these 124 dogs, 67 dogs (54%) were taken for exercise regularly and 57 dogs (46%) were taken for exercise irregularly (either on an alternate day or twice a week). The majority of dogs (n=104, 83.87%) were taken for less than 0.5-hour duration of exercise and in 19 dogs (15.32%) duration of exercise was 30 minutes to 1 hour per day and in only one dog (0.8%) duration of exercise was more than 1 hour per day (Table 1). Exercise status, regularity, duration and type of exercise significantly affected obesity when analyzed statistically using the Chi-square test at p<0.0001 (Table 1).

Owner Characteristics (Interactions between Owner and Dog Characteristics)

Owners Age and Health Status- All the owners of dogs were categorized into three age groups, young (<20 years), adult (20-40 years) and old (>40 years). Only 2 (1.11%) out of 180 overweight or obese dogs were owned by the young age group and 46 dogs (25.55%) were owned by adults while a majority of 132 overweight and obese dogs (73.33%) were kept by the old age group of people (Table 1). A majority of normal dogs (n=58) were owned by adult age group (Table 1). Hence, the prevalence of obesity was higher in dogs owned by old-aged people followed by adult-group and it was least in the young-age group. There was a highly significant difference in the obesity of

dogs amongst owners of various age groups (**X^2=72.38, p<0.0001**).

The owners of these dogs were categorized as lean or underweight, normal weight and overweight or obese according to their body weight. Out of 180 owners of overweight and obese dogs, 1 owner (0.55%) was lean, 97 owners (53.88%) were in the normal weight category. In comparison, 82 owners (45.55%) were either overweight or obese while out of 70 owners of normal weight dogs only 2 were overweight/obese, 1 lean and 67 owners were normal. The health status of owners also significantly affected obesity amongst dogs (**X^2=42.33, p<0.0001**).

Gender of Owners- Among owners of 180 overweight and obese dogs, 125 dogs (69.44%) were owned by males while 55 dogs (30.56%) were owned by females. Similarly, 53 owners of normal weight dogs were male and 17 owners were female.

Numbers of Members in Family- In the present study, the number of individuals in a household was divided into three categories, i.e. 1-2, 2-4 and more than 4 and prevalence of obesity were highest in dogs (n=82, 45.55%), where the number of persons was 2-4 followed by dogs where the number of persons was more than 4 (n=64, 35.55%) (Table 1). There was a highly significant difference in obesity in dogs kept by households with a different number of individuals (**X^2=22.70, p<0.0001**).

Number of Pets in the Household- Prevalence of obesity was found more in dogs (n=159, 88.33%) kept as a single pet in comparison to those owners who kept more than one pet (n=21, 11.67%). However, chi-square analysis did not show any effect of the number of pets in the household on obesity in dogs (Table 1).

Living Environment and Home Demography

House Type- The prevalence of obesity was highest in dogs (n=99, 55%) that lived in apartment buildings followed by those that lived in single-story buildings (n=47, 26.11%), villa (n=32, 17.78%) and least in those that lived in farmhouses (n=2, 1.11%) (Table 1). In comparison to this, a majority of normal weight dogs lived in the villa (n=45) followed by those lived in single-story (n=17), farmhouse (n=6) and apartments (n=2). The house types had a highly significant effect on obesity (**X^2=80.26, p<0.0001**).

Area of House- Out of 180 overweight and obese dogs majority (n=94, 52.22%) lived in houses with areas less than 100 yards (Y) followed by those dogs (n=56, 31.11%) that lived in houses with area 100-200 yards and the least number of overweight and obese dogs (n=30, 16.67%) lived in large area houses having area >300yards. There was a highly significant difference in the prevalence of obesity in dogs that lived in small houses compared to dogs that lived in houses having an area of more than 300 yards (**X^2=65.45, p<0.0001**).

Preventive Health Measures

Deworming- Out of 180 overweight and obese dogs, in 45 dogs deworming was done regularly (Table 1). In comparison to this, deworming was regularly done in 50 normal dogs (71.43%). There was a highly significant difference in obesity between dogs who were dewormed regularly and irregularly (**X^2=47.87, p<0.0001**).

Vaccination- Out of 180 overweight or obese dogs, vaccination was either irregular or not done in 109 dogs (60.56%). There was a highly significant difference in obesity between regularly and irregularly vaccinated dogs (**X^2=58.42, p<0.0001**).

Breed Type

In the present study, breed-wise prevalence of obesity ranged from 1.11% to 55.55% (Table 2). Highest prevalence was recorded in Labrador Retrievers (n=100, 55.55%) followed by Pug (n=34, 18.89%), Beagle (n=15, 8.33%), Spitz (n=10, 5.55%), German Shepherd (n=5, 2.78%), Toy Pom (n=4, 2.22%), Boxer (n=3, 1.67%), Dachshund (n=3, 1.67%), Cocker Spaniel (n=2, 1.11%) and mixed breed (n=4, 2.22%).

Table 1: Risk factor analysis for obesity (based on questionnaire)

S. No.	Parameters	Variable	Number of dogs (n=250)	Normal (n=70)	Overweight dogs (n=111)	Obese dogs (n=69)	Ow+Obese (n=180)	Chi Square	P Value
1	Gender	Male	182 (72.8%)	56 (80.00%)	77(69.37%)	49 (71.01%)	126 (70%)	2.6	0.272
		Female	68 (27.2%)	14(20.00%)	34(30.63%)	20(28.99%)	54 (30%)		
2	Breed type	Pure bred	215 (86%)	61 (87.14%)	94 (84.68%)	60 (86.96%)	154 (85.56%)	0.28	0.865
		Cross bred	35 (14%)	9 (12.86%)	17 (15.32%)	9 (13.04%)	26 (14.44%)		
3	Reproductive status	Intact	227 (90.8%)	69 (98.57%)	100 (90.09%)	58 (84.06%)	158 (87.78%)	8.88	0.0118*
		Neutered	23 (9.2%)	1 (1.43%)	11 (9.91%)	11 (15.94%)	22 (12.22%)		
4	Duration of owning/ Time of Adoption	Since birth	15 (6%)	9 (12.86%)	4 (3.60%)	2 (2.90%)	6 (3.33%)	15.38	0.004**
		Early adoption	226 (90.4%)	61 (87.14%)	99 (89.19%)	66 (95.65%)	165 (91.65%)		
		Adult adoption	9 (3.6%)	0 (0%)	8 (7.21%)	1 (1.45%)	9 (5%)		
5	Age	1-3Yr	59 (23.6%)	36 (51.43%)	15 (13.51%)	8 (11.59%)	23 (12.78%)	55.75	<0.0001***
		3-5Yr	65 (26%)	21 (30%)	31 (27.93%)	13 (18.84%)	44 (24.44%)		
		5-7Yr	51 (20.4%)	5 (7.14%)	25 (22.52%)	21 (30.43%)	46 (25.55%)		
		7-9Yr	52 (20.8%)	6 (8.57%)	26 (23.42%)	20 (28.99%)	46 (25.55%)		
		>9Yr	23 (9.2%)	2 (2.86%)	14 (12.61%)	7 (10.14%)	21 (11.67%)		
6	Owner awareness about obesity	Yes	140 (56%)	50 (71.43%)	50 (45.05%)	40 (57.97%)	90 (50%)	12.27	0.0022**
		No	110 (44%)	20 (28.57%)	61 (54.95%)	29 (42.03%)	90 (50%)		
7	BCS awareness	Yes	4 (1.6%)	0 (0%)	1 (0.90%)	3 (4.35%)	4 (2.22%)	4.79	0.0911
		No	246 (98.4%)	70 (100%)	110 (99.10%)	66 (95.65%)	176 (97.78%)		
8	BCS by owner	Underweight	0	0	0	0	0	68.21	<.0001***
		Normal	171 (68.4%)	70 (100%)	74 (66.67%)	27 (39.13%)	101 (56.11%)		
		Overweight /Obese	79 (31.6%)	0	37 (33.33%)	42 (60.87%)	79 (43.89%)		
9	Owners opinion	Useful	244 (97.6%)	70 (100%)	107 (96.39%)	67 (97.10%)	174 (96.67%)	2.48	0.289
		Not Useful	6 (2.4%)	0 (0%)	4 (3.60%)	2 (2.90%)	6 (3.33%)		
10	Food control	Control Feeding	229 (91.6%)	69 (98.57%)	102 (91.89%)	58 (84.06%)	160 (88.89%)	9.53	0.0085**
		Free feeding	21 (8.4%)	1 (1.43%)	9 (8.10%)	11 (15.94%)	20 (11.11%)		
11	Type of food	Home cooked	115 (46%)	15 (21.43%)	66 (59.46%)	34 (49.27%)	100 (55.55%)	26	<0.0001***
		Commercial	6 (2.4%)	2 (2.86%)	3 (2.70%)	1 (1.44%)	4 (2.22%)		
		Both	129 (51.6%)	53 (75.71%)	42 (37.84%)	34 (49.27%)	76 (42.22%)		
12	Table scraps	Yes	116 (46.4%)	3 (4.29%)	66 (59.46%)	47 (68.11%)	113 (62.77%)	70.61	<.0001***

		No	134 (53.6%)	67 (95.71%)	45 (40.54%)	22 (31.88%)	67 (37.22%)		
13	Snacks and treats	Yes	172 (68.8%)	11 (15.71%)	94 (84.68%)	67 (97.10%)	161 (89.44%)	128.34	<.0001***
		No	78 (31.2%)	59 (84.29%)	17 (15.31%)	2 (2.90%)	19 (10.56%)		
14	Feeding frequency	Once a day	4 (1.6%)	1 (1.43%)	2 (1.80%)	1 (1.45%)	3 (1.66%)	72.83	<.0001***
		Twice a day	111 (44.4%)	61 (87.14%)	32 (28.82%)	18 (26.09%)	50 (27.77%)		
		Several times a day	135 (54%)	8 (11.43%)	77 (69.37%)	50 (72.46%)	127 (70.55%)		
15	Nutritional supplements	Yes	26 (10.4%)	9 (12.86%)	9 (8.11%)	8 (11.59%)	17 (9.44%)	1.18	0.553
		No	224 (89.6%)	61 (87.14%)	102 (91.89%)	61 (88.40%)	163 (90.56%)		
16	Exercise status	Yes	193 (77.2%)	69 (98.57%)	76 (68.47%)	48 (69.56%)	124 (68.88%)	25.25	<0.0001***
		No	57 (22.28%)	1 (1.43%)	35 (31.53%)	21 (30.43%)	56 (31.12%)		
17	Regularity (n=193)	Regular	125 (64.77%)	58 (84.06%)	50 (65.79%)	17 (35.42%)	67 (54%)	55.98	<0.0001***
		Irregular	68 (35.23%)	11 (15.94%)	26 (34.21%)	31 (64.58%)	57 (46%)		
18	Duration of exercise (n=193)	<0.5hr	128 (66.32%)	24 (34.78%)	63 (82.89%)	41 (85.42%)	104 (83.87%)	84.07	<0.0001***
		0.5-1hr	64 (33.16%)	45 (65.22%)	12 (15.79%)	7 (14.58%)	19 (15.32%)		
		>1hr	1 (0.5%)	0	1 (1.31%)	0 (0%)	1 (0.8%)		
19	Type of exercise (n=193)	Walking only	168 (87.05%)	45 (65.22%)	75 (98.68%)	48 (100%)	123 (99.2%)	76.82	<.0001***
		other exercise	25 (12.95%)	24 (34.78%)	1 (1.31%)	0 (0%)	1 (0.8%)		
20	Age of Owner	<20Yr	4 (1.6%)	2 (2.86%)	1 (0.90%)	1 (1.45%)	2 (1.11%)	72.38	<.0001***
		20-40Yr	104 (41.6%)	58 (82.86%)	31 (27.93%)	15 (21.74%)	46 (25.55%)		
		>40Yr	142 (56.8%)	10 (14.29%)	79 (71.17%)	53 (76.81%)	132 (73.33%)		
21	Health of Owner	Lean	2 (0.8%)	1 (1.43%)	1 (0.90%)	0 (0%)	1 (0.55%)	42.33	<.0001***
		Normal	164 (65.6%)	67 (95.71%)	67 (60.36%)	30 (43.48%)	97 (53.88%)		
		Overweight/ Obese	84 (33.6%)	2 (2.86%)	43 (38.74%)	39 (56.52%)	82 (45.55%)		
22	Gender	Male	178 (71.2%)	53 (75.71%)	82 (73.87%)	43 (62.32%)	125 (69.44%)	3.73	0.154
		Female	72 (28.8%)	17 (24.29%)	29 (26.13%)	26 (37.68%)	55 (30.56%)		
23	Number of Persons	1-2Pr	36 (14.4%)	2 (2.86%)	24 (21.62%)	10 (14.49%)	34 (18.9%)	22.7	0.0001***
		2-4Pr	105 (42%)	23 (32.86%)	46 (41.44%)	36 (52.17%)	82 (45.55%)		
		>4Pr	109 (43.6%)	45 (64.29%)	41 (36.94%)	23 (33.33%)	64 (35.55%)		
24	Number of Pets	1	214 (85.60%)	55 (78.57%)	101 (90.99%)	58 (84.06%)	159 (88.33%)	5.55	0.062
		>1	36 (14.40%)	15 (21.43%)	10 (9.01%)	11 (15.94%)	21 (11.67%)		
25	House Type	Apartment	101 (40.4%)	2 (2.86%)	64 (57.66%)	35 (50.72%)	99 (55%)	80.26	<0.0001***
		Single Story	64 (25.6%)	17 (24.29%)	25 (22.52%)	22 (31.88%)	47 (26%)		

		Villa	77 (30.8%)	45 (64.29%)	21 (18.92%)	11 (15.94%)	32 (17.78%)		
		Farm House	8 (3.2%)	6 (8.57%)	1 (0.90%)	1 (1.45%)	2 (1.11%)		
26	Area	<100Y	98 (39.2%)	4 (5.71%)	56 (50.45%)	38 (55.07%)	94 (52.55%)	65.45	<0.0001***
		100-200Y	78 (31.2%)	22 (31.43%)	38 (34.23%)	18 (26.09%)	56 (31.11%)		
		>300Y	74 (29.6%)	44 (62.86%)	17 (15.31%)	13 (18.84%)	30 (16.67%)		
27	Deworming	Irregular	155 (62%)	20 (28.57%)	85 (76.57%)	50 (72.46%)	135 (75%)	47.87	<0.0001***
		Regular	95 (38%)	50 (71.43%)	26 (23.42%)	19 (27.54%)	45 (25%)		
28	Vaccination	Irregular	114 (45.6%)	5 (7.14%)	65 (58.56%)	44 (63.77%)	109 (60.56%)	58.42	<0.0001***
		Regular	136 (54.4%)	65 (92.86%)	46 (41.44%)	25 (36.23%)	71 (39.44%)		

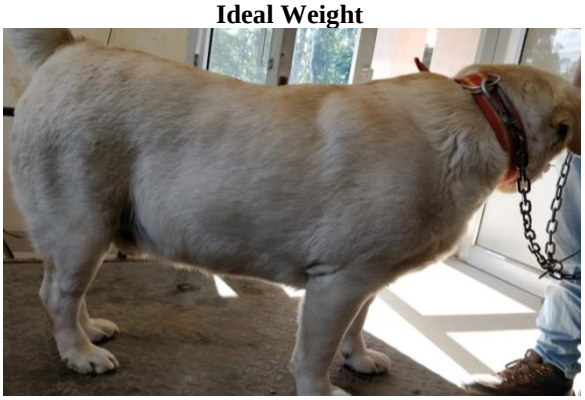
Table 2: Breed wise distribution of obesity in companion dogs

S. No.	Breed Name	Total (Ow+Obese)	Overweight (n=111)	Obese (n=69)	Normal (N=70)
1	Labrador Retriever	100 (55.55%)	51 (45.94%)	49 (71.01%)	26 (37.14%)
2	Pug	34 (18.89%)	27 (24.32%)	7 (10.14%)	18 (25.71%)
3	Beagle	15 (8.33%)	11 (9.91%)	4 (5.79%)	9 (12.85%)
4	Spitz	10 (5.55%)	7 (6.30%)	3 (4.34%)	13 (18.57%)
5	GSD	5 (2.78%)	4 (3.60%)	1 (1.45%)	1 (1.43%)
6	Toy Pom	4 (2.22%)	3 (2.70%)	1 (1.45%)	0
7	Dachshund	3 (1.67%)	2 (1.80%)	1 (1.45%)	3 (4.28%)
8	Boxer	3 (1.67%)	3 (2.70%)	0	0
9	Cocker Spaniel	2 (1.11%)	1 (0.90%)	1 (1.45%)	0
10	Mixed Breed	4 (2.22%)	2 (1.80%)	2 (2.90%)	0

Lean

Ideal Weight

Overweight



Obese

(a) Side view – Absence of abdominal tuck in overweight and obese dogs

Lean **Ideal Weight** **Overweight** **Obese**

(b) Top view – Absence of lumbar waist in overweight and obese dogs

Figure 1 (a-b): BCS using visual assessment

Discussion

In this study, risk factors for dogs having an elevated BCS (BCS 4 or 5) on 5 point BCS scale were investigated based on a sample of companion dogs presented at multispecialty hospital.

I. **Dog Characters**- In our study, male dogs showed a higher prevalence of obesity, possibly due to a higher preference for keeping male pets. This contrasts with previous findings that crossbred dogs are more prone to obesity (McGreevy *et al* 2005) whereas Colliard *et al* (2006), Sallander *et al* (2010) and Usui *et al* (2016) reported a higher prevalence of obesity in females than males. Neutering was associated with increased obesity rates, likely due to hormonal changes affecting appetite regulation, neutered dogs were 1.4 times more likely to be overweight than intact dogs, and this increased obesity in neutered dogs could be attributed to lower metabolic levels (McGreevy *et al* 2005). Neutering decreases the accumulation of androgens and estrogens in the central nervous system that functions on satiety factors contributing to decreased appetite in neutered dogs (Crane 1991). Early adoption was linked to higher obesity rates, possibly because most dogs are acquired at a young age. However, Nijland *et al* (2009) reported there is no correlation between length of ownership, gender and age of the animal and gender, age, education level and activity score of the owner with obesity. Obesity prevalence peaked around 9 years of age before declining, likely due to metabolic changes and reduced appetite in older dogs (Lund *et al* 2006; Laflamme 2012)

II. **Owner Awareness and Perception**- Courcier *et al* (2010) reported that there was a 5% higher prevalence of obesity in less educated people as compared to the dog owners who were more educated. The findings of our study suggested that most of the owners of overweight and obese dogs underestimate the BCS and body weight of their dogs. Similar findings were also reported by Colliard *et al* (2006) who found that the body condition of dogs by their owners was underestimated when compared with a veterinarian's assessment.

III. **Feeding Practices**- Feeding practices significantly impact dogs' likelihood of obesity. Dogs with robust appetites, especially if they have unrestricted access to food, are more prone to obesity (Sallander *et al* 2010). Feeding homemade food elevates obesity risk compared to commercial diets (Lund *et al* 2006). Table scraps and treats, often used for communication with dogs, contribute to obesity (Kienzle *et al* 1998). Both snacks and homemade foods are risk factors for obesity (Courcier *et al* 2010; Heuberger and Wakshlag 2011; Sallander *et al* 2010). Dogs fed semi-moist homemade foods face increased risk due to higher caloric density (Robertson 2003).

Feeding frequency also matters, with once-daily feeding linked to higher obesity rates (Colliard *et al* 2006; Bland *et al* 2009). However, this could be influenced by owners providing snacks at other times. Contradictory findings

suggest higher obesity incidence in dogs given nutritional supplements, possibly due to confusion between treats and supplements (Mao *et al* 2013).

Sallander *et al* (2010) found dogs with good appetite had 3.42 times higher chances of obesity. They also noted a greater risk in dogs with free food access. Lund *et al* (2006) reported higher obesity rates in dogs fed homemade food. Mao *et al* (2013) found lower obesity rates in dogs fed commercial diets. Studies by Kienzle *et al* (1998) and Courcier *et al* (2010) highlighted table scraps and treats as significant contributors to obesity.

Feeding semi-moist homemade foods poses increased obesity risk due to calorie density and different feeding practices (Robertson 2003; Preet *et al* 2019). Robertson (2003) emphasized the role of snacks in obesity and stressed the importance of considering all food sources in measuring a dog's nutritional intake. Feeding once daily raises obesity likelihood compared to twice daily, possibly due to additional snack feeding by owners (Colliard *et al* 2006; Bland *et al* 2009). This contradicts findings by Mao et al. (2013) regarding nutritional supplements and obesity.

IV. **Exercise and Activity**- During relaxation and activity, use of snacks differs with feeding and exercise management along with difference between BCS of their owners. This study was in agreement with Lund *et al.* (2006) who reported exercise as a major risk factor in the development of obesity in companion dogs and owners of obese dogs easily ignored their exercise and occupation further adding to obesity (Kienzle *et al* 1998). Bland *et al* (2009) and Courcier *et al* (2010) also reported that obese dogs received less exercise than non-obese dogs. The population density of the city where the dogs live was related to the probability that the dogs were overweight. Australian studies found that due to excessive feeding and decreased training time/exercise, dogs were at a higher risk of being overweight compared to metropolitan dogs (McGreevy *et al* 2005). Practices of feeding and exercise, the important risk factors for obesity are the duration of daily activity.

V. **Interactions between Owner and Dog Characteristics**- The likelihood of dogs being overweight or obese is substantially correlated with the weight status of their owners. Dogs belonging to overweight or obese owners are more likely to be overweight or obese themselves (Colliard *et al* 2006; Courcier *et al* 2010; Montoya-Alonso *et al* 2017). Conversely, dogs owned by individuals with a normal weight have a lower likelihood of being overweight or obese. Access to outdoor space, such as a yard or garden, significantly decreases the chances of dogs becoming overweight or obese, particularly for those living in villas. The correlation between outdoor activity and weight status should be further investigated to understand its impact on energy expenditure. A higher incidence of obesity in dogs owned by obese individuals, particularly those in middle or elderly age groups (>40Years) (Mason, 1970). Colliard *et al* (2006), Courcier *et al* (2010) and Montoya-Alonso *et al* (2017) also reported that the incidence of obesity in dogs increased (65%) with an increase in the age of owner (over 55 years old). The exercise and dietary habits of owners play a crucial role in the bodyweight of dogs (Robertson, 2003). Lack of exercise, dietary factors, and social environment contribute to obesity in both dogs and their owners (German 2006; Bryan *et al* 2017). In general, human beings are responsible for their own chosen lifestyle, which may inturn be influenced by cultural factors, such as the obesogenic climate. Nevertheless, dogs are owner-dependent and are completely influenced by the interests and behaviour of their owners (Yam *et al* 2016). Furthermore, the number of people and pets in a household can influence the likelihood of obesity in dogs, with more individuals and pets promoting a playful environment and increased energy expenditure, reducing the risk of obesity (Robertson 2003; Bland *et al* 2009).

VI. **Living Environment and Home Demography** - Colliard *et al* (2006) reported that 62.2 % of obese dogs lived in apartment buildings, while 37.7% lived in houses. Mao *et al* (2013) reported the prevalence of obesity was highest in dogs living in cages (67.4%), followed by those living in apartment buildings (44.4%) and single-storied buildings (43.4%). Several times, feeding with restricted activity leads to a positive energy balance that promotes the accumulation of fat, resulting in obesity (Laflamme 2012).

VII. **Preventive Health Measures**- While comparing preventive health records and obesity it was found that prevalence of obesity was highest in dogs (n=135, 75%) in which deworming was either not done or if done than irregularly as compared to those dogs (n=45, 25%) in which deworming was done regularly. The preventive health measures were studied to check the owner's concern and awareness regarding dog health and disease prevention; however, no study was available to support these findings.

VIII. **Breed Types**- The findings of the present study were in agreement with Edney and Smith (1986) who reported higher incidences of obesity in breeds like Labrador Retrievers, Cocker Spaniels, Long Haired Dachshund, Shetland Sheepdogs, Baset Hounds, Cavalier King Charles Spaniels and Beagles. Genetic predisposition as risk factors in certain breeds like Labrador Retrievers, Cairn Terrier, Cavalier King Charles, Cocker Spaniel and Scottish Terrier has been illustrated by Edney and Smith (1986). Retrievers are proven to be 4.65 times more obese than other breeds (Colliard *et al* 2006). Similarly, Lund *et al* (2006) has reported that obese dogs include Cocker Spaniels, Labrador Retrievers, Shetland Sheepdogs, Rottweilers, and mixed breed dogs. Pugs and Cocker Spaniels have the highest tendency to obesity, according to Mao *et al* (2013).

Our study, like previous research efforts, possesses both strengths and limitations that require acknowledgment when interpreting the findings. Nevertheless, these results may lay the groundwork for future prospective longitudinal studies. Past investigations into the risk factors for canine obesity have been conducted in diverse communities, employing varied recruitment methods and criteria for participant inclusion and exclusion like that of Lund *et al* 2006; Courcier *et al* 2010; Mao *et al* 2013. In several studies, the assessment of body condition score (BCS) was performed by clinical personnel, whereas in others, it was carried out by pet owners, often resulting in an underestimation of BCS. In our study, efforts were made to minimize bias in BCS assessment by training a single evaluator and ensuring inter-observer reliability. Dogs under 1 year of age and those with acute or chronic illnesses were excluded from the analysis. Dogs were then categorized into three BCS classes: Normal/average, overweight, and obese. Determining a clear cutoff point for identifying true excess weight based on BCS results poses a challenge, given the significant overlap in body fat percentage observed across different BCS systems, especially across various dog breeds.

Conclusion

In conclusion, our study found that risk factors associated with obesity were middle age, neutering status, breed, poor dietary control, low physical activity, Living environment and home demography and breed. Furthermore, the owner, less aware of obesity, underestimating obesity, increasing age and sedentary lifestyle were more likely to have obese dogs. This study can help both veterinarians and owners to evaluate the risk factors associated with obesity and can help owners to maintain ideal body weight.

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Contribution by Authors

Each co-author contributes equally.

Conflict of Interests

There is no conflict of interest.

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