International VETEXPO-2019 Veterinary Sciences Congress
September 20-22 2019. Double Tree by Hilton Hotel, Avcilar /Istanbul, Turkey

Oral presentation

The evaluation of prevalence and risk factors of overweight and obesity in cats from some private veterinary clinics in Istanbul, Turkey

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Abstract

Overweight and obesity in cats is known as one of the most common welfare issues. According to various studies, many risk factors such as age, breed, gender, neutering, food type, inactivity, diseases etc. played role in this problem. The aim of this study was to evaluate the relationship between potential risk factors and overweight or obesity in cats. A total of 264 cats were evaluated in the study and dataset related age, breed, sex, neutering status, exercise status, food type, disease category and BCS were obtained from several veterinary clinics by using a standardized questionnaire. Chi-square test was used for comparing subgroups of potential risk factors in terms of prevalence of overweight or obese cats. Univariable analysis was performed to determine associations between being overweight/obese and possible risk factors. A multivariable analysis was performed to determine the most important risk factor among variables investigated in the study. Statistical analysis of dataset showed that BCS of 5 was the most common score (29.17%), followed by score 6 (18.56%). Prevalence of overweight or obese cats (BCS $\geq$ 7) was 18.56% and it was higher in age groups 3 (5-8 years old) (27.50%) and 4 (9-14 years old) (22.73%) than in age group 1 ($\leq$1 years old) (4.65%). It was also higher in SA and SNA cats than cats whose exercise was not recommended ($P<0.05$). There was a tendency towards the association of sex ($P=0.055$) and neutering status ($P=0.068$) with being overweight or obese. Male cats were 1.95 times more likely to be overweight and obese than female ones. Neutered cats were also more likely to be overweight and obese than intact cats. Breed differences, food type and disease category had no significant effect on being overweight or obese.

Keywords: Overweight, obesity, cat, prevalence, risk factors

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VETEXPO-2019 homepage: http://vetexpo.org/

Introduction

Obesity is the formation of excessive adipose tissue with positive energy balance, and is the most common multifactorial nutritional disorder of pet cats (Michel and Scherk, 2012; Linder and Mueller 2014). Because of its prevalence and its detractive effects on quality of life and longevity by predisposing animals to several diseases and conditions, obesity is a significant problem (Lund et al., 2005; Scarlett et al., 1994; German et al., 2010). The incidence of obesity in cats and dogs has increased dramatically and it has become a serious concern in veterinary medicine (German, 2006). Older reports suggested that 6-12% of cats were overweight while recently published studies reported a prevalence of 19-29% and 6-8% of overweight or obese cats, respectively. In the United States, it is estimated that 53% of cats are overweight or obese (Lund et al., 2005; German et al., 2010). Many risk factors are recognized for feline obesity and the factors with significant roles in the development of obesity are inactivity, middle age, sex, neutering, age at neutering and breed (Scarlett et al., 1994; Russell et al., 2000). Of these risk factors common to all studies, age, sex and neutered status are identified consistent three risk factors and neutering was the most strongly associated factor with obesity (Cave et al., 2012). Furthermore, number of cats in a house, presence of a dog, inactivity, middle age, being mixed-bred, food type, feeding treats, ad libitum feeding and being unawareness of body weight or body condition were also accepted as risk factors in some studies (Lund et al, 2005; Robertson, 1999; Allan et al., 2000; Russell et al., 2000). In companion animals, individuals are generally accepted as obese if more than 20% heavier than ideal body weight and overweight if 10% to 20% greater than optimal body weight (Burkholder and Toll, 2000; Zoran, 2009; Laflamme, 2012; Linder and Mueller 2014). Rather than classification of obesity based on body weight, the Body Condition Score (BCS) is the most widely accepted method of assessing overweight and obesity and has been validated in domestic cats (German et al., 2006; Bjornvad et al., 2011). The most commonly used system for BCS are the 5-point scale (Allan et al., 2000; Lund et al., 2005; Courcier et al., 2010; Courcier et al., 2012) and 9-point scale (Cave et al., 2012; Corbee 2014; Laflamme, 1997).

In Turkey, there are many studies on the prevalence and risk factors for overweight and obesity in human medicine, but studies on cats in veterinary medicine are quite rare. Though many veterinarians agree that the prevalence of overweight and obesity in cats is increasing, there is no enough data regarding this health problem in Turkey. Therefore, the aim of this survey study was to evaluate the relationship between potential risk factors and overweight or obesity in cats.

Materials and Methods

Data collection

A total of 264 cats were evaluated in this study. All data were collected from cats visited several participating clinics by using questionnaires completed by veterinarians in Istanbul-Turkey. Data regarding BCS (9-point scale), age, breed, sex, neutering status, exercise status, food type, disease category was considered for each cat.

Statistical analysis

All statistical analyses were performed using SPSS 25.0 for Windows programme (IBM Corp, Armonk, NY, USA). Age group, breed group, sex, neutering status of cat, exercise status, food type and disease category were evaluated as potential risk factors for being overweight or obese (BCS $\geq$ 7). The number and percentages of cats in different BCSs were calculated for the subgroups of each potential risk factor to characterize demographic variables. Chi-square test was used for comparing subgroups of potential risk factors in terms of prevalence of overweight or obese cats.

Univariable logistic regression analysis was performed to determine associations between being overweight / obese and possible risk factors. In the hypothesis of this analysis, risk factors that cause overweight or obesity in cats were assumed to be different from the factors that cause underweight. Therefore, data of

cats with a BCS 1 and 2 (n=21) were deleted from dataset in logistic regression analysis. The dependent variable in logistic regression analysis was BCS category. BCS values of 3-6 were assumed as normal weight category, while BCS values that equal or greater than 7 were considered overweight or obese category.

A multivariable logistic regression analysis was performed to determine the most important risk factor among variables investigated in the study. Explanatory variables which yielded a Wald test P value <0.10 in the univariable logistic regression test were included in the multivariable test (Rowe et al., 2015). The two-way interactions of explanatory variables were also assessed in the multivariable analysis. Stepwise logistic regression procedure was applied. Backward-selection based on likelihood ratio statistics was used for variable selection. The criteria of $P<0.05$ and $P>0.1$ were chosen in stepwise procedure for entry and removal of variables, respectively.

Results

Descriptive statistics

Table 1 shows the number and percentages of cats in different body condition scores. A total of 264 cats were evaluated in the study. The most frequently seen cat breed was Tekir (n=189; 71.59%). There were more male cats (58.71%) than female ones (41.29%). The majority of the cats were neutered (79.55%) and only 20.45% of cats was intact. Of the 264 cats, 78.79% were fed with dry diet. BCS of 5 was the most common score (29.17%), followed by score 6 (18.56%). Spearman correlation between weights of cats and body condition scores (1-9 scale) was 0.837 ($P<0.001$).

Prevalence of overweight or obese

Prevalence of overweight or obese cats (BCS ≥ 7) was 18.56% (Table 2). Age group had a significant influence on being overweight or obese ($\chi2=10.854$; $P=0.013$). Prevalence of overweight or obese cats was higher in age groups 3 (27.50%) and 4 (22.73%) than in age group 1 (4.65%). Differences among breed groups in terms of prevalence of overweight or obese cats were not significant ($\chi2=0.245$; $P=0.993$). Male cats had higher prevalence of overweight or obesity compared with female ones ($\chi2=4.014$; $P=0.045$). Neutered cats had higher prevalence of overweight or obesity than intact cats ($\chi2=3.885$; $P=0.049$). Exercise status had also a significant effect on being overweight or obese ($\chi2=7.798$; $P=0.005$). The prevalence of overweight and obese cats was higher in SA and SNA cats than that of cats whose exercise was not recommended ($P<0.05$). Neither food type ($\chi2=0.291$; $P=0.589$) nor health status ($\chi2=7.947$; $P=0.242$) influenced the prevalence of overweight or obese cats.

Univariable analysis

According the univariable analysis, age group ($P=0.015$) and exercise status ($P=0.033$) were determined to be associated with overweight or obesity. Age groups 3 and 4 showed an increased risk of overweight and obesity. SNA cats had an increased risk of overweight and obesity compared with SA cats, while a decreased risk was observed in NS cats. There was a tendency towards the association of sex ($P=0.055$) and neutering status ($P=0.068$) with being overweight or obese. Male cats were 1.95 times more likely to be overweight and obese than female ones. Neutered cats were also more likely to be overweight and obese than intact cats. On the other hand, no association was observed between food type or disease category and being overweight or obese.

Multivariable analysis

According the results of stepwise logistic regression based on backward-selection procedure, only two risk factors were included in the final multivariable regression model: exercise status and sex of cat. SNA cats were 3.163 times more likely to be overweight and obese than SA cats. NS cats had lower odds of being overweight and obese than SA cats. Male cats tended to have more risk to be overweight and obese than female ones. Age group, breed group, neutering status, food type, disease category and sex × neutering status interaction were not a significant predictor in the multivariate model.

Discussion

In this study, the most common BCS was 5 (29.17%). Of cats evaluated in this study, 73.49% were normal weight and 18.56% were overweight or obese. The prevalence of overweight or obese cats were 18.56%. In the present study, four risk factors, age, sex, neutering status, exercise status, were significant on being overweight or obese. In several studies, the results have indicated that obesity is more common in middle-aged (5 to 11 years old) cats due to reductions in metabolism and physical activity depending on age (Kronfeld et al., 1994; Scarlett et al., 1994; Robertson, 1999; Lund et al., 2005; Kienzle and Bergler, 2006; McGreevy et al., 2008; Courcier et al., 2012). Also, it was reported that below 1year old was a lower risk factor and adult age (2-9 years old) was a positive risk factor for feline obesity (Colliard et al., 2009). In this study, statistical analysis showed that age group (Group 1: ≤1, Group 2: 2-4, Group 3 5-8, and Group 4: 9-14 years old) had a significant influence on being overweight or obese ($\chi 2$=10.854; P=0.013). Parallelly to prior studies, prevalence of overweight or obese cats was higher in age groups 3 (27.50%) and 4 (22.73%) than in age group 1 (4.65%).

In this study, sex was a significant factor in the terms of being overweight or obesity. According to the results, male cats had higher prevalence of overweight or obesity compared with female ones, similar to what has previously been shown (Lund et al., 2005; Courcier et al., 2012; Colliard et al., 2009; Öhlund et al, 2018). In the present study, multivariable analysis shown that male cats tended to have more risk to be overweight and obese than female cats, and univariable analysis shown that male cats were 1.95 times more likely to be overweight and obese than female ones. This result was agree with Teng et al. (2017) who reported that sex was significant (P=0.01) in the univariable model with 1.24 (95% CI: 1.08-1.43) times the odds of overweight in male cats, compared to female cats. The tendency toward overweight or obesity in male cats might be due to the maintenance energy requirement per kg BW in female cats is higher than males (Bermingham et al., 2010), therefore, males might consume excess energy in a feeding programme without considering sex.

In the present study, neutering was a significant risk factor for overweight and obesity in both sexes. Neutered cats had higher prevalence of overweight or obesity than intact cats. While most of the studies reported that neutering increased the probability of overweight or obesity in cats (Cave et al., 2012; Courcier et al., 2010; Colliard et l., 2009; McGreevy et al., 2008; Hoenig and Ferguson, 2002), some of the other studies shown that neuter status was not significant (Kienzle and Berglert, 2006; Rowe et al., 2015). When compared to intact cats, the higher prevalence of overweight or obesity in neutered cats in this study can be the result of an increase in daily food intake and a decrease in metabolic rate and energy expenditure as suggested by several studies (Mitsuhashi et al., 2011; Bermingham et al., 2010; Fettman et al., 1998; Flynn et al., 1996; Root et al., 1996).

The other significant risk factor for overweight and obesity in this study was exercise status. Among sub groups of exercise status (SA: Exercise was suggested by veterinarian and applied by owner; SNA: Exercise was suggested by veterinarian but it was not applied by owner; NS: Exercise was not suggested by veterinarian), the prevalence of overweight and obese cats was higher in SA and SNA cats than that of NS cats. According to the result of univariable and multivariable analysis in this study, SNA cats had an increased risk of overweight and obesity compared with SA cats, and SNA cats were 3.163 times more likely to be overweight and obese than SA cats, while a decreased risk was observed in NS cats. The suggestion of exercise (regardless of whether it was applied or not) by veterinarian can be considered as an indicator for prevalence of overweight and obesity in pet cats. In previous studies, inactivity has been shown as a risk factor for overweight and obesity in cats (Sloth, 1992; Scarlett et al., 1994; Fettman et al., 1998; Robertson ,1999; Allan et al., 2000) and these reports supported the increase in the risk of overweight and obesity in SNA cats in the present study. However, there were also some studies reported no associations between activity and obesity (Courcier et al., 2010; Russell et al., 2000; Scarlett et al., 1994; Cave et al., 2012).

Statistical analysis of dataset in this study showed that breed, food type and disease category were not significant risk factor for being overweight and obesity. The major proportion cat breed was Tekir, a domestic breed in Turkey, in this study and the other breeds (mixed-breeds and purebred) was minor. The no significant effect of breed differences in this study was in accordance with some previous studies (Colliard et al., 2009; Courcier et al., 2010; Courcier et al., 2012; Rowe et al., 2015) but was in disagreement with other

studies that found significant difference (Robertson, 1999; Lund et al., 2005; McGreevy et al., 2008; Teng et al., 2017). This disagreement might be due to the minor populations of some breeds in this study, therefore, the study was not able to detect individual breed effects, possibly due to lack of statistical power. With the terms of disease category, in a newest study conducted by Kocabağlı et al. (2017), it was reported that overweight-obese cats were more likely to be diagnosed with osteoarthritis, hepatic lipidosis, gastrointestinal disease and neoplasia, also, overweight cats were at increased risk for urinary diseases, however, there was no any relationship between obesity and urinary diseases. In our study, disease categories (such as respiratory, urinary, digestive, inflectional, skin and other diseases) were not significant risk factor for being overweight and obesity. In this study, 78.79% of 264 cats were fed with dry diet. The prevalence of overweight and obese cats was not influenced by food type. Also, no association was observed between food type and being overweight or obese in univariate and multivariate model. In contrast to this result, some recent studies showed feeding a dry food to be risk factor for overweight (Rowe et al., 2015; Rowe et al., 2017; Öhlund et al., 2018). Because of the limitations of the study, the amount of food given, the frequency of feeding and the composition of the diets were not assessed in this study. A comprehensive study containing these parameters might present a detailed approach on the risk factors for being overweight and obese. The prevalence of overweight or obese cats was not influenced by health status of cats in this study and no association was observed between disease category and being overweight or obese. Although some studies reported that overweight and obesity increased risk of diseases such as lower urinary tract disease, dermatoses, non-allergic skin conditions, lameness, diabetes mellitus, orthopedic, disease and certain types of cancer (Scarlett and Donoghue, 1998; Lund et al., 2005; German, 2006), a relationship between overweight-obesity and disease categories was not found in this study because there were fewer overweight or obese cats and effects of grouping many disease into one category.

Table 1. Number (n) and percentages (%) of cats in different body condition scores (BCS) according to the risk factors investigated in the study.

Risk Factors		Body Conditic				
		1	2	3	4	5
	n	n (%)	n (%)	n (%)	n (%)	n (%)
Age group						
1	43	0 (0.00)	3 (6.89)	6 (13.95)	6 (13.95)	24 (55.81)
2	97	1 (1.03)	3 (3.09)	14 (14.43)	11 (11.34)	35 (36.08)
3	80	0 (0.00)	6 (7.50)	9 (11.25)	9 (11.25)	13 (16.25)
4	44	3 (6.82)	5(11.36)	6 (13.64)	7 (15.91)	5 (11.36)
Breed group						
British-Scotish	26	0 (0.00)	0 (0.00)	3 (11.54)	4 (15.38)	10 (38.46)
Tekir	189	3 (1.59)	12 (6.35)	24 (12.70)	23 (12.17)	52 (27.51)
Persian-Chincilla	27	1 (3.70)	3 (11.11)	6 (22.22)	2 (7.41)	7 (25.93)
Van-Angora	12	0 (0.00)	2 (16.67)	1 (8.33)	1 (8.33)	4 (33.33)
Others	10	0 (0.00)	0 (0.00)	1 (10.00)	3 (30.00)	4 (40.00)
Sex						
Female	109	2 (1.83)	8 (7.34)	15 (13.76)	16 (14.68)	36 (33.03)
Male	155	2 (1.29)	9 (5.81)	20 (12.90)	17 (10.97)	41 (26.45)
Neutering status						
Neutered	210	3 (1.43)	12 (5.71)	24 (11.43)	28 (13.33)	56 (26.67)
Intact	54	1 (1.85)	5 (9.26)	11 (20.37)	5 (9.26)	21 (38.89)
Exercise status*						
SA	57	0 (0.00)	1 (1.75)	1 (1.75)	7 (12.28)	21 (36.84)
SNA	94	0 (0.00)	1 (1.06)	2 (2.13)	5 (5.32)	21 (22.34)
NS	113	4 (3.54)	15 (13.27)	32 (28.32)	21 (18.58)	35 (30.97)
Food type						
Dry diet	208	2 (0.96)	11 (5.29)	25 (12.02)	25 (12.02)	62 (29.81)
Others	56	2 (3.57)	6 (10.71)	10 (17.86)	8 (14.29)	15 (26.79)
Disease Category						
Healthy	133	2 (1.50)	4 (3.01)	12 (9.02)	13 (9.77)	43 (32.33)
Respiratory Sys.	11	0 (0.00)	0 (0.00)	2 (18.18)	4 (36.36)	4 (36.36)
Urinary Sys.	29	2 (6.90)	4(13.79)	6 (20.69)	5 (17.24)	4 (13.79)
Digestive Sys.	24	0 (0.00)	0 (0.00)	3 (12.50)	2 (8.33)	9 (37.50)
Infections	29	0 (0.00)	3 (10.34)	9 (31.03)	3 (10.34)	8 (27.59)
Skin	24	0 (0.00)	1 (4.17)	2 (8.33)	4 (16.67)	8 (33.33)
Others	14	0 (0.00)	5 (35.71)	1 (7.14)	2 (14.29)	1 (7.14)
TOTAL	**264**	**4 (1.52)**	**17 (6.44)**	**35 (13.26)**	**33 (12.50)**	**77 (29.17)**

*Exercise status sub groups: SA: Exercise was suggested by veterinarian and applied by owner; SNA: Exercise was suggested by veterinarian but it was not applied by owner; NS: Exercise was not suggested by veterinarian

Table 2. Prevalence of overweight or obese (BCS ≥ 7) cats by the risk factors investigated in the study.

Risk Factors		Number of cats	Number of overweight or obese cats	Prevalence of overweight or obese cats (%)	Chi-Square	*P*-v
Age group					10.854	0.0
	1	43	2	4.65[b]		
	2	97	15	15.46[ab]		
	3	80	22	27.50[a]		
	4	44	10	22.73[a]		
Breed group					0.245	0.9
	British-Scotish	26	4	15.38		
	Tekir	189	36	19.05		
	Persian-Chincilla	27	5	18.52		
	Van-Angora	12	2	16.67		
	Others	10	2	20.00		
Sex					4.014	0.0
	Female	109	14	12.84[b]		
	Male	155	35	22.58[a]		
Neutering status					3.885	0.0
	Neutered	210	44	20.95[a]		
	Intact	54	5	9.26[b]		
Exercise status*					7.798	0.0
	SA	57	11	19.30[a]		
	SNA	94	28	29.79[a]		
	NS	113	0	0.00[b]		
Food type					0.291	0.5
	Dry diet	208	40	19.23		
	Others	56	9	16.07		
Disease Category					7.947	0.2
	Healthy	133	33	24.81		
	Respiratory Sys.	11	1	9.09		
	Urinary Sys.	29	4	13.79		
	Digestive Sys.	24	3	12.50		
	Infections	29	2	6.90		
	Skin	24	4	16.67		
	Others	14	2	14.29		
TOTAL		**264**	**49**	**18.56**		

*Exercise status sub groups: SA: Exercise was suggested by veterinarian and applied by owner; SNA: Exercise was suggested by veterinarian but it was not applied by owner; NS: Exercise was not suggested by veterinarian
[a,b]: Percentages in the columns with different letters differ at $P < 0.05$

Table 3. Results of univariable logistic regression analysis for risk factors of overweight or obesity in cats.

Risk Factors		*B*	S.E.	OR	OR (95% C.I.)	*P*-value
Age group						
	1	-	-	1 (ref)	-	-
	2	1.296	0.778	3.654	0.795-16.798	0.096
	3	2.084	0.769	8.038	1.782-36.270	0.007
	4	1.989	0.815	7.308	1.478-36.124	0.015
Breed group						
	British-Scotish	-	-	1 (ref)	-	-
	Tekir	0.361	0.575	1.435	0.465-4.427	0.530
	Persian-Chincilla	0.424	0.742	1.528	0.357-6.545	0.568
	Van-Angora	0.318	0.959	1.375	0.210-9.015	0.740
	Others	0.318	0.959	1.375	0.210-9.015	0.740
Sex						
	Female	-	-	1 (ref)	-	-
	Male	0.668	0.348	1.950	0.986-3.854	0.055
Neutering status						
	Neutered	-	-	1 (ref)	-	-
	Intact	-0.919	0.503	0.399	0.149-1.069	0.068
Exercise status*						
	SA	-	-	1 (ref)	-	-
	SNA	1.039	0.397	2.826	1.298-6.154	0.009
	NS	-19.794	4145.588	0.000	n=0	0.996
Food Type						
	Dry diet	-	-	1 (ref)	-	-
	Others	-0.112	0.410	0.894	0.400-1.998	0.785
Disease Category						
	Healthy	-	-	1 (ref)	-	-
	Respiratory Sys.	-1.256	1.068	0.285	0.035-2.311	0.240
	Urinary Sys.	-0.511	0.586	0.600	0.190-1.892	0.383
	Digestive Sys.	-0.899	0.650	0.407	0.114-1.453	0.166
	Infections	-1.438	0.763	0.237	0.053-1.060	0.060
	Skin	-0.511	0.586	0.600	0.190-1.892	0.383
	Others	-0.206	0.827	0.814	0.161-4.115	0.803

B: Regression coefficient; OR: Odds ratio; C.I: Confidence interval; ref: Reference level
*Exercise status sub groups: SA: Exercise was suggested by veterinarian and applied by owner; SNA: Exercise was suggested by veterinarian but it was not applied by owner; NS: Exercise was not suggested by veterinarian

Table 4. Results of multivariable logistic regression analysis for risk factors of overweight or obesity in cats

Risk Factors		*B*	S.E.	OR	OR (95% C.I.)	*P*-value
Exercise status*						
	SA	-	-	1 (ref)	-	-
	SNA	1.151	0.399	3.163	1.446-6.918	0.004
	NS	-19.763	4116.463	0.000	n=0	0.996
Sex						
	Female	-	-	1 (ref)	-	-
	Male	0.653	0.385	1.922	0.904-4.086	0.090

B: Regression coefficient; OR: Odds ratio; C.I: Confidence interval; ref: Reference level
*Exercise status sub groups: SA: Exercise was suggested by veterinarian and applied by owner; SNA: Exercise was suggested by veterinarian but it was not applied by owner; NS: Exercise was not suggested by veterinarian

Conclusions

In this study, the most common BCS was 5 (29.17%). Within a population of cats visiting veterinary clinics, the prevalence of overweight or obese cats were 18.56%. Age, sex, neutering status and exercise status were significant on being overweight or obese, similar to other reports. However, no association was observed between food type or disease category and being overweight or obese. Also, differences among breed groups in terms of prevalence of overweight or obese cats were not significant. Further studies needs to be undertaken to expose the associations between the risk factors and overweight or obesity with large scale cat population. Obtaining data and evaluating the results from comprehensive researches on predisposing and risk factors in overweight and obesity is important and will be benefit to develop a strategy to avoid this common health problem in pets.

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