

# Epidemiology of small animal obesity

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1.1	Definition	1
1.2	Prevalence and time trends	1
1.3	Risk factors	2
1.3.1	<i>Animal-specific factors</i>	2
1.3.1.1	<i>Genetics and breed</i>	2
1.3.1.2	<i>Age</i>	2
1.3.1.3	<i>Gender and neutering</i>	7
1.3.2	<i>Human-specific factors</i>	8
1.3.2.1	<i>Diet type and feeding method</i>	8
1.3.2.2	<i>Physical activity</i>	9
1.3.2.3	<i>Owner attitudes and household characteristics</i>	9
1.4	Conclusion	10
	References	10

## 1.1 DEFINITION

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Obesity results from a chronic positive energy balance, when caloric intake exceeds caloric needs, leading to excess body weight as body fat accumulates (1–3). Overweight pets are 10%–20% above ideal body weight; obese pets are more than 20% above ideal (4). Body composition studies note 25%–35% body fat is considered overweight and >35% obese (5,6). These obesity definitions should also include a component of disease, as excess body fat modifies bodily functions and contributes to disease processes (1–3).

## 1.2 PREVALENCE AND TIME TRENDS

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Obesity is the number one nutrition problem in companion animals. The prevalence of canine obesity in industrialized countries is estimated at 11.2% to

59.4% (Table 1.1) (7–20). In cats, the prevalence rate ranges from 11.5% to 63.0% (Table 1.2) (10,21–32).

The presented data, however, has many limitations. The available studies spread a large time span and may not reflect the situation today. Moreover, studies have been conducted in a limited number of veterinary practices or were performed in very specific pet populations, using a variety of techniques to estimate body condition leading to various definitions of overweight/obesity. Also the person assessing the pet's body condition varies among studies.

Differences between countries and time trends are therefore difficult to investigate. A relatively constant distribution of body condition was noted in a cat population over a 4-year timespan (22,23). Also cat households surveyed in the same city in 1993 and 2007 did not show a difference of obesity prevalence (26,31).

### 1.3 RISK FACTORS

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Obesity is a multifactorial condition. Many risk factors affect energy intake and energy utilization, creating a positive energy balance (1,2). Veterinarians believe that only 3% of obese cases were attributed to animal-specific factors, while 97% was caused by human-specific factors such as dietary factors, physical activity, owner attitudes, and household characteristics (Figure 1.1) (33).

#### 1.3.1 Animal-specific factors

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##### 1.3.1.1 GENETICS AND BREED

Genetic factors of obesity are illustrated by breed predisposition. Still, the obesity frequency in specific dog breeds depends on the breed prevalence in the region of study. Overall, basset hounds, beagles, cairn terriers, cocker spaniels, dachshunds, golden retrievers, Labrador retrievers, pugs, and Shetland sheepdogs are among the predisposed breeds (8,9,13,14,18–20). Selection for a specific purpose or physical condition may be the reason. For some dog breeds the breeding standard seems to be overweight (19,20). Moreover, body composition varies among breeds (34), influencing energy expenditure (35). Contrary, crossbred cats are at higher risk to be overweight (22,24,27,28). Nonetheless, British shorthair, Persian, and Norwegian Forest cat have higher body condition scores among purebreds (32,36).

##### 1.3.1.2 AGE

The obesity prevalence increases with age (8,11–13,18,22,31), due to decreasing energy requirements especially as physical activity declines and age-related body composition changes cause the basal metabolic rate to drop (37,38). Harper described a 20% decrease in dogs, yet observed constant energy requirements throughout adult life in cats (37). Bermingham et al. could however not confirm a decline of energy requirements in aging dogs (39), yet did find an age-related reduction of energy expenditure in cats (40). Epidemiological studies report the highest prevalence of obesity in the middle-aged years for both dogs (12,14,18) and

**Table 1.1** Prevalence of obesity in various canine populations in various countries over 55-year time period (from 1960 to 2015)

Authors	Year	Country	Population	Sample size	Evaluation method	Prevalence rate
Krook et al. (7)	1960	Sweden	Canine necropsies	10,993	Pathologist Presence of pathologic adiposity	Obese: 11.2%
Mason (8)	1970	UK	One veterinary practice	1000	Attending veterinarian 3-point scale: thin, normal or obese, fat covering thorax	Obese: 28.0%
Edney and Smith (9)	1986	UK	11 veterinary practices, ranging from veterinary schools to private practices	8268	Attending veterinarians 5-point scale: thin, lean, optimum, obese, gross	Obese/gross: 24.3%
Lund et al. (10)	1999	USA	52 veterinary practices	86,772	Attending veterinarians 5-point scale: fat covering ribs and tail base and abdominal contour.	BCS $\geq$ 4/5: 28.3%
Robertson (11)	2003	Australia	2326 households, telephone survey	657	Owners 3-point scale: underweight, correct weight, overweight/obese	Overweight/obese: 25.2%
McGreevy et al. (12)	2005	Australia	209 veterinary practices	2661	Attending veterinarians: 5-point scale: Hill's weight guide chart for dogs and cats showing silhouettes	BCS $\geq$ 4/5: 1.1%
Colliard et al. (13)	2006	France	Vaccination service of veterinary school	616	Attending veterinarian 5-point scale, adapted from Laflamme (5)	BCS $\geq$ 4/5: 38.8%

(Continued)

Table 1.1 (Continued) Prevalence of obesity in various canine populations in various countries over 55-year time period (from 1960 to 2015)

Authors	Year	Country	Population	Sample size	Evaluation method	Prevalence rate
Lund (14)	2006	USA	52 veterinary practices	21,754	Attending veterinarians 5-point scale: fat covering ribs and tail base and abdominal contour	BCS $\geq 4/5$ : 34.1%
Courcier et al. (15)	2010	UK	One charitable and 4 private first-opinion veterinary practices	696	Attending veterinarians or student veterinarians Morphometric technique adapted from a 7-point scale S.H.A.P.E. <sup>TM</sup> score (74)	S.H.A.P.E. <sup>TM</sup> $\geq 5/7$ : 59.4%
Sallander et al. (16)	2010	Sweden	Owners of pure-bred, dogs registered with large animal-insurance company, telephone survey	461	Owners 5-point scale: very lean, lean, normal, obese and very obese, using pictures after Laflamme (5) and previously validated (75,76)	Obese/very obese: 16.0%
Heuberger and Wakshlag (17)	2011	USA	Dog owners recruited using word of mouth and advertisement, mail survey	61	Owners 5-point scale: underweight, slightly underweight, ideal weight, slightly overweight, obese	Slightly overweight/obese: 21.3%
Mao et al. (18)	2013	China	14 veterinary practices	2391	Attending veterinarians: 5-point scale (4,5)	BCS $\geq 4/5$ : 44.4%
Corbee (19)	2013	Netherlands	One dog show	1379	Board Certified Veterinary Nutritionist <sup>TM</sup> 9-point scale (5)	BCS $\geq 6/9$ : 19.8%
Such and German (20)	2015	UK	Photographs of dogs that appeared at a dog show	960	Veterinarian with experience in assessing BCS from photographs 9-point scale and previously validated (77)	BCS $\geq 6/9$ : 26.0%

Abbreviations: BCS: body condition score; S.H.A.P.E.<sup>TM</sup>: Size, Health And Physical Evaluation.

Table 1.2 Prevalence of obesity in the feline population in various countries, and time trends over 23 years (from 1992 to 2015)

Authors	Year	Country	Population	Sample size	Evaluation method	Prevalence rate
Sloth (21)	1992	Denmark	One veterinary practice	233	Attending veterinarian 4-point scale: underweight, normal weight, overweight, obese weight	Overweight/ obese: 40.0%
Scarlett et al. (22)	1994	USA	31 veterinary practices	2091	Attending veterinarians 6-point scale: cachectic, lean, optimal-lean, optimal, heavy, and obese using silhouettes	Heavy/obese: 25.0%
Donoghue and Scarlett (23)	1998	USA	27 veterinary practices, information from previously studied cats (22)	1654	Attending veterinarians 6-point scale (22)	Heavy/obese: 24.5%
Lund et al. (10)	1999	USA	52 veterinary practices	42,774	Attending veterinarians 5-point scale: fat covering ribs and tail base and abdominal contour, adapted from Scarlett et al. (22)	BCS $\geq$ 4/5: 27.5%
Robertson (24)	1999	Australia	2195 households, telephone survey	644	Owner 3-point scale: underweight, correct weight, overweight (obese)	Overweight/ obese: 18.9%
Russell et al. (25)	2000	UK	Households, door-to-door visit	136	Experienced assessor 17-point scale adapted from Laflamme (6)	Overweight/ obese: 52%

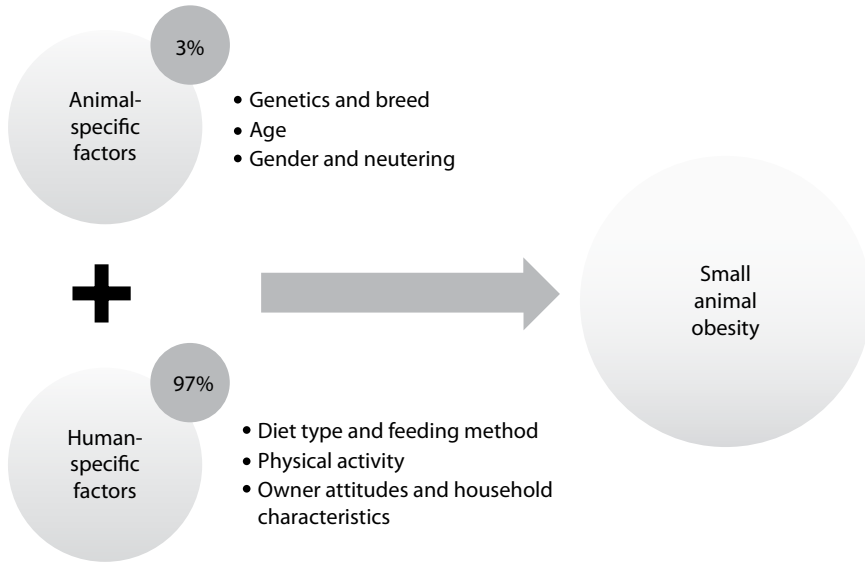
(Continued)

Table 1.2 (Continued) Prevalence of obesity in the feline population in various countries, and time trends over 23 years (from 1992 to 2015)

Authors	Year	Country	Population	Sample size	Evaluation method	Prevalence rate
Allan et al. (26)	2000	New Zealand	492 households, door-to-door survey	182	Experienced assessor 3-point scale: normal weight, overweight, obese, assessing inguinal, abdominal and subcutaneous fat	Overweight/ obese: 25.8%
Lund et al. (27)	2005	USA	52 veterinary practices	8159	Attending veterinarians 5-point scale: fat covering ribs and abdominal contour	BCS $\geq 4/5$ : 35.1%
Colliard et al. (28)	2009	France	Vaccination service at veterinary school	385	Attending veterinarian 5-point scale adapted from Laflamme (6)	BCS $\geq 4/5$ : 26.8%
Courcier et al. (29)	2010	UK	One charity first-opinion veterinary practice	118	Student veterinarian 5-point scale adapted from Laflamme (6)	BCS $\geq 4/5$ : 39.0%
Courcier et al. (30)	2012	UK	47 charity first-opinion veterinary practices	3219	Attending veterinarians 5-point scale	BCS $\geq 4/5$ : 11.5%
Cave et al. (31)	2012	New Zealand	1045 households, door-to-door survey, similar to Allen et al. (26)	200	Two independent experienced assessors	BCS $\geq 7/9^a$ : 27.4%
Corbee (32)	2014	Netherlands	Two cat shows	268	Board Certified Veterinary Nutritionist™ 9-point scale (6)	BCS $\geq 6/9$ : 63.0% BCS $\geq 6/9$ : 45.5%

Abbreviation: BCS: body condition score.

<sup>a</sup> The validated 9-point scale (6) can be compressed into the non-validated 5-point scale, where 1/9 is equivalent to 1/5; 2-3/9 = 2/5, 4-6/9 = 3/5, 7-8/9 = 4/5, and 9/9 = 5/5 (31).



**Figure 1.1** Risk factors of small animal obesity, including animal-specific and human-specific factors. Percentages according to Bland et al. (33).

cats (22,24,27,28,30). The obesity frequency declines after about 10 years of age (12,22), as overweight animals may have a shorter lifespan because of detrimental health effects (41).

### 1.3.1.3 GENDER AND NEUTERING

Epidemiological data show an overrepresentation of overweight female dogs (7,8,12,13,15,16,18), which may be related to differences in body composition and energy requirements. Male dogs have more lean tissue compared to females (42), suggesting lower energy requirements in females, predisposing them to weight gain. Still, a recent meta-analysis could not confirm that gender affects energy requirements of dogs (39). In cats, lower energy requirements have been confirmed in females compared to males (43), while males are unexpectedly more at risk to become overweight (22,24,27,28,30,36).

A key link exists between neutering and obesity (9,11,13,14,18,21,22,24,27–30,32,36). Neutered dogs are 2.8 times (11) and neutered cats 3.6 times more likely to be overweight than their intact counterparts (30). A higher frequency of obesity was also reported in dogs neutered between 5.5 and 12 months of age compared to before 5.5 months (44). The latter, however, could not be confirmed in cats (45). This link occurs due to removal of sex hormones. A reduction of estrogen-induced appetite suppression may occur in females (46). When fed *ad libitum*, female Beagles consumed more food postneutering and their body weight increased more compared to intact controls (46). Similar effects were noted in neutered cats when compared to intact controls or to before surgery (47–49). At the same time, substantial food restriction is necessary to maintain ideal body weight

postneutering in queens (49,50) and bitches (51). Also resting energy expenditure is 30% lower after gonadectomy in cats of both genders (52,53). At last, neutering also leads to a reduction in spontaneous activity, because of decreased roaming and sexual behavior, especially among males (54,55).

## 1.3.2 Human-specific factors

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### 1.3.2.1 DIET TYPE AND FEEDING METHOD

Highly palatable, energy dense foods put pets at risk for weight gain, especially when fed free-choice. Dietary fat is the most concentrated and most efficiently stored energy source (3). In dogs (56) and cats (57,58), high-fat, low-carbohydrate diets resulted in more body fat and weight gain compared to low-fat, high-carbohydrate diets. Nonetheless, all macronutrients (fat, protein and carbohydrates) are stored as body fat and will all lead to weight gain when fed in excess (3). Conversely, inclusion of dietary fiber, water or air can decrease energy density. In dogs, a positive association between high dietary fiber content and normal body condition has been reported (17).

Most studies found no influence of commercial diet types on the obesity prevalence (9,11,15,24,26,29,31). Though, some reported higher risk in cats consuming “premium” dry foods and/or therapeutic diets (22,27,28), probably because of higher energy density compared to most economy type diets (22,27). Also, owners tend to feed dry food *ad libitum* (23). Despite an increased proportion of owners feeding dry food, Australian researchers noted no association with dry food feeding in 1993 (26) and 2007 (31), and no increase of obesity occurred over this period (31). Moreover, epidemiological studies cannot determine whether the findings associated with therapeutic diets are cause or effect. It is also noteworthy that confounding may have occurred as low-energy therapeutic diets are prescribed for weight loss (27,28). Likewise, dogs and cats fed homemade food, table scraps, and/or treats are more inclined to obesity (8,11,14–18,59,60).

Free-choice or *ad libitum* feeding contributes to excess energy intake, while dividing the daily portion into multiple meals may increase energy loss from thermogenesis (61) and physical activity (62). Research disagrees on the effect of *ad libitum* feeding and feeding frequency, which can often not be teased apart. Depending on the study, dogs are at higher risk to become obese when fed once a day (11), when receiving several meals (18), or when fed either one or three-plus portions (59). In cats, *ad libitum* feeding or feeding frequency has been shown to be a risk factor by some (25,48,60) but not by others (22,24,26,28,31), and one study found the opposite, that is, cats fed twice daily were more likely to be obese than cats fed *ad libitum* (29). Food items may be given only once or twice per day, but may be available all day (24). Also division of the appropriate daily portion into small meals and providing excess energy by feeding free-choice food throughout the day should not be confused.

Overall, overfeeding is more important. Determining the daily portion based on package instructions may lead to excess energy intake, as recommendations are based on ranges and averages of energy requirements. Owners overestimate their pet’s activity level (63) and underestimate their pet’s body condition



(13,26,29,31,64–66), increasing the likelihood to overfeed. Seventy percent of cat owners feed until their cat stops eating, while only 8% follow package instructions and only 4% ask their veterinarian (29). Besides, most pet owners do not weigh the food with a gram scale but rather use a measuring cup. This is quick and convenient, but also imprecise and inaccurate, contributing to the obesity epidemic (67).

### 1.3.2.2 PHYSICAL ACTIVITY

Lack of exercise has also been identified as a major risk factor (11,15,18,21,22,24,26,59); especially as low levels of physical activity reduce energy expenditure (68). Most studies attributed this to the type of habitat. Obese pets tend to live indoors and may have restricted opportunities for exercise (11,21,22,24,26). Still, two feline studies could not associate activity with obesity, probably because of differences in confinement between countries and because the owner's assessment of activity is biased (25,31). Habitat may, however, not be the best indicator. Dogs with garden access as an exercise regime, rather than walks, are more likely to be obese (59). And dogs residing in apartments are walked more frequently than dogs living in a detached house (69). Overall, the risk of canine obesity decreases with each hour of weekly exercise (11,15), yet the intensity of exercise (walking versus running) did not affect obesity (11). Unfortunately, most pet owners overestimated their dog's activity level as they consider their dogs moderately to very active (63). Also less active pets tend to have less active owners (70).

### 1.3.2.3 OWNER ATTITUDES AND HOUSEHOLD CHARACTERISTICS

In general, obese pets are overhumanized by their owners and have a potential role as substitute for human companionship. For example, obese dogs sleep more often in the owner's bed and owners of obese pets talk more to their dog and cat (60,71). These pets are no longer treated as typical companion animals, ignoring needs such as exercise, play, work, protection, and environmental enrichment (60,71). The pet's health and nutritional needs are also ignored (60,71). Behavior signals are often misread, causing overfeeding as owners assume the pet is hungry when it is not and food is frequently used as reward (71). Owners of overweight dogs also have less interest in balanced dog nutrition (71,72) and will especially pay attention to low price and special offers rather than quality of ingredients and nutritional composition when buying dog food (71,72). This is partly due to a lower income among these owners (15,71), but also results from their own health and eating habits (71). Owners of obese dogs often suffer from obesity as well (8,13,17,71,73). They may engage less in exercise and pay less attention to a healthy diet. Owners who ate low-calorie diets had nonobese dogs (17). In cats however, no correlation could be found between the degree of overweight of cats and the body mass index of their owners (60,73). Studies also report a higher risk of obesity for dogs kept by middle-aged or elderly people than when kept by adults under 40 years of age (8,13,15). This was attributed to lack of exercise (8), yet owner age did not affect the amount of exercise a dog received (15). Moreover, older people own the oldest dogs (13). Likewise cat owner's age was not a real risk factor, as the owner's age also confounded the cat's age (28). Additionally, one would think

that children may give too many treats or overfill the food bowl; yet living with one child was reported to lower the obesity risk in cats (28). Also households with only one dog (11) or only one or two cats (22,24) showed a higher risk, while the presence of dogs reduced the risk of cats to become obese (26).

Owners underestimating their pet's body condition (8,13,15,26,28,29,31,60,65,66) is another reason to overfeed and has been identified to be a major factor in feline obesity (26,28,29,31). For example, owners who consider their normal weight cats to be underweight may be encouraged to feed more (28) and if owners don't perceive their pet to be overweight, owners will not be motivated to reduce the pet's energy intake (31). Likewise, if informed by their veterinarian that their dog is overweight, owners may be either reluctant to accept this judgment or may not think this is an important concern (65).

## 1.4 CONCLUSION

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Numerous risk factors including animal-specific factors and human-specific factors are involved in pet obesity, making for a disease that is often hard to tackle. Risk factors should be identified by a thorough nutritional assessment in every pet at every veterinary health exam to prevent weight gain or to achieve weight loss. Animal-specific factors can be targeted in individualized calculations of daily energy requirements. However, of utmost importance is owner education and elimination of human-specific factors, such as dietary factors, physical activity, owner attitudes, and household characteristics, which contribute the most to the obesity epidemic.

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