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The role of pet humanization on body condition perception, feeding choices, and obesity in companion animals: Findings from French pet-owners

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PREFACE

This dissertation follows a “thesis by publication” format and consists of three scientific articles published in international peer-reviewed journals.

Over the past decades, the relationship between humans and their companion animals has undergone a profound transformation [1]. Pets are increasingly regarded not merely as animals but as integral members of the family, a phenomenon often described as “pet humanization” [2]. This shift has reshaped many aspects of pet ownership, including feeding practices, health management, and the emotional dynamics between owners and their pets, modelling the profile of the modern “pet-parent”. Scientific research has shown that pet ownership is associated with several important social benefits. Companion animals can facilitate social interaction by acting as social catalysts, increasing conversations and connections between individuals, particularly in public settings such as parks or neighborhoods [3]. Pets may also reduce feelings of loneliness and social isolation by providing companionship and a sense of purpose, especially in older adults and individuals living alone. Pet ownership has been linked to increased social support, as relationships with animals can complement human social networks and enhance perceived emotional support [4]. Additionally, caring for a pet often encourages routine activities and community engagement, which may strengthen social ties and promote social integration [5]. These social effects highlight the role of companion animals in supporting human well-being beyond their physical and emotional health benefits.

The pet food industry has undergone substantial transformation in recent decades, increasingly mirroring trends found in the human food sector through marketing strategies that emphasize natural, organic, and ethically sourced products [6]. This evolution is largely driven by the humanization of companion animals, a socio-cultural phenomenon in which pet owners perceive their pets as family members and apply human values and dietary preferences to animal nutrition, often prioritizing product attributes such as recognizable ingredients, “human-grade” or wholesome labels, and premium formulations[7]. Such consumer expectations have expanded the range of pet food offerings, despite limited scientific evidence supporting the purported benefits of many of these trends for canine and feline physiology. This convergence of human and pet food marketing reflects broader consumer behavioral drivers: pet owners with stronger emotional bonds to their animals tend to place greater importance on health, quality, freshness, and ingredient profiles that resemble human dietary ideals, which may shape purchasing decisions beyond objective nutritional requirements [8]. While such trends reflect a growing concern for pet well-being, they may also contribute to anthropomorphic decision-making, where human dietary values and emotions influence choices for animals with distinct nutritional needs. Veterinarians thus play a critical role in helping owners navigate these trends and align pet food choices with individual requirements rather than owner perceptions alone.

The overarching aim of this dissertation is to investigate how the humanization of pets and the strength of the human–pet bond affects owners' pet feeding practices, and the perception and awareness of their pets' body condition, and the impact on the overweight and obesity among companion animals in France.

This research aims to contribute to the development of more effective communication frameworks between veterinarians and pet-owners, thereby enhancing mutual understanding and trust. By examining the influence of emotional and cognitive biases on feeding-related decision-making, the study seeks to inform the design of targeted educational initiatives and evidence-based intervention strategies to mitigate the risk of overweight and obesity in companion animals. Ultimately, this work aspires to promote healthier, scientifically grounded feeding practices that acknowledge both the emotional dimensions of the human–animal bond and the specific physiological requirements of pets.

This research is driven by two central questions:

1. Does the humanization of pets and their food, and anthropomorphism in the pet food industry influence how pet-owners make the dietary choices for their pets?
    a. Hypothesis: Pet owners who perceive their pets as family members are more likely to be influenced by anthropomorphic marketing strategies in the pet food industry, leading them to select pet foods that align with human dietary trends and values.
2. Is the pet-owners' awareness and perception of the body condition of their pets influenced by the human-pet bond, and does it affect the prevalence of overweight and obesity?
    a. Humanization of pets reduces pet owners' awareness and accuracy in perceiving their pets' body condition, often leading to misjudgment of weight status and contributing to a higher prevalence of overweight and obesity among pets

To address these research questions, the study was divided into two main key investigations:

1. The **first task** involved gathering data to characterize the modern pet-owner ("pet-parent"), emphasizing their decision-making regarding pet food selection.
2. The **second task** explored pet owners' understanding of their pets' body condition, along with the key factors influencing the occurrence of overweight and obesity.

The dissertation titled "The role of pet humanization on body condition perception, feeding choices, and obesity in companion animals: Findings from French pet-owners" is divided into four chapters:

- **CHAPTER 1:** A cross-sectional survey study titled “Comparison of canine owner profile according to food choice: an online preliminary survey in France” published in BMC Veterinary Research (2022). https://doi.org/10.1186/s12917-022-03258-9
  This study explores lifestyle and dietary differences between French pet owners who feed their dogs non-conventional diets (NCD) and those who use conventional diets (CD). It emphasizes the importance of enhancing veterinarian–client communication about nutrition, especially since NCD owners often display lower trust in veterinary advice. By understanding the motivations and lifestyles of these owners, veterinarians can better tailor their communication strategies to address specific concerns, build trust, and ultimately improve pet health outcomes.
- **CHAPTER 2:** A cross-sectional questionnaire study titled “The perception of the body condition of cats and dogs by French pet owners and the factors Influencing underestimation” published in Animals (2023). https://doi.org/10.3390/ani13233646
  This study examines how French pet owners perceive the body condition of their cats and dogs, focusing on factors that lead to underestimating their pets’ weight status and the implications for managing obesity. The study’s first objective was to assess how accurately owners in France perceive their pets’ body condition. The second objective was to compare owner perceptions when using a simple verbal scale versus a detailed nine-point Body Condition Score (BCS) system with visual aids. The third objective was to identify factors associated with underestimation of body condition.
- **CHAPTER 3:** A cross-sectional multi-center survey titled “Prevalence and factors associated with overweight and obesity in dogs presenting to French university veterinary teaching hospitals during the COVID-19 pandemic” published in Topics in Companion Animal Medicine (2024). https://doi.org/10.1016/j.tcam.2024.100875
  The present study provides insight into the prevalence and contributing factors of overweight and obesity in dogs presented to veterinary hospitals in France during the COVID-19 pandemic. The findings highlight the pivotal role of owner perception in canine weight management, revealing that many owners tend to underestimate their dogs’ body condition. This misperception may contribute to delayed recognition and management of excessive weight, thereby exacerbating the risk of obesity-related health problems. Educating owners about recognizing signs of overweight is essential for effective weight management and intervention strategies.
- **CHAPTER 4:** Discussion and conclusions.

CHAPTER 1

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RESEARCH ARTICLE Open Access

Comparison of canine owner profile according to food choice: an online preliminary survey in France

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Abstract

Background: Nowadays, more people are treating dogs as family members. This reflects their increased attention towards their nutrition, with renewed interest for non-conventional diets such as Biologically Appropriate Raw Food/Bones and Raw Food in United States (BARF) or homemade. In previous studies, owners feeding their dog non-conventional diets reported lower levels of trust in veterinary advice. The aim of the study was to identify differences in lifestyle between owners feeding dogs non-conventional diets and those feeding conventional diets (i.e., dry/wet pet food) to give further insight for improving communication between veterinarians and owners.

Results: A total of 426 surveys were usable. Fifteen percent of the participants lived in the metropole of Paris and had more than one dog (mean 1.72 dogs). Thirty-eight percent of the survey respondents stated that their dogs were fed exclusively with non-conventional diets, while 55% declared using conventional diets alone (not considering treats). The study canine population was for the most part neutered (63%) and purebred (68%). Amongst owners feeding conventional diets exclusively, 47% determined how much food to feed by consulting the feeding guidelines on the packaging, and only 28% said that the amount of food was prescribed by their veterinarian or veterinary nurse. Out of the participants feeding non-conventional diets, 65% declared that the information for formulating the recipes was gathered on the internet or in non-veterinary books. When compared with owners feeding exclusively conventional diets, those feeding non-conventional diets were living more frequently outside the metropole of Paris, had fewer children (0.23 ± 0.57 vs 0.37 ± 0.78; $p = 0.03$) and had more frequently other animals. They also dewormed less often their pets, walked their dog more each day (91 vs 78%; $p < 0.001$) and without leash for more than 6 h per week (46 vs 31%; $p = 0.003$).

Conclusions: This survey described differences in the habits of owners feeding dogs non-conventional diets in comparison with those feeding conventional diets. Data suggest that owners using non-conventional diets may be more attentive to the ethological needs of their dog which could be a starting point for practitioners for achieving better client-veterinarian communication.

Keywords: Pet food, Survey, Non-conventional diets, Canine nutrition, Biologically Appropriate Raw Food

Background

The dog population in France was evaluated to be 7.6 million in 2018 with a 4% increase compared with 2016 [8]. These numbers represent a growing market for the pet food industry which invests continuously in new products trying to meet the preferences of pet-owners. The latter's expectations have evolved rapidly in recent

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years (e.g., novel vision of "natural" dog food, increase in Biologically Appropriate Raw Food/prey model diets). In this context, to attract consumers, marketing professionals are more and more interested in the owners' perception [3]. Some marketing ploys may bias the owner's perception of the nutritional quality of the chosen diet: a recent study about the Italian pet food buyers, reported that the presence of "natural" ingredients was considered as an important indicator of pet food quality from pet owners point of view [21]. On the other hand, there is an increasing interest of owners about nutrition trends like "grain free", "homemade", "raw food" or "vegetarian" diets for dogs. According to a survey study in English-speaking countries (Australia, Canada, New Zealand, UK and USA) concerning canine feeding practices by own- ers between 2008 and 2018, the proportion of dogs fed with inclusion of non-conventional diets like home-made diets or vegetarian appears to be increasing [6]. These changes in feeding practices are raising concerns about microbiological risks regarding owners and dogs when raw products are involved [19]. Furthermore, analysis of these recipes frequently showed several nutrients below recommendations [17] which can be extremely dangerous for some pets (Kitten, puppy, senior animals, cardiac dogs). Recently grain free diets has been linked to cardiac disease [1]. Pet nutrition is the centre of owner preoccupation and veterinarian face hardly to multiple question between science and marketing. Because the aforementioned study by Dodd et al. [6] showed different results from one country to another, conducting surveys in different countries will be a useful tool to improve veterinary education in the field of nutrition. In absence of information from veterinarians, owners will search on the internet [13, 14]. Communication is a cornerstone of nutrition consultation but the profile of owners feeding dogs non-conventional diets (NCD) compared to profile of owners feeding dogs with conventional diets (CD) (i.e., dry/wet pet food) has not been clearly defined and is essential for good veterinarian-client communication. A marketing study has defined 3 profiles of owners with regards to the relation dog–human and anthropomorphism items, "Dog people"/ "Dog parents"/ "Dog owners", [3]. But these definitions do not give information on potential differences in terms of lifestyle (canine and human) between owners feeding dogs non-conventional diet like homemade diets (NCD) versus those feeding conventional diets (CD) like industrial diets. Another study reported some characteristics of pet owners who prefer to feed dogs with raw animal products, like majority women, aged around 41 years-old and mainly without children [14]. Current studies mainly focus on owners' perceptions and motivations, but only few about life habits.

In France, only one nutrition epidemiological survey [4] was conducted and concerned canine obesity:14.1% of dogs were fed only with a home-prepared diet but few details were given about pet owners feeding a NCD.

The aim of the present study was to identify poten- tial differences in terms of lifestyle and habits between dog owners feeding a NCD and those feeding a CD in the French population. The objective is to increase the knowledge of veterinarians to better address this evolving situation. Moreover, this study was an opportunity to assess the French online dog-owners' population. To this end, an online survey was conducted during the COVID-19 lockdown at the beginning of 2020.

Authors hypothesized that dog owners using NCD are older than those using CD, and that the number of children is lower in the population of owners feeding NCD as observed in Morgan et al. [14] survey in US. According to the model of "the wolf", frequently used by marketing, there is the assumption that dogs of owners using NCD are more frequently males, entire and purebred [13]. Finally, we supposed that dogs of owners using NCD lived more frequently in a household with several animals, as wild canids do in their natural environment. Finally, due to the lack of trust in veterinarians reported in other studies, supposed that owners using NCD are deworming less their animals.

Results

Survey participants

The survey was stopped with 561 answers. After cleaning the data base, 429 dog owners remained (Table 1). Fif- teen percent of owners resided in the metropole of Paris (65/429), 42% aged 26–40 years old (179/429) and 49% had a household of 2 people (209/429). In the sample, the average number of dogs per family was 1.72 (SD: ± 1.17; range 1–8). The diet choices were quite variable: 38% (162/429) of owners declared feeding only a NCD (BARF, prey model, whole prey, cooked homemade food)), 55% (235/429) stated an exclusive CD and 7% (29/429) used a mix of both (NCD and CD).

Canine population

Forty-eight percent of dogs in this study were females (203/429; Table 2). Mean age was 4.45 years (SD: ± 3.15). Most dogs were neutered (64%; 268/429; Table 2). Mean weight was 22.18 kg (SD: ± 11.60) and 68% of dogs were purebred. Environment and lifestyle were varied. Thirty-eight percent (163/429) of dogs practiced a sport activ- ity (i.e. agility, …). Sixty-four percent (274/429) lived in a house in contrast with apartment or other situations (i.e.: kennel, apartment, and a house). Forty-two per- cent (174/429) had daily walks lasting 1 to 2 h in total. More than half (53%; 226/429; Table 2) had the possibility

Table 1 Demographics of survey respondents ($n = 429$)

	Dog owners n (%)
Region	
Out of Paris area	361 (85%)
Metropole of Paris	65 (15%)
Number of children	
Mean ± SD	0.33 ± 0.72
Median (Range)	0 (0—6)
Age	
18–25 years old	126 (30%)
26–40 years old	179 (42%)
41–60 years old	103 (24%)
> 60 years old	18 (4%)
Household	
1 people	81 (19%)
2 people	209 (49%)
3 or more	136 (32%)
Number of dogs	
Mean ± SD	1.73 ± 1.16
Median	1 (1–8)
Type of diets	
Conventional (dry and/or wet pet food) exclusively (CD)	235 (55%)
Non-conventional exclusively (homemade, BARF, ...) (NCD)	162 (38%)
Mix of both (CD and NCD)	29 (7%)

Table 2 Characteristics of dogs enrolled in the survey

	DOGS n (%)
Gender	
Female	203 (48%)
Male	223 (52%)
Age (years)	
Mean ± SD	4.45 ± 3.15
Median (Range)	4 (1–20)
Neutered	
Yes	268 (63%)
No	158 (37)
Weight (kg)	
Mean ± SD	22.18 ± 11.60
Median (range)	21.25 (1.96–62)
Body condition according to owner	
Normal	356 (84%)
Slightly overweight	49 (12%)
Slightly underweight	19 (5%)
Obese	1 (< 1%)
Underweight	1 (< 1%)
Purebred	
Yes	290 (68%)
No	136 (32%)
Muscular mass according to owner	
Normal and muscular	370 (87%)
Low	56 (13%)
Sport activity	
Yes	163 (38%)
No	263 (62%)
Habitat	
Apartment	148 (35%)
House	274 (64%)
Other (both, outside, …)	4 (1%)
Time per day spent outside by the dog	
Less than 30 min	15 (4%)
30—60 min	89 (21%)
1 -2 h	174 (41%)
More than 2 h	148 (35%)
Frequency of walk with the dog (outside garden or house)	
Occasionally (the week-end, ...)	60 (14%)
Rarely (during holidays, …)	9 (2%)
Each day, multiple times	226 (53%)
Each day, one time	131 (31%)
Contact with other animals at home	
Yes	296 (69%)
No	130 (31%)
Toys	
Yes, but not used	81 (19%)
Yes, used	326 (77%)
No	19 (5%)

to go outdoor several times per day. Sixty-nine percent (296/429) lived in the same household with other animals (dogs, cats, …) and 77% (326/429) had toys and used them on their own.

Dogs' feeding habits practiced by owners using conventional diets (CD)

Forty-four percent (104/ 235) of CD were veterinary brands (in France, by market share: Royal Canin©, Hill's©, Virbac HPM©, Purina Pro Plan©, Specific©). Only for 28% (66/235) the food amount was prescribed by a veterinarian (or a nurse). Seventy-three percent (172/235; Table 3) of dogs had two meals or more per day.

Dogs' feeding habits practiced by owners using non-conventional diets (NCD)

Eighty-five percent of recipes were BARF/Whole prey rations. Sixty-six percent (106/162; Table 4) of reci- pes came from online sources. Veterinarian recipes corresponded to 8% of rations. Seventy-two percent (116/162) of NCD did not have vitamin and/or mineral supplements.

Table 3 Habits of owners using CD

	Owners using CD – 235 individuals n (%)
Veterinarian brand	
Yes	104 (44%)
No	131 (56%)
Amount	
Prescribed by the veterinarian or nurse	66 (28%)
As indicated on the package (feeding guidelines)	105 (47%)
Prescribed by someone else (not a veterinarian, a nurse, or a manufacturer)	35 (15%)
Ab libitum	29 (12%)
Number of meals/days	
Ab libitum	19 (8%)
Once a day	44 (19%)
2 or more	172 (73%)

Table 4 Habits of owners

	Owners using NCD – 162 individuals n (%)
Type of recipe	
BARF/Whole prey…	137 (85%)
Cooked homemade	25 (15%)
Number of meals/days	
Once a day	36 (22%)
2 or more	126 (78%)
Origin of recipe	
Prescribed by a veterinarian during a consultation	4 (2%)
Prescribed by a veterinarian on the internet	10 (6%)
Personal recipe	28 (17%)
Recipe from a book written by a veterinarian	14 (9%)
Recipe from the internet or a book but not calculated by a veterinarian	106 (66%)
Presence of vitamin and/or mineral supplements	
Yes	46 (28%)
No	116 (72%)

Comparison of owners using NCD versus CD

Owners using NCD, compared to those using exclu- sively CD, lived less in the metropole of Paris (9 vs 20%; $p = 0.007$; Table 5), had fewer children ($p = 0.03$) and a smaller household ($p = 0.004$). They had more frequently other animals at home (80 vs 63%; $p < 0.001$; Table 5) and allowed more daily outdoor access to their dogs (91 vs 78%; $p < 0.001$; Table 5). They also tended to treat less for internal parasites, in fact, significantly fewer of them dewormed their dogs more than once a year (62 vs 89%; $p < 0.0001$; Table 5). Pet-owners feed- ing NCD walking more their dogs without leash 6 h/ week than owners feeding CD (46 vs 31%; $p = 0.003$; Table 5). Among NCD 50 dogs were mix-breed and the most common breeds were Belgian Shepherd Malinois ($n = 5/162$), German Shepherd ($n = 4/162$); White Shepherd ($n = 4/162$); Golden Retriever ($n = 4/162$) and Jack Russell ($n = 4/162$). Among CD, most of dogs were also mix-breed ($n = 80/235$). The most common breeds were Australian Shepherd ($n = 15/235$); Golden Retriever ($n = 9/235$); Husky ($n = 7/235$); Jack Russel ($n = 7/235$).

Discussion

The present study is the first to compare lifestyles of owners and dogs according to the dog's diet in France. Moreover, there are very few data about the habits of French pet owners in terms of owner food choice for their dogs [4]. Last, but not least, this survey is focused on the Internet population, which is a highly active population as far as BARF and raw diets are concerned but still under-researched. Information collected in this study highlights differences between owners/dogs using NCD versus owners using CD. Owners using NCD lived more frequently outside of the metropole of Paris, had fewer children, and dewormed less than owners using CD. These results are consistent with the analysis by Morgan et al., [14], where pet owners who fed raw animal products were in majority without child (61%) and only 28% lived in an urban area. But in contrast to Morgan et al. [14] results, owners using NCD were mostly 40 years or younger. This difference can be explained by the earlier presence of the trend of raw diets and homemade food in the US compared with France or an age population more present on internet (40 years or younger). This difference must be more studied in future survey. The present study results draw a profile of a home in a residential setting, less urban, and a family more focused on "nature". It would be interesting to explore the compliance of these owners with veterinary counselling or dog vaccination. It may well be those owners using NCD vaccinate less their dogs due to lack of veterinary trust, as observed in Morgan studies, with a tendency of pet owners feeding raw products less likely to vaccinate and deworm. This assumption agrees with the origin of the recipes used by owners using NCD. In our study, only 14 owners using NCD (9%) reported a veterinary recipe prescribed for the dog, 14 owners used a NCD recipe found in a veterinary book and the majority (83%) used recipes from the Inter- net or non-veterinary books, or personal prescription. Another online survey reported similar results, with only 14% of the interviewed people having asked a veterinar- ian or a nutrition-trained expert for advice for raw meat- based diets [13]. For these owners, veterinarians were

Table 5 Comparison of lifestyle between owners using NCD and owners using CD

	OWNERS USING NCD – 162 INDIVIDUALS N (%)	OWNERS USING CD – 235 INDIVIDUALS N (%)	*P*-VALUE
Region			
Paris metropole	15 (9%)	46 (20%)	0.007*
Out of Paris metropole	147 (91%)	189 (80%)	
Number of children			
Mean ± SD	0.23 ± 0.57	0.37 ± 0.78	0.03*
Aged of 40 years and older			
Yes	37 (23%)	69 (29%)	0.18
No	125 (77%)	166 (70%)	
Household (n of people)			
Mean ± SD	2.17 ± 0.90	2.49 ± 1.35	0.004*
Gender			
Female	72 (44%)	119 (51%)	
Male	90 (56%)	116 (49%)	0.27
Age (years)			
Mean ± SD	4.41 ± 2.86	4.46 ± 3.34	0.86
Neutered			
Yes	102 (63%)	153 (65%)	0.74
No	60 (37%)	82 (35%)	
Purebred			
Yes	112 (69%)	155 (66%)	0.58
No	50 (31%)	80 (34%)	
Sport activity			
Yes	68 (42%)	83 (35%)	0.21
No	94 (58%)	152 (65%)	
Time per day spent outside by the dog			
< 30 min	6 (4%)	7 (3%)	0.68
30–60 min	34 (21%)	49 (21%)	
1–2 h	71 (44%)	92 (39%)	
> 2 h	51 (31%)	87 (37%)	
Dog walked daily (outside garden or house)			
Yes	147 (91%)	183 (78%)	< 0.0001*
No	15 (9%)	52 (32%)	
Deworming more than once a year			
Yes	101 (62%)	209 (89%)	< 0.0001*
No	61 (38%)	26 (11%)	
More than 6 h of walk without a leash/week			
Yes	75 (46%)	73 (31%)	0.0003*
No	87 (53%)	162 (69%)	

Significative *p*-value were presented with the symbol *

not the first source of information about nutrition, which confirms the important role of other sources of information like the Internet [14]. When compared with own- ers using CD, the first source of information about food quantity was the manufacturer (47%), and veterinarians were the second (28%). This proportion of owners using veterinarian information, even if higher for owners using CD, is still low and in accordance with observations of other surveys [10, 12, 14]. There is a need of increased veterinarian communication about nutrition as suggested in a recent publication [7], especially on the Internet, where owners are searching information. This naturally suggests a requirement for more nutrition training in veterinary schools to prepare students [2] and a better vet communication about their ability in canine nutri- tion. This lack of trust regarding veterinarians may also

have implications for animal and public health. Indeed, raw homemade food are more and more present on the market and this dietary practice is known to be associ- ated with microbiological risks both for pets and their owners [5, 19]. Studies have reported mineral deficiencies in home-prepared diets, mainly calcium (Dillitzer et al., 2011; [18]. The Dillitzer study reported in 2011 that 60% of bone and raw food ration had major nutrient imbal- ances. The present study's results confirm this danger, with only 28% of the French online respondents feeding NCD already using a mineral and/or vitamin supplement to balance their recipe. The improvement of communica- tion regarding nutrition between veterinarians and own- ers using NCD may be a benefit to dogs' health with an appropriate modification of the NCD if imbalanced.

In order to improve communication, there is a need to better understand the audience (NCD owners in the present case). This survey helps to better define the characteristics of NCD French dog owners. Compared to owners using CD, they had more frequently other animals at home, provided more often daily access to the outside to their dogs (outside of the garden and the house), and walked them more frequently off-leash for more than 6 h per week (which may be associated with a more rural lifestyle). These life-conditions provide an enriched environment for dogs [22] and closer to the species' ethological needs. These observations may relate with the fact that the majority of owners using NCD lived outside the metropole of Paris, but even in an urban environment, there is possibility to walk a dog each day. Another hypothesis is the new trend to "natural foods", which takes inspiration from the human food marketing [15]. According to Moscato and Machin [15], in human marketing the term "natural" is associated with authenticity, and with the idea of being a good mother. The "natural" adjective may help to simplify food decision [11, 15] by luring consumers into purchasing the idea of some health-giving properties. The trend "back to nature" is also present in pet foods, with an increased demand for this sector and a market corresponding to 25% of the total value of the pet food market in the US in 2016 [20]. This can be explained by the humanization of pets and the fact that owners transposed their own dietary choice for "natural food" on their dogs. Two common reasons for choosing raw diets are their perception as "more natural" and "healthier" [14]. In terms of communication, dogs are often compared to wolves as model of wild canids eating natural food. The comparison between dogs and wolves is very present in the online community, which may explain a choice of dog breeds with higher body weight for owners using NCD. The major argument is that, since wolves are dogs' ancestors, food found in wild conditions by the former is supposedly optimal for a dog. This frequent comparison may have led owners using NCD to take care of ethological needs (more off-leash walk, more often daily access to the outside) of their dogs more carefully than owners using CD because of comparison with wolf lifestyle (in group, living outside, …). To explore this hypothesis, it will be mandatory to compare the ethological knowledge of owners using NCD versus owners using CD. Ethology could be a promising approach angle to dis- cuss nutrition with owners using NCD rather than focus- ing only on canine dietary requirements if this hypothesis is confirmed.

Although expected, lower neutered prevalence in the NCD population compared to the CD population as presented by Morelli et al. [13] was not evidenced in our data.

The present study was centered on the online population, which is a highly active community about canine nutrition and one of the main source of information for owners [14]. Due to the social media recruitment, the high prevalence of owners using NCD in this sur- vey is not representative of the owners using NCD in the French population as NCD owners may be more active and present on internet compared to CD own- ers. Nonetheless, the objective of this study was not to quantify the prevalence of owners using NCD in France. Moreover, there is no reason to believe that owners who have access to social media have a different lifestyle compared to owners who are not social media users.

The definition of "non-conventional" diets has no consensus yet [16]. The term "alternative" could be used as suggested by Parr and Remillard [16], but this expression included the trend of "grain free" and" vegetarian" kibbles in France. In the present study, "non-conventional" diets referred to "raw, homemade, vegetarian" as suggested by the WSAVA Nutritional assessment guidelines [24]. As no vegetarian diet was reported in the survey, "non-conventional" diets only included "raw" and "homemade" diets. The distinction "commercial" versus "non-commercial" was not appropriate as some new raw recipes are industrially made. A comparison between owners using raw products and owners using cooked products should be conducted to explore the profile of NCD owners and adapt communication. The low percentage of owners using cooked products in this study did not allow such comparison. The body score index was not included in the survey, due to the difficulty for owners to correctly answer the question on a internet survey. Images of the dog were requested but only few owners sent quality pictures to assess the body condition. This study was not designed to assess differences in body score index according to diet choice, but difference of format and body score should be included in a future survey.

These results led to questions about differences between owners using NCD and owners using CD, like the reason of their choices, their economic and social status and their personality profiles which can influ- ence food choice [9]. Moreover, this study did not com- pare owners who used a mix of NCD and CD by lack of individuals in this group (7%). It would be interesting to explore their profiles compared to owners using NCD and CD. Additional studies are needed to explore the dif- ferences of lifestyle and personality of owners using NCD versus owners using CD in the social media population and general population visiting veterinary clinics.

Conclusion

This study is the first to assess the differences between owners using NCD and CD in the sampled online French population. Results showed that the majority of owners feeding NCD lived outside the metropole of Paris, had fewer children but more animals at home, dewormed less frequently their dogs, had dogs with higher body weight, took them more often on a walk and left dogs off-leash more than 6 h per week. Moreover, this study shows that veterinarians are rarely consulted as a source of advice by owners using NCD, which may indicate a lack of trust in French veterinarians on the importance of pet nutrition or a lack of veterinarian's communication regarding their nutrition competencies. These results may help to better understand these populations of owners and improve communication with veterinarians about nutrition.

Methods

Survey design and recruitment

A web-based questionnaire was created in French language on the Google Forms platform to recruit own- ers. No approval by an institutional review board was required because enrolment was on a voluntary basis. The survey was anonymous, and a question asked the authorisation to use data for publication. No animal has been used in this protocol.

The survey was beta-tested among authors. The survey consists of 103 questions and was inspired by the questionnaire or [4]. Twenty-nine questions were mandatory, moreover, there were 30 open-questions and 44 conditional questions. The first section concerned dog and family profile (age, postal code, number of people in the family, number of children, profession, age of the dog, neutered status, neutering age, breed, health condition, body condition according to owners, change in weight over time, muscular status). A second section focused on lifestyle (deworming, level of activity according to owners, walk time, sport activity with the dog, habitat of the dog, time spent playing with the dog, presence of other animals and interactions). A third part was about toys and resting places. The fourth part was focused on nutrition (type of diet, amount fed, number of meals, place to buy food, category of the food, composition of the diet). The last part was about the dog's relationship to their diet (where is presented the diet, how accurate is the amount fed, is another dog present, time to finish the meal, …). A last question was about the authorisation to use data. The questionnaire is present in the supplementary files (See Additional file 1 and Additional file 2).

Survey link was communicated on social media (Facebook, LinkedIn, Instagram), with support by the head of communication of Paris Veterinarian school, Lyon Veterinarian School and Toulouse Veterinarian school. The survey was kept online from the 22nd of April to the 4th of June 2020. No ethics approval and consent to participate was required because of the voluntary and anonymous enrolment.

Inclusion and exclusion criteria

Owners with dogs aged more than one year and living with the dog were enrolled. To avoid the impact of disease on the dietary choice, dogs with previously diagnosed diseases were excluded (however, conditions like osteoarthritis, dysplasia and ichthyosis reported by the owners were accepted. These conditions are quite common in dogs and do not necessarily involve a change of diet, mostly in case of pathology linked to genetics like dysplasia or ichthyosis). Only one dog per owner was accepted (questions in the survey were used to verify the multiple entries from some owners – postcode, name of dogs, gender, number of dogs, …). Some French speakers from other countries have answered the survey and have been excluded because the postcode was outside France. Questionnaires with missing values regarding family characteristics (region, number of children, age, household, number of dogs, type of diets) were excluded.

Data transformation and analysis

Data from Google form were transferred into Microsoft Excel. Binary variables were created (living in French metropole area of Paris; neutered, female, gestation, purebred dog, sport activity with the dog, no-gluten food (according the petfood references named by the owner), food reward, measuring food accuracy, walking each day, deworming at least every 6 months, walking more than 6 h/walk without leash, age of 40 years and more). The household place was divided between "French metro- pole area of Paris" and "Rest of France" because of higher occurrence of the former. The age of owners was split at 40 years to compare with the results by [14] where 39 percent of Raw animal product feeders were 40 years of age or younger in United State population. Owner aging 40 years and older may have different belief in nutritional

requirement which should be studied in other survey. The different homemade diets have been grouped as NCD (including commercial BARF). Information about the recipes for NCD was mostly imprecise (lack of information about the amounts of the single ingredients) and did not allow a study of the diet's nutritional adequacy. The body index reported by owners was not taken into consideration as owners may have used different crite- ria, not comparable with the standardised approach used during veterinary consultations, in estimating their dogs' body condition leading to a result of difficult interpreta- tion [23].

Two different population of owners were compared: owners feeding NCD (homemade/commercial BARF, cooked homemade diet, prey model, ….) and owners feeding CD (dry or wet pet food). Owners using both (i.e., kibbles in the morning and cooked homemade food in the evening) were not taken into consideration. Statistical analysis was performed on R (R version 3.5.3) via R Studio (R Studio version 1.1.463). Student's t-test, chi-squared and Fisher's test were the statistical tests used for data analysis. A p-value < 0.05 was considered statistically significant. Only variables with hypothesis were tested to avoid a multiple test situation.

Abbreviations

BARF: Biologically Appropriate Raw Food / Bones and Raw Food in United States; NCD: Non-conventional diets; CD: Conventional diets; SD: Standard Deviation.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12917-022-03258-9.

Additional file 1. Questionnaire: Lifestyle and nutrition habits. In this file, the questionnaire used for this study was original written in French and has been translated in English Language.

Additional file 2. Original questionnaire: Lifestyle and nutrition habits (French).

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This study has been realized on a preliminary survey commanded by the French pet food syndicate (FACCO). Due to the exceptional epidemiologic situation, this survey has been modified to evaluate the profile of owners according to their food choices. The funding body was consulted regarding the design of the study and help to recruit owners though their social media but did not interfere with the analysis and interpretation of data.

Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

Protocol was reviewed by the Veterinary medicine of Toulouse ethics committee (SSA N°115): no ethics approval process was needed for such procedure, as enrollment was on a voluntary basis and the participants consented to anonymous information collection with a written question in the survey to ask for the authorization to use data as per Regulation (EU) N.2016/679 of the European parliament of 27 April 2016. By completing and returning the survey, participants agreed to the inclusion of data. No animals have been used in this study.

Consent for publication

Not Applicable.

Competing interests

This study has been realized on a preliminary survey commanded by the French pet food syndicate (FACCO).
SH has previously worked for the petfood industry.

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References

1. Adin D, DeFrancesco TC, Keene B, Tou S, Meurs K, Atkins C, Aona B, Kurtz K, Barron L, Saker K. Echocardiographic phenotype of canine dilated cardiomyopathy differs based on diet type. J Vet Cardiol. 2019;21:1–9. https://doi.org/10.1016/j.jvc.2018.11.002.
2. Becvarova I, Prochazka D, Chandler ML, Meyer H. Nutrition Education in European veterinary schools: are european veterinary graduates competent in nutrition? J Vet Med Educ. 2016;43:349–58. https://doi.org/10.3138/jvme.0715-122R1.
3. Boya UO, Dotson MJ, Hyatt EM. A comparison of dog food choice criteria across dog owner segments: an exploratory study. Int J Consum Stud. 2015;39:74–82. https://doi.org/10.1111/ijcs.12145.
4. Colliard L, Ancel J, Benet J-J, Paragon B-M, Blanchard G. Risk factors for obesity in dogs in France. J Nutr. 2006;136:1951S-1954S. https://doi.org/10.1093/jn/136.7.1951S.
5. Davies RH, Lawes JR, Wales AD. Raw diets for dogs and cats: a review, with particular reference to microbiological hazards. J Small Anim Pract. 2019;60:329–39. https://doi.org/10.1111/jsap.13000.
6. Dodd S, Cave N, Abood S, Shoveller A-K, Adolphe J, Verbrugghe A. An observational study of pet feeding practices and how these have changed between 2008 and 2018. Veterinary Record. 2020;186:643–643. https://doi.org/10.1136/vr.105828.
7. Empert-Gallegos A, Hill S, Yam PS. Insights into dog owner perspectives on risks, benefits, and nutritional value of raw diets compared to commercial cooked diets. PeerJ. 2020;8:e10383. https://doi.org/10.7717/peerj.10383.

8. Facco, 2019. Les chiffres pour tout savoir sur le marché du petfood. Facco. URL https://www.facco.fr/les-chiffres/ (accessed 7.9.20).
9. Gustavsen GW, Hegnes AW. Individuals' personality and consumption of organic food. J Clean Prod. 2020;245:118772. https://doi.org/10.1016/j.jclepro.2019.118772.
10. Laflamme DP, Abood SK, Fascetti AJ, Fleeman LM, Freeman LM, Michel KE, Bauer C, Kemp BLE, Doren JRV, Willoughby KN. Pet feeding practices of dog and cat owners in the United States and Australia. J Am Vet Med Assoc. 2008;232:687–94. https://doi.org/10.2460/javma.232.5.687.
11. Li M, Chapman GB. Why do people like natural? Instrumental and ideational bases for the naturalness preference. J Appl Soc Psychol. 2012;42:2859–78. https://doi.org/10.1111/j.1559-1816.2012.00964.x.
12. Michel KE, Willoughby KN, Abood SK, Fascetti AJ, Fleeman LM, Freeman LM, Laflamme DP, Bauer C, Kemp BLE, Doren JRV. Attitudes of pet owners toward pet foods and feeding management of cats and dogs. J Am Vet Med Assoc. 2008;233:1699–703. https://doi.org/10.2460/javma.233.11.1699.
13. Morelli G, Bastianello S, Catellani P, Ricci R. Raw meat-based diets for dogs: survey of owners' motivations, attitudes and practices. BMC Vet Res. 2019;15:74. https://doi.org/10.1186/s12917-019-1824-x.
14. Morgan SK, Willis S, Shepherd ML. Survey of owner motivations and veterinary input of owners feeding diets containing raw animal products. PeerJ. 2017;5:e3031. https://doi.org/10.7717/peerj.3031.
15. Moscato EM, Machin JE. Mother natural: motivations and associations for consuming natural foods. Appetite. 2018;121:18–28. https://doi.org/10.1016/j.appet.2017.10.031.
16. Parr JM, Remillard RL. Handling alternative dietary requests from pet owners. Vet Clin North Am Small Anim Pract. 2014;44:667–88, v. https://doi.org/10.1016/j.cvsm.2014.03.006.
17. Pedrinelli V, Gomes M, Carciofi A. Analysis of recipes of home-prepared diets for dogs and cats published in Portuguese. J Nutri Sci. 2017;6:e33. https://doi.org/10.1017/jns.2017.31.
18. Pedrinelli V, Zafalon RVA, Rodrigues RBA, Perini MP, Conti RMC, Vendramini THA, de Carvalho Balieiro JC, Brunetto MA. Concentrations of macronutrients, minerals and heavy metals in home-prepared diets for adult dogs and cats. Sci Rep. 2019;9:13058. https://doi.org/10.1038/s41598-019-49087-z.
19. Runesvärd E, Wikström C, Fernström L-L, Hansson I. Presence of pathogenic bacteria in faeces from dogs fed raw meat-based diets or dry kibble. Veterinary Record. 2020. https://doi.org/10.1136/vr.105644.
20. Viana LM, Mothé CG, Mothé MG. Natural food for domestic animals: a national and international technological review. Res Vet Sci. 2020;130:11–8. https://doi.org/10.1016/j.rvsc.2020.02.008.
21. Vinassa M, Vergnano D, Valle E, Giribaldi M, Nery J, Prola L, Bergero D, Schiavone A. Profiling Italian cat and dog owners' perceptions of pet food quality traits. BMC Vet Res. 2020;16:131. https://doi.org/10.1186/s12917-020-02357-9.
22. Wells DL. A review of environmental enrichment for kennelled dogs, Canis familiaris. Appl Anim Behav Sci. 2004;85:307–17. https://doi.org/10.1016/j.applanim.2003.11.005.
23. White GA, Hobson-West P, Cobb K, Craigon J, Hammond R, Millar KM. Canine obesity: is there a difference between veterinarian and owner perception? J Small Anim Pract. 2011;52:622–6. https://doi.org/10.1111/j.1748-5827.2011.01138.x.
24. WSAVA Nutritional Assessment Guidelines Task Force Members. WSAVA nutritional assessment guidelines. J Feline Med Surg. 2011;13:516–25. https://doi.org/10.1016/j.jfms.2011.05.009.

Publisher's Note

CHAPTER 2

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Article

The Perception of the Body Condition of Cats and Dogs by French Pet Owners and the Factors Influencing Underestimation

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Simple Summary: Obesity is a significant health concern among companion animals, particularly dogs and cats, with numerous detrimental health implications. Many pet owners struggle with managing their pets' weight, and they often underestimate their pets' body condition. This study, held in France from 2020 to 2022, revealed that about one quarter of pet owners underestimate their pets' body condition. Having children was linked to this underestimation for both dog and cat owners. This discovery highlights the importance of taking a comprehensive approach to the health and well-being of pets and emphasizes the need for a holistic "One Health" strategy.

Abstract: Managing pet obesity relies heavily on the active involvement of owners; however, a key challenge arises from misperceptions about their own pet's body condition. Given evolving societal dynamics like the body positivity movement, understanding owners' perceptions is increasingly pivotal. To evaluate the differences in owners' perception, this study compared the use of verbal and visual body condition score scales versus the established nine-point body condition score system. The factors linked to underestimation were further specifically investigated. Owners of healthy adult dogs and cats attending vaccination consultations in Veterinary Hospitals in France between 2020 and 2022 were recruited. They were required to assess their pets' body condition initially using an oral description and then with the nine-point BCS visual scale. Their assessments were then compared with the BCS determined by veterinary health care personnel, considered the primary investigator. A total of 304 dogs and 270 cats were included in the study. It was observed that 27% of dog owners and 24% of cat owners underestimated their pets' body condition. Among dog and cat owners, factors associated with the underestimation of body condition were the pets' overweight status and having children. This discovery emphasizes the need for a holistic One Health approach that prioritizes the health and well-being of both humans and their pets. When it comes to pet owners evaluating their pets' body condition, underestimation proved to be the predominant misperception. Addressing this issue requires comprehensive education to empower owners to recognize and comprehend their pets' overweight status, a critical step for the overall well-being of companion animals.

Keywords: canine; feline; obesity; overweight; owner; perception; veterinarian

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1. Introduction

Obesity is a prevalent health concern among companion animals, particularly dogs and cats, and has been associated with a multitude of adverse health effects [1]. For instance, within European veterinary settings, overweight conditions (defined as body condition score (BCS) > 5/9 or >3/5 [2]) affect 46.6% of dogs in Denmark [3] and 45% of cats in Sweden [4]. Overweight pets are at an increased risk of developing chronic conditions such as diabetes [5], cardiovascular diseases [6], and osteoarthritis [7], and a reduced lifespan overall [8,9]. Addressing this issue requires the active involvement of pet owners, who play a crucial role in managing their pets' body condition and weight.

One significant challenge in tackling pet obesity is the misperception of body condition by pet owners [10,11]. These misperceptions can hinder effective weight management strategies, leading to a lack of appropriate intervention and perpetuating the problem of obesity in companion animals. Few studies conducted worldwide have shed light on the global misperception of body condition by pet owners [11–13]. These investigations have identified some factors associated with misperception, including the animal's body condition being either over- or underconditioned [12,13], young age [13], the living place of the owners (with people from countryside more often underestimating their dogs' body condition score) [12], or their gender (with women better estimating their dogs' body condition [13]). However, while these studies have contributed valuable insights into the broader problem, a specific examination of French pet owners' misperception has not been carried out since 2006 [14,15]. This absence of recent data becomes increasingly relevant in the context of significant societal shifts, such as the rise and proliferation of the body positivity movement. This movement, championing self-acceptance despite overweight or obesity, has gained momentum through social media and may potentially limit the effectiveness of public health campaigns [16]. Conversely, the COVID-19 pandemic has led to heightened concern among Americans about overweight issues and a greater willingness to seek interventions [17]. To the authors' knowledge, only one European study on dog owners' perception of body condition [11] has been published since the pandemic. None have been published since then on cat owners' body condition perceptions. This study, conducted in France, holds the potential to provide insights that could extend to other countries.

Based on previous research, the authors hypothesize that a substantial proportion of French pet owners will demonstrate a misperception of their dogs' and cats' body condition, underestimating their pets' weight status. It is expected that owners of dogs will be more likely to underestimate their dogs' body condition than cat owners [12]. Therefore, the first aim of this study was to evaluate the owners' perception of their pets' body condition in France. The second aim was to compare the perception of owners when using a verbal scale versus a more comprehensive nine-point body condition score (BCS) system with accompanying figures. A third aim was to investigate the factors associated with an underestimation of the body condition.

2. Materials and Methods

Pet owners were asked to voluntarily complete a questionnaire (Supplementary Files 1 and 2) during their pets' vaccination visits at the University Veterinary Hospi- tals of Toulouse and Maisons-Alfort in France between 2020 and 2022. The questionnaire was designed to gather information on variables previously identified through a literature review to be associated with pet overweight. Given that overconditioning is a widely acknowledged factor that can lead to the underestimation of a pet's body condition [12,13,18], it was imperative to recognize these aspects as potential confounding variables. The questionnaire was adapted from an online survey used in a previous study [19] and was modified for use during veterinary consultations. It was filled out before engaging in any discussions with the veterinary staff to minimize the potential for bias and influence. The study included healthy adult pets aged one year or older. Only data from the first visit of pets who presented multiple times were considered for analysis. During the consultation,

the veterinarian assessed each pet's body condition score with the nine-points scale BCS and weighed the animal [20]. All veterinarians involved in this study underwent compre- hensive training and instruction to guarantee consistency in the evaluation process. They underwent a full day of training in each veterinary school consisting in scoring the same 30 dogs and 30 cats, ultimately reaching a consensus on the body condition scores.

In the survey questionnaire, owners were first asked to evaluate their pets' body condition using the response options of "very skinny", "a bit skinny", "ideal", "a bit fat", or "very fat" in French. This assessment will be referred to as "the verbal scale". To align with the nine-point body condition score system, the following classifications were employed: "very skinny" and "a bit skinny" referred to a BCS < 4 for dogs and a BCS < 5 for cats, "ideal" referred to a BCS of 4–5 for dogs and a BCS of 5 for cats, "a bit fat" referred to a BCS of 6–7, and "very fat" referred to a BCS of 8–9 [2]. Based on these comparisons, the owners' perception of their pets' body condition was categorized into "underestimation", "agreement", or "overestimation" [12]. Owners were requested to assess their pets' BCS on a scale of 1 to 9 using images from the Nestlé PURINA®Body Condition System without palpation. While this scale is typically designed for evaluating visible and palpable characteristics [20], in this instance, it was exclusively used for its visual representations [12]. This approach aimed for a swift assessment by owners, with the potential consideration of its effectiveness for application in larger studies if proven successful. This assessment, referred to as "the visual scale", occurred after the verbal scale evaluation.

All statistical analyses were conducted using R 4.2.2. The level of agreement between verbal and visual estimations from the owners, and BCS estimations by the veterinarian were evaluated using the linear weighted Kappa (Kp) test [12]. This test assesses whether the observed agreement is higher than what would be expected by chance alone. The degree of agreement was classified as follows: very low ($\kappa < 0.00$), low (0.00 to 0.20), reasonable (0.21 to 0.40), moderate (0.41 to 0.60), high (0.61 to 0.80), and almost perfect (0.81 to 1.00) [12]. A chi-square test of proportion equality was employed to examine potential differences in perception between dog owners and cat owners [12]. For the analysis of factors associated with misperception, the number of owners who overestimated their pets' body condition was insufficient for inclusion in the analysis, consisting of only 17 dog owners and 34 cat owners. Consequently, the study focused exclusively on examining factors associated with underestimation. For each species (dogs and cats), the associations between underestimation and explanatory variables were assessed using binary logistic regression. A stepwise backward and forward elimination process was conducted, involving the inclusion of only variables that were deemed relevant based on a literature review and had a p-value less than 0.25 in univariate analysis [13]. The variables considered included household size, presence of children, owner age, animal's sex, overall activity level, access to outdoor space, presence of another dog, presence of a cat, use of a slow-feeding bowl, place of purchase of food, begging behavior, proportion of dietary energy from treats, body condition, and age for dogs and presence of children, neutering status, frequency of wet food consumption, feeding ad libitum, and body condition for cats. The resulting models were validated using the Area Under the Curve (AUC) metric [13].

3. Results

A total of 304 dogs and 270 cats were included in this study. A detailed description of the dogs' and cats' population, categorized based on the owners' perception, can be found in Supplementary File 3.

3.1. Agreement between Owners and Veterinarians

Approximately 21% of dog owners and 39% of cat owners inaccurately estimated their pets' weight in kilograms with a ±10% accuracy allowance. This included underestimation rates of 14% for dogs and 21% for cats, along with overestimation rates of 7% for dogs and 18% for cats.

When using the verbal scale, a substantial proportion of dog and cat owners disagreed with the veterinarian regarding their pets' body condition. Among dog owners, 32.6% disagreed (27.0% underestimating and 5.6% overestimating), while among cat owners, 36.7% disagreed (24.1% underestimating and 12.6% overestimating). This percentage of disagreement increased as the excess body weight of the pets increased. Specifically, when considering pets with ideal body conditions, 12% of dog owners and 29% of cat owners disagreed with the veterinarian. For overweight, but not for obese, pets, the disagreement rate rose to 66% for dog owners and 64% for cat owners. For obese pets, all dog owners and 83% of cat owners disagreed with the veterinarian regarding their body condition (Tables S1 and S2).

In contrast, when showing the nine-point BCS scale, 60% of dog owners and 52% of cat owners did not guess the correct BCS for their pets. However, the nine-point BCS scale enabled a greater number of owners to identify excess body weight in their pets (Tables S3 and S4). Among dog owners, 49% detected excess body weight using the BCS scale, compared to 38% using the verbal scale. Similarly, among cat owners, 75% identified excess body weight using the BCS scale, whereas only 64% did so with the verbal scale. When analyzing misperception in dogs, it was observed that all cases of misperception in underweight dogs were underestimation, while 99% of misperception in overweight dogs were underestimation. In cats, all misperceptions were overestimation in underweight cats, and 91% of misperception in overweight cats was underestimation. Comparing misperception (underestimation and overestimation) with agreement, a significant differ- ence ($p < 0.004$) was observed between dog and cat owners, with more overestimation in cat owners and more underestimation in dog owners (Table 1). When considering only underestimation versus agreement, the significant difference disappeared ($p > 0.05$).

Table 1. Differences between cat and dog owners' perception of their pets' body condition.

Characteristic	Underestimation	Agreement	Overestimation	*p*-Value [1]
Species				**0.004**
cat	65 (43%)	171 (46%)	34 (69%)	
dog	85 (57%)	204 (54%)	15 (31%)	

[1] Chi-square test. Statistically significant *p*-values ($p < 0.05$) are shown in bold.

With the verbal scale, the degree of concordance between owners and the veterinarian was reasonable for dogs (Kp = 0.30, 95%CI = [0.21–0.39]) and moderate for cats (Kp = 0.47, 95%CI = [0.39–0.55]). With the visual scale, the degree of concordance was moderate for both dogs (Kp = 0.43, 95%CI = [0.34–0.51]) and cats (Kp = 0.49, 95%CI = [0.42–0.56]).

Concerning owners' preferences for their pets' weight, 71% and 46% of those with over- weight dogs and cats (BCS 6–7), and 29% and 14% of those with obese dogs and cats (BCS 8–9), respectively, expressed a desire to maintain their pets' current body weight. A detailed breakdown of the owners' preferences can be found in Table S5.

3.2. Factors Associated with Owners' Underestimation of Pet Body Condition

After the literature review and univariable analysis, the variables kept for multivari- able analysis were number of people in the household, presence of children, owner age, animals' sex, time of leashed activity per week, outdoor access, presence of another dog, presence of a cat, slow-feeding bowl, food store, begging behavior, percentage of energy intake by treats, body condition, and age for dogs (Table S6) and presence of children, neutering, wet food frequency, feeding ad libitum, and body condition for cats (Table S7). Factors positively associated with underestimation of body condition by dog owners were dogs' overweight condition (OR = 81.2; 95%CI: 27.8–288; $p < 0.001$), having a cat (OR = 2.86; 95%CI: 1.14–7.60; $p = 0.028$), and having children (OR = 2.67; 95%CI: 1.04–7.15; $p = 0.044$).

Age of the dog (OR = 0.85; 95%CI: 0.74–0.96; $p = 0.010$) and having another dog (OR = 0.27; 95%CI: 0.10–0.67; $p = 0.007$) were associated with a better estimation (Table 2). The dog model had a high level of accuracy with an AUC of 0.91. Factors associated with an under-

estimation of body condition by cat owners were cats' overweight condition (OR = 8.56; 95%CI: 4.15–19.3; $p < 0.001$) and having children (OR = 2.55; 95%CI: 1.24–5.36; $p = 0.011$) (Table 3). The cat model had a moderate accuracy with an AUC of 0.75.

Table 2. Results of the multivariable analysis for owners' underestimation of dog body condition.

Variable	N	Odds Ratios	CI [1]	*p*-Value
Dog's status (Overweight)	82	81.2	27.8–288	**<0.001**
Dog's age (Years)	226	0.85	0.74–0.96	**0.010**
Dog's sex (Male)	111	1.94	0.82–4.89	0.14
Another dog (Yes)	76	0.27	0.10–0.67	**0.007**
Cat (Yes)	68	2.86	1.14–7.6	**0.028**
Children (Yes)	58	2.67	1.04–7.15	**0.044**

[1] Confidence Interval. Statistically significant *p*-values ($p < 0.05$) are shown in bold.

Table 3. Results of the multivariable analysis for owners' underestimation of cat body condition.

Variable	N	Odds Ratios	CI [1]	*p*-Value
Status (Overweight)	123	8.56	4.15–19.3	**<0.001**
Children (Yes)	65	2.55	1.24–5.36	**0.011**

[1] Confidence Interval. Statistically significant *p*-values ($p < 0.05$) are shown in bold.

4. Discussion

This study found that 32.6% of dog owners and 36.7% of cat owners disagreed with the veterinarian's assessment of their pets' body condition, and this disagreement increases with excess body weight. The disagreement resulted in two out of seven obese dogs and one out of seven obese cats, where the owners were content in maintaining the current weight of their pet. This included one dog owner perceiving their dog as "ideal" and another dog owner, along with a cat owner, who considered their pet to be "a bit fat". Only 79% of dog owners and 61% of cat owners were able to tell their pets' weight in kilograms (±10%). The degree of concordance for body condition between owners and veterinarian was reasonable (Kp = 0.30) for dogs and moderate (Kp = 0.47) for cats. The implementation of the photographs from the nine-point BCS scale did not lead to a notable improvement in the degree of concordance between owners and veterinarians. However, with this scale, a higher proportion of owners with overweight pets described their animals as being overweight. Among dog and cat owners, factors associated with the underestimation of body condition were the pets' overweight status and having children. For dogs, underestimation was also associated with owning a cat, and an agreement was associated with the increasing age of the dog and owning another dog.

In a previous British study, 69% of dog owners were able to provide a description of their dogs' weight in either kilograms or pounds [18]. However, the level of precision in their estimates was not specified. This finding falls between the results of the current study, with 55% of dog owners achieving a precision level of ±5% and 79% achieving a precision level of ±10%. The estimation accuracy of cat owners was relatively lower, even when considering the broader precision range of ±10%: only 61% of cat owners accurately estimated their cat's weight within this range.

Beyond simply knowing the weight of their pets, it is crucial for owners to be able to interpret it accurately. Unfortunately, when it comes to assessing body condition, there is a substantial level of misperception among pet owners, which aligns with the findings from previous studies showing low Kp [13–15]. Although the percentage of owners with dogs in an ideal body condition in agreement with the veterinarian's assessment was similar to a previous study (here 88% vs. 80%), there is a lower agreement among owners of overweight dogs (here, 31% vs. 53%) [18].

Interestingly, when considering cats, owners of overweight cats exhibited higher agreement levels compared to dog owners, with 55% agreement observed. This outcome aligns with the findings from the sole prior study that directly compared the opinions from

dog owners to those of cat owners [12]. The hypothesis proposed in the aforementioned study suggested that the disparity might be due to dog owners who engage in physical activities with their pets possibly perceiving exercise as a contributing factor and, conse- quently, underestimating their animals' weight. Another possible explanation could be that excess body weight is more noticeable in smaller pets like cats from a human perspective, which makes it easier for owners to accurately assess their cats' weight. In fact, it has been suggested that the larger body size of male cats might present challenges for owners when evaluating their body condition [21].

Consistent with previous studies, it has been observed that pet owners tend to normalize their pets' body condition, leading to an underestimation in the case of overweight animals and an overestimation for underweight ones [13]. The misperception surrounding obesity has been shaped by societal factors, including a shift in generational norms regarding human body weight. What was once considered "overweight" now tends to be viewed as "about right" [22]. This shift is further amplified by the influence of social media platforms [16], and a similar trend may be occurring in the context of pets, perpet- uating the belief that overweight animals are the norm in today's society. However, it is crucial to recognize the potential of these communication channels to be harnessed for a positive purpose. Rather than perpetuating the misperception, social media platforms could serve as effective tools to fight pet obesity by disseminating advice and raising awareness about the associated risks, similar to the efforts mentioned regarding pediatric obesity [22]. When communicating about pet obesity, it is essential to be mindful of the potential for unintended consequences. Framing the issue in a way that suggests blame on pet owners may inadvertently reinforce the notion that excess weight in pets reflects low moral worth [23,24], leading owners to reject the information altogether and hindering their ability to address the problem effectively. Another explanation for this normalization is that owners, interacting with their animals every day, might not notice gradual weight gain. Weighing the pet regularly could help counteract this, as is the case in humans [25]. However, this study reveals that not all owners are necessarily aware of their pets' weight. This may explain a lack of monitoring and a regular weight gain that goes unnoticed. It could be beneficial to encourage owners to track their pets' weight trajectory throughout its life, such as parents for children [26].

The misperception surrounding pet body condition is a significant problem with far-reaching implications. Firstly, it contributes to the increasing prevalence of overweight animals, as an underestimation of pets' body conditions has been associated with pets being overweight [15]. Additionally, this misperception poses a challenge when veterinarians attempt to implement weight loss plans. Owners, who play a crucial role in the process, may lack motivation [10] or may fail to notice their pets' weight loss progress, especially if they do not regularly weigh their pets.

This study sheds light on the complexity of weight loss plans by exploring the intentions of owners regarding their animals' weight. Interestingly, 68% of dog owners and 44% of cat owners with overweight pets expressed a desire for their animals to maintain the same weight. It is worth noting that this question was posed prior to the consultation, and it would have been valuable to assess any change in owners' perspectives following the discussion with the veterinarian. Disagreements between the perspectives of veterinarians and clients have been observed in previous studies [27], and research has demonstrated that many owners remain in a pre-contemplative state, even when aware of their animals' overweight status [23]. One of the primary concerns in Western societies is the humanization of pets [28]. The act of providing food has become a means for owners to express their affection, and they often associate feeding with pleasure [10,29]. This humanization process can lead to resistance from owners regarding weight loss plans and may hinder effective communication with veterinarians [18].

Apart from excess body weight, one intriguing finding was that having children was the sole factor associated with an underestimation in both dog and cat owners, with approximately 2.5 times higher odds of underestimating their pets' body condition. Inter-

estingly, studies conducted in human populations have discovered a similar trend among parents in underestimating their overweight/obese child's body condition [30–32]. As proposed in the context of pets, the normalization of body condition may result from unconscious habituation, given the routine exposure to their child on a daily basis, coupled with a self-preservation instinct aimed at avoiding feelings of guilt for their children's overweight [33,34]. Several other hypotheses have been proposed to explain this underestimation phenomenon. One possibility is that parents may resist labeling or stigmatizing their children and, consequently, fail to acknowledge that their child is overweight [35–37]. Moreover, parents may be reluctant to recognize their child's weight issue because addressing it would require implementing healthy lifestyle changes for themselves as well [30]. This same tendency may extend to how parents perceive their pets' body condition. To gain deeper insights into these hypotheses, an intriguing approach would be to conduct a study where parents are asked to rate the body condition of both pets and children who are not their own. This method draws inspiration from a previous experiment in which adults were asked to assess images of men, revealing a tendency to underestimate the status of overweight and obese individuals [38]. While employing children in such a study necessitates stringent ethical approval, this approach would provide a deeper understanding of whether parental bias extends beyond their immediate family. Another explanation could be that parents are preoccupied with their children's needs and may not prioritize monitoring their pets' body condition as closely. Moreover, parents may unconsciously use their children's body condition as a reference point for evaluating their pets, even though there are notable differences. Human babies, in particular, have a higher proportion of body fat compared to many other species, rendering them an unsuitable benchmark [39]. As a result, humans may perceive the plumper appearance of pets as "cute", much like how they find obese humans endearing because curvilines can make them resemble babies [39].

In any case, the observation that parents fail to perceive their children and pets as overweight provides compelling evidence for the importance of adopting a "One Health" approach [40]. Considering this shared concern, collaboration between veterinarians and pediatricians holds immense potential for developing joint awareness campaigns aimed at addressing overweight issues in children and pets alike. This collaboration can lead to impactful interventions that promote healthy habits, raise awareness, and ultimately contribute to improving the well-being of both children and pets.

Findings of this study suggest that dog owners who also have cats may have a higher likelihood of underestimating their dogs' body condition compared to dog owners without cats. Further research and investigation would be needed to understand the underlying reasons for this association. Factors such as caregiving patterns, or interactions between the two species could potentially contribute to this phenomenon.

Age (in years) was identified as a factor associated with a better estimation of body condition by dog owners. This finding is consistent with a previous study which reported a 24% reduced risk of underestimation in senior dogs aged 9–18 years [13]. The hypothesis previously mentioned is that owner attitudes towards acceptable body shape may evolve over a dog's lifespan. Another plausible explanation is that owners tend to be more attentive and to provide greater care for their older pets, knowing that these animals are susceptible to illness and potential weight loss. This result could also highlight that older dogs may be more likely to have owners with a better understanding of dogs in general and ideal body condition. Furthermore, owning another dog was also found to be associated with an agreement in our study. This finding reinforces the "knowledge hypothesis" as owners of multiple dogs may possess a broader awareness of canine body condition, potentially contributing to more accurate assessments. In a prior study, the previous ownership of dogs in individuals' lives was linked to a disagreement about their actual dogs' body condition [11]. However, in this current study, participants were not queried about their historical dog ownership; instead, they were asked to provide the current number of dogs in their care. It may be that possessing multiple dogs may potentially improve owners' perception by enabling comparisons among them. Indeed, research indicates that the

perception of human body condition often involves a comparative analysis with others [41]. These results underscore the possibility of owners' perception being transformed and enhanced through education over time.

Although previous studies did not demonstrate a superior agreement coefficient for visual scales compared to verbal scales [42], it remains a valuable tool in raising awareness among owners of overweight pets about their pets' weight issues, as observed in both the current study and previous studies conducted in France [14,15]. In this study, the scale was used solely for pictures and descriptions, with owners not encouraged to perform palpation. The aim was to be able to implement this quick assessment in larger studies. In a recent study in Sweden, instructing owners in the proper utilization of the nine-point BCS scale, including palpation, was significantly associated with an improvement in their assessment [11]. This led to no difference in the mean estimated BCS between owners and veterinary staff, demonstrating a more substantial improvement compared to studies, such as this one, using only pictures [43]. Taken altogether, these results affirm the necessity of teaching owners palpation. Veterinarians should provide owners the opportunity to train with tactile models simulating various BCS. This hands-on approach could help owners identify different BCS levels by feeling the models, offering a more effective alternative to waiting room posters. Future studies should concentrate on validating the use of online video tutorials to teach BCS estimation with pictures and palpation to owners. This approach could be quicker than direct teaching by veterinary staff and more beneficial than relying solely on pictures.

This study has several limitations that should be considered. Firstly, the assessment of BCS was conducted by six veterinarians, which could introduce some variability in the measurements. However, efforts were made to ensure consistency in scoring by providing a full day of training to vet staff in each school and adhering to the standardized guidelines of the validated nine-point scale BCS method, known for its good reproducibility [20]. Secondly, it is important to acknowledge that the study was conducted in two specific veterinary schools, namely Alfort and Toulouse. Consequently, the sample of participants may not be fully representative of the entire population of dog and cat owners in France. However, the study offers valuable insights into the perception of body condition among owners of healthy pets and can be compared to other studies also made in veterinary clinics. In contrast to a preceding study conducted in a Brazilian veterinary clinic from 2013 to 2018, this study demonstrates higher levels of agreement for owners of both dogs (67.4% vs. 38.8%) and cats (63.3% vs. 40.9%) [12]. The level of agreement may potentially be higher in European countries compared to Brazil, as indicated by another European study conducted in Glasgow, which reported a 55.9% agreement rate for dog owners [13]. Finally, owners were not taught the palpation evaluation of the pets' BCS, hindering the ability to assess potential improvements in their estimations

Acknowledging its limitations, this study contributes valuable insights into owners' perception of pet body condition and highlights areas for further research. For instance, future studies should consider evaluating the attachment between owners and their pets, possibly using tools like the Lexington Attachment to Pet Scale [44], even though its validation in the French language is lacking. This assessment could shed light on the role of the animal within the family unit. Furthermore, incorporating specific questions related to whether owners view their pets as children could provide valuable insights into the connection between having children and underestimating the pets' weight. Additionally, future studies should encompass inquiries about prior veterinary consultations, including whether the veterinarian discussed the pet's weight, and introduce a post-consultation questionnaire for a comprehensive understanding of the owner–veterinarian interaction in weight management.

5. Conclusion

Misperception of pets' body condition by owners was estimated to be about 33% for dogs and 37% for cats in France between 2020 and 2022. This study unveiled a significant

association between having children and the tendency to underestimate their pets' body condition. This noteworthy finding underscores the importance of future research to delve deeper into this connection, further contributing to a One Health approach that considers the health and well-being of both humans and their animal companions. The most common form of misperception was underestimation, leading to owners being satisfied with the weight of their overweight pets. To address this issue, owners can be educated to recognize and understand the overweight status of their pets. Since using pictures of different BCS levels has not demonstrated significantly greater effectiveness, this education should emphasize the technique of palpation for accurate BCS estimation.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/ani13233646/s1, Supplementary File 1: Questionnaire for dog owners; Supplementary File 2: Questionnaire for cat owners; Supplementary File 3: Description of the population; Table S1: Dog owners' opinion according to BCS rated by a veterinarian; Table S2: Cat owners' opinion according to BCS rated by a veterinarian; Table S3: Dog owners' BCS with the visual scale according to BCS rated by a veterinarian; Table S4: Cat owners' BCS with the visual scale according to BCS rated by a veterinarian; Table S5: Owners' will about their pets' weight; Table S6: Results of the univariate analysis for dog owners' underestimation; Table S7: Results of the univariate analysis for cat owners' underestimation.

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References

1. Chandler, M.; Cunningham, S.; Lund, E.M.; Khanna, C.; Naramore, R.; Patel, A.; Day, M.J. Obesity and Associated Comorbidities in People and Companion Animals: A One Health Perspective. *J. Comp. Pathol.* **2017**, *156*, 296–309. [CrossRef]
2. Brooks, D.; Churchill, J.; Fein, K.; Linder, D.; Michel, K.E.; Tudor, K.; Ward, E.; Witzel, A. 2014 AAHA Weight Management Guidelines for Dogs and Cats. *J. Am. Anim. Hosp. Assoc.* **2014**, *50*, 1–11. [CrossRef] [PubMed]
3. Bjørnvad, C.R.; Gloor, S.; Johansen, S.S.; Sandøe, P.; Lund, T.B. Neutering Increases the Risk of Obesity in Male Dogs but Not in Bitches-A Cross-Sectional Study of Dog- and Owner-Related Risk Factors for Obesity in Danish Companion Dogs. *Prev. Vet. Med.* **2019**, *170*, 104730. [CrossRef]
4. Öhlund, M.; Palmgren, M.; Holst, B.S. Overweight in Adult Cats: A Cross-Sectional Study. *Acta Vet. Scand.* **2018**, *60*, 5. [CrossRef] [PubMed]
5. Lund, E.; Armstrong, P.J.; Kirk, C.; Klausner, J. Prevalence and Risk Factors for Obesity in Adult Cats from Private US Veterinary Practices. *Int. J. Appl. Res. Vet. Med.* **2005**, *4*, 177–185.
6. Partington, C.; Hodgkiss-Geere, H.; Woods, G.R.T.; Dukes-McEwan, J.; Flanagan, J.; Biourge, V.; German, A.J. The Effect of Obesity and Subsequent Weight Reduction on Cardiac Structure and Function in Dogs. *BMC Vet. Res.* **2022**, *18*, 351. [CrossRef] [PubMed]
7. Budsberg, S.C.; Bartges, J.W. Nutrition and Osteoarthritis in Dogs: Does It Help? *Vet. Clin. N. Am. Small Anim. Pract.* **2006**, *36*, 1307–1323. [CrossRef]
8. Teng, K.T.; McGreevy, P.D.; Toribio, J.-A.L.; Raubenheimer, D.; Kendall, K.; Dhand, N.K. Strong Associations of Nine-Point Body Condition Scoring with Survival and Lifespan in Cats. *J. Feline Med. Surg.* **2018**, *20*, 1110–1118. [CrossRef]

9. Salt, C.; Morris, P.J.; Wilson, D.; Lund, E.M.; German, A.J. Association between Life Span and Body Condition in Neutered Client-Owned Dogs. *J. Vet. Intern. Med.* **2019**, *33*, 89–99. [CrossRef]
10. Larsen, J.A.; Villaverde, C. Scope of the Problem and Perception by Owners and Veterinarians. *Vet. Clin. N. Am. Small Anim. Pract.* **2016**, *46*, 761–772. [CrossRef]
11. Gille, S.; Fischer, H.; Lindåse, S.; Palmqvist, L.; Lärka, J.; Wolf, S.; Penell, J.; Söder, J. Dog Owners' Perceptions of Canine Body Composition and Effect of Standardized Education for Dog Owners on Body Condition Assessment of Their Own Dogs. *Vet. Sci.* **2023**, *10*, 447. [CrossRef] [PubMed]
12. Teixeira, F.A.; Queiroz, M.R.; Oba, P.M.; Olivindo, R.F.G.; Ernandes, M.C.; Duarte, C.N.; Rentas, M.F.; Brunetto, M.A. Brazilian Owners Perception of the Body Condition Score of Dogs and Cats. *BMC Vet. Res.* **2020**, *16*, 463. [CrossRef] [PubMed]
13. Courcier, E.A.; Mellor, D.J.; Thomson, R.M.; Yam, P.S. A Cross Sectional Study of the Prevalence and Risk Factors for Owner Misperception of Canine Body Shape in First Opinion Practice in Glasgow. *Prev. Vet. Med.* **2011**, *102*, 66–74. [CrossRef] [PubMed]
14. Colliard, L.; Ancel, J.; Benet, J.-J.; Paragon, B.-M.; Blanchard, G. Risk Factors for Obesity in Dogs in France. *J. Nutr.* **2006**, *136*, 1951S–1954S. [CrossRef] [PubMed]
15. Colliard, L.; Paragon, B.-M.; Lemuet, B.; Bénet, J.-J.; Blanchard, G. Prevalence and Risk Factors of Obesity in an Urban Population of Healthy Cats. *J. Feline Med. Surg.* **2009**, *11*, 135–140. [CrossRef] [PubMed]
16. McWhorter, K.L. Obesity Acceptance: Body Positivity and Clinical Risk Factors. In *Cardiac Diseases—Novel Aspects of Cardiac Risk, Cardiorenal Pathology and Cardiac Interventions*; Gaze, D.C., Kibel, A., Eds.; IntechOpen: Rijeka, 2020.
17. Kissin, R.; Khoury, L.; Wallenborn, G.; Kothari, S.N. When the COVID-19 Pandemic Collides with the Obesity Epidemic in the United States: A National Survey. *Surg. Obes. Relat. Dis.* **2023**, *19*, 434–439. [CrossRef] [PubMed]
18. White, G.A.; Hobson-West, P.; Cobb, K.; Craigon, J.; Hammond, R.; Millar, K.M. Canine Obesity: Is There a Difference between Veterinarian and Owner Perception? *J. Small Anim. Pract.* **2011**, *52*, 622–626. [CrossRef]
19. Hoummady, S.; Fantinati, M.; Maso, D.; Bynens, A.; Banuls, D.; Santos, N.R.D.; Roche, M.; Priymenko, N. Comparison of Canine Owner Profile According to Food Choice: An Online Preliminary Survey in France. *BMC Vet. Res.* **2022**, *18*, 163. [CrossRef]
20. Laflamme, D. Development and Validation of a Body Condition Score System for Dogs. *Canine Practice.* **1997**, *22*, 10–15.
21. Robertson, I.D. The Influence of Diet and Other Factors on Owner-Perceived Obesity in Privately Owned Cats from Metropolitan Perth, Western Australia. *Prev. Vet. Med.* **1999**, *40*, 75–85. [CrossRef]
22. Vandewater, E.A.; Denis, L.M. Media, Social Networking, and Pediatric Obesity. *Pediatr. Clin. N. Am.* **2011**, *58*, 1509–1519. [CrossRef] [PubMed]
23. Sutherland, K.A.; Coe, J.B.; O'Sullivan, T.L. Assessing Owners' Readiness to Change Their Behaviour to Address Their Companion Animal's Obesity. *Vet. Rec.* **2023**, *192*, e1979. [CrossRef] [PubMed]
24. Degeling, C.; Rock, M. Owning the Problem: Media Portrayals of Overweight Dogs and the Shared Determinants of the Health of Human and Companion Animal Populations. *Anthrozoös* **2012**, *25*, 35–48. [CrossRef]
25. Shieh, C.; Knisely, M.R.; Clark, D.; Carpenter, J.S. Self-Weighing in Weight Management Interventions: A Systematic Review of Literature. *Obes. Res. Clin. Pract.* **2016**, *10*, 493–519. [CrossRef] [PubMed]
26. Nemecek, D.; Sebelefsky, C.; Woditschka, A.; Voitl, P. Overweight in Children and Its Perception by Parents: Cross-Sectional Observation in a General Pediatric Outpatient Clinic. *BMC Pediatr.* **2017**, *17*, 212. [CrossRef]
27. Bland, I.; Guthrie-Jones, A.; Taylor, R.; Hill, J. Dog Obesity: Veterinary Practices' and Owners' Opinions on Cause and Management. *Prev. Vet. Med.* **2010**, *94*, 310–315. [CrossRef] [PubMed]
28. Endenburg, N.; Takashima, G.; van Lith, H.A.; Bacon, H.; Hazel, S.J.; Jouppi, R.; Lee, N.Y.P.; Seksel, K.; Ryan, S. Animal Welfare Worldwide, the Opinion of Practicing Veterinarians. *J. Appl. Anim. Welf. Sci.* **2021**, *24*, 215–237. [CrossRef]
29. Lynden, J.; Hollands, T.; Ogden, J. Animal Obesity: What Insights Can a One Health Approach Offer When It Comes to Veterinarians "Making Every Contact Count"? *Vet. Rec.* **2022**, *191*, e1904. [CrossRef]
30. Lundahl, A.; Kidwell, K.M.; Nelson, T.D. Parental Underestimates of Child Weight: A Meta-Analysis. *Pediatrics* **2014**, *133*, e689–e703. [CrossRef]
31. Laurent, J.S.; Tompkins, C.L.; Cioffredi, L.-A.; Wollenburg, E.; Smith, D.; Fontaine, E. Are We Underestimating Overweight and Obesity Prevalence in Children? *Public Health Nurs.* **2020**, *37*, 655–662. [CrossRef]
32. Alshahrani, A.; Shuweihdi, F.; Swift, J.; Avery, A. Underestimation of Overweight Weight Status in Children and Adolescents Aged 0-19 Years: A Systematic Review and Meta-Analysis. *Obes. Sci. Pract.* **2021**, *7*, 760–796. [CrossRef] [PubMed]
33. Davis, J.L.; Goar, C.; Manago, B.; Reidinger, B. Distribution and Disavowal: Managing the Parental Stigma of Children's Weight and Weight Loss. *Soc. Sci. Med.* **2018**, *219*, 61–69. [CrossRef] [PubMed]
34. Persky, S.; Goldring, M.R.; El-Toukhy, S.; Ferrer, R.A.; Hollister, B. Parental Defensiveness about Multifactorial Genomic and Environmental Causes of Children's Obesity Risk. *Child. Obes.* **2019**, *15*, 289–297. [CrossRef] [PubMed]
35. Latner, J.D.; Stunkard, A.J.; Wilson, G.T. Stigmatized Students: Age, Sex, and Ethnicity Effects in the Stigmatization of Obesity. *Obes. Res.* **2005**, *13*, 1226–1231. [CrossRef] [PubMed]
36. Aamann, I.C.; Erlik, M. 'Am I That Bad?': Middle-Class Moralism and Weight Stigma towards Parents of Children with Higher Weight. *Child. Soc.* **2023**, *37*, 1737–1753. [CrossRef]
37. Eli, K.; Howell, K.; Fisher, P.A.; Nowicka, P. "A Little on the Heavy Side": A Qualitative Analysis of Parents' and Grandparents' Perceptions of Preschoolers' Body Weights. *BMJ Open* **2014**, *4*, e006609. [CrossRef] [PubMed]

38. Robinson, E.; Parretti, H.; Aveyard, P. Visual Identification of Obesity by Healthcare Professionals: An Experimental Study of Trainee and Qualified GPs. *Br. J. Gen. Pract.* **2014**, *64*, e703–e708. [CrossRef]
39. Dijker, A.J.M.; DeLuster, R.; Peeters, N.; de Vries, N.K. Seeing Overweight Adults as Babies: Physical Cues and Implications for Stigmatization. *Br. J. Psychol.* **2017**, *108*, 757–782. [CrossRef]
40. Bomberg, E.; Birch, L.; Endenburg, N.; German, A.J.; Neilson, J.; Seligman, H.; Takashima, G.; Day, M.J. The Financial Costs, Behaviour and Psychology of Obesity: A One Health Analysis. *J. Comp. Pathol.* **2017**, *156*, 310–325. [CrossRef]
41. Robinson, E. Overweight but Unseen: A Review of the Underestimation of Weight Status and a Visual Normalization Theory. *Obes. Rev.* **2017**, *18*, 1200–1209. [CrossRef]
42. Porsani, M.Y.H.; de Oliveira, V.V.; de Oliveira, A.G.; Teixeira, F.A.; Pedrinelli, V.; Martins, C.M.; German, A.J.; Brunetto, M.A. What Do Brazilian Owners Know about Canine Obesity and What Risks Does This Knowledge Generate? *PLoS ONE* **2020**, *15*, e0238771. [CrossRef] [PubMed]
43. Gant, P.; Holden, S.L.; Biourge, V.; German, A.J. Can You Estimate Body Composition in Dogs from Photographs? *BMC Vet. Res.* **2016**, *12*, 18. [CrossRef] [PubMed]
44. Johnson, T.P.; Garrity, T.F.; Stallones, L. Psychometric Evaluation of the Lexington Attachment to Pets Scale (Laps). *Anthrozoös* **1992**, *5*, 160–175. [CrossRef]

CHAPTER 3

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Research Article

Prevalence and factors associated with overweight and obesity in dogs presenting to French university veterinary teaching hospitals during the COVID-19 pandemic

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ABSTRACT

Pet obesity is still a major health issue, which is considered an epidemic by some researchers. Prevention is one of the cornerstones of veterinary care, emphasizing the importance of proactive measures. Human lifestyle was affected during the COVID-19 pandemic, resulting in an increased overweight prevalence in the population. The prevalence of overweight and obesity in dogs during this period has been poorly explored. This study's objectives were to assess the percentage of the French dog population with overweight and obesity, compare the results with a study conducted before the COVID-19 pandemic, and investigate any potential changes in the risk factors. The study collected data through a survey completed by dog owners during their pets' vaccination visits at university veterinary hospitals of Maisons-Alfort (Paris) and Toulouse, in France, between 2020 and 2022. The veterinarian recorded the dog's weight and the body condition score using a 9-point scale. The study included a total of 309 dogs. Of these, 1.6 % were underweight, 63.1 % had an ideal body condition, and 35.3 % were overweight, including 2.3 % of all dogs classified as obese. During the pandemic, French dog diets shifted towards increased commercial food consumption and twice-daily feedings compared to a 2003 study. Factors positively associated with overweight were being female (OR = 3.55; 95 % CI: 1.65–8.01; P=0.002), being senior (OR=4.91; 95 % CI: 2.07–12.2; P<0.001) or geriatric (OR=5.81; 95 % CI: 2.04–17.0; P=0.001) and having an owner underestimating dog's body condition (OR=74.1; 95 % CI: 29.8–215; P<0.001). Recognizing the impact of owner perception enables early intervention strategies, such as educating owners during consultations and conducting teaching sessions at the clinic. This proactive approach could contribute to improved health outcomes and help prevent the onset of obesity-related issues in dogs. The new trends in dogs' diets may have global relevance due to the pandemic's widespread impact. Although no immediate impact on overweight is evident, ongoing research is crucial to understand the pandemic's long-term effects.

Introduction

Similar to humans, overweight and obesity are significant health concerns for dogs[1], as they are associated with various health risks and could lead to negative health outcomes. Multiple studies have shown that overweight and obese dogs are more likely to develop several medical conditions, including osteoarthritis[2], cardiovascular disease[3], respiratory disorders[4], and cancer.[5] In addition, obesity is associated with a chronic inflammatory state in dogs[6], which exacerbates negative health outcomes. Obesity and associated comorbidity can lead to a severely affected quality of life[7] and even result in premature death[8].

In other countries, various risk factors for overweight have been identified, which can be broadly classified into five categories: dog-related, owner-related, diet-related, environment-related, and activity-

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[1] Passed away before the completion of this manuscript. We are deeply grateful for his contributions to this work.

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related. Dog-related risk factors have been widely studied, and literature strongly supports the positive association with canine obesity to age[9], female sex[9,10], being neutered[11,12], and certain breeds, such as Retrievers and French bulldogs.[13] Owner-risk factor positively associated with obesity were age[14], low education level[15], and allowing dogs to sleep in owners' beds.[16] Diet-related risk factors include consuming low-cost food[16], leftovers[11], and frequent treats.[12] Environmental risk factors include the presence of multiple individuals in the household[17] and the presence of other animals.[10] Finally, activity-related risk factors include inability to exercise freely[18] and insufficient exercise.[15]

The prevalence of overweight and obesity among dogs in Europe exhibits wide regional variations. For instance, with the same cutoff in body condition score (BCS) for excess body weight (> 5), prevalence rates range from 32 % in dog shows in Sweden[13] to 69 % in vet clinics in the Canary Islands, Spain.[14] Prior to the COVID-19 pandemic (2003), Alfort Veterinary School conducted a study in the canine population, which estimated 38.8 % prevalence of overweight.[19] Given the profound and widespread societal changes influenced by the COVID-19 pandemic, it is pertinent to investigate whether significant alterations have occurred in the prevalence of these conditions.

The COVID-19 pandemic significantly impacted both humans and their pets' daily lives. Changes in exercise habits, increased home-cooking, and more time spent indoors are just a few examples of how the pandemic may have influenced the lifestyle of dogs and their owners.[20,21] Furthermore, the pandemic underscored the significance of the human-dog bond. The companionship of dogs played a pivotal role in diminishing the feeling of isolation and loneliness. During this challenging period, dogs also positively contributed to their owner's overall mental and physical well-being.[22] The increased appreciation for the bond between dogs and humans may have strengthened owners' affection and care for their canine companions. In humans, the pandemic and lockdown have been associated with weight gain.[23,24] Potentially, these factors had the same influence in dogs, since their physical activity[25] and overweight[26,27] are associated with those of their owners.

In regard to the human French population, the prevalence of overweight status has remained stable, while the prevalence of obesity has doubled between 1997 and 2020.[28] As dogs often share owners' lifestyle, an increase in the canine obesity prevalence is expected.[29] The objectives of this study were twofold: to re-evaluate canine overweight prevalence in France and to reassess the risk factors associated with overweight and obesity during the COVID-19 pandemic. Based on the findings of both a twenty-year-old French study[19] and a more recent European study that found associations between age, female gender, and neutering status with overweight dogs[14], the authors anticipate the same factorial association and overweight in the current investigation. Additionally, we expect an increased canine overweight prevalence due to lifestyle changes influenced by the COVID-19 pandemic.

Materials and methods

Data collection

Data were collected using a standardized questionnaire consisting of 88 questions related to the dog's environment, lifestyle, and diet (nn file 1). A previous questionnaire[30] was modified and used during vaccine consultations at Veterinary Teaching Hospitals of Toulouse and Maisons-Alfort, between 2020 and 2022. The survey was completed before engaging with the veterinary staff to minimize bias and potential influence. During the consultation, the veterinarian recorded each dog's body condition score, muscle condition score (MCS), and weight. Only healthy adult dogs (≥ 1 year old) at maintenance were included in the study, as growth, gestation, lactation, and chronic diseases may affect energy requirements.[31] Animals' identifications were checked, and if a dog was presented multiple times, only the first visit was included.

Body condition assessment

The previously validated nine-point scale BCS[32] was employed in this study, to ensure reproducible results in the assessment of body condition. To minimize inter- and intra-observer variability, all participating veterinarians underwent a rigorous training program at their respective veterinary schools. This program consisted of a full day of hands-on training where participants independently scored and discussed the BCS of 30 dogs to achieve consensus scoring agreements. To be consis- tent with existing literature, dogs were considered at ideal weight when BCS was 4–5, overweight at BCS 6–7 and obese at BCS 8–9.[33]

Muscle condition assessment

An attempt to assess muscle condition was made with the use of muscle condition score.[34] Unfortunately, the scores were highly correlated with the veterinary school, indicating poor reproducibility of the tool. Consequently, MCS was not included in the analysis.

Owner's perception

In the questionnaire, dog owners were asked to assess their dogs' body condition using the options of "very skinny," "a bit skinny," "ideal," "a bit fat," or "very fat." For the purpose of this study, the categories of "very skinny" and "a bit skinny" were compared to BCS < 4, "ideal" was compared to BCS of 4–5, "a bit fat" to BCS of 6–7, and "very fat" to BCS of 8–9. Owner's perception was therefore classified into "underestimation," "good estimation" and "overestimation."

Age classification

Dogs were classified by age and weight into three categories: adult, senior, and geriatric, according to their size. Specifically, dogs with an ideal body weight ≥ 22.7 kg were considered senior at 6 to 8 years of age and geriatric at ≥ 9 years of age. While dogs with an ideal body weight < 22.7 kg were considered senior at 7 to 10 years of age and geriatric at ≥ 11 years of age.[35] This method helps to account for the variation in life expectancy across dog's size, with smaller breeds tending to have longer lifespans.[36]

Data analysis

As the number of underweight dogs (n = 5) was too small for meaningful analysis, they were excluded from the statistical analysis aimed at identifying factors associated with weight status. Variables included in the analysis were carefully selected through a comprehensive literature review of overweight in dogs. Explicative variables were all categorical data. The association between each variable and weight status (Ideal vs Excess body weight), was determined by univariate chi-square tests, and variables with a p-value less than 0.25 were selected for multivariate analysis.[37] The chi-square test is a widely used statistical test and was selected for its robustness and versatility in analyzing data from both two-group and multiple-group studies.[38] This double selection (literature review and association with univariate test) helps to mitigate the issue of conducting multiple statistical tests, and allows for the creation of a more interpretable model, highlighting the most important factors associated with the dependent variable. Each pair of explanatory variables was assessed for correlation, and if two variables were highly correlated (chi-square p-value < 0.05), the less associated variable with overweight was excluded. This process was made to avoid multicollinearity issues.[39] One exception was made for the pair "neutering" and "place of food purchase," as neutering is a well-established risk factor for obesity and is more clinically relevant than the place of food purchase.[40] Variables kept at this stage were: dog's age, sex, neutering status, outdoor time, play time, sleeping in owner's bed, treat frequency, and perception of body condition by the owner. Finally, a

multivariable binary logistic regression model was developed using the remaining variables after a stepwise backward elimination process (dog's age, sex, neutering status, sleeping in bed, and owner perception) and model with the lowest Akaike Information Criterion (AIC) was selected. While excluding cases with incomplete data from the prevalence calculation may introduce bias and underestimate the true prevalence of overweight in the population, it was necessary to exclude cases with incomplete data on any of the variables in the model from the multiple logistic regression analysis (n = 23). The area under the Receiver Operating Characteristic (ROC) curve (package pROC) and the Somer's Rank Correlation (Dxy) (package Hmisc) indicator values were used to evaluate the model's predictive ability and performance. All statistical analysis was performed on R 4.2.2.

Results

Dogs

A total of 321 questionnaires were collected from dog owners during their pets' vaccination visit. However, 5 questionnaires were excluded due to being about gestating bitches, 4 had unknown date of birth, and 1 had missing BCS information. As a result, a total of 309 questionnaires were included in the final analysis. Among these, 192 dogs (62 %) came from Maisons-Alfort and 117 (38 %) from Toulouse.

Sex and neutering

The dog population consisted of 158 (51 %) males and 151 (49 %) females. Amongst the total population, 166 (54 %) dogs had been neutered. Of the females, 54 (36 %) were intact and 97 (64 %) were neutered. In contrast, 89 (56 %) of the males were intact, and 69 (44 %) had been neutered (Table 1).

Weight and BCS

Weights of this dog population was not normally distributed. The median weight of all the dogs included in this study was 15.0 [IQR 7.5–26.1] kg. The median weight of male dogs was lower (13.3 [IQR 7.0–29.0] kg) than that of female dogs (15.2 [IQR 7.9–23.2] kg).

The median BCS of the dogs was 5, ranging from 3 (1.6 % of dogs) to 9 (0.6 % of dogs). Based on BCS, 63 % of dogs were classified as having an ideal body condition, while 35.3 % were overweight, including 2.3 % of all dogs classified as obese. A small percentage of dogs (1.7 %) were underweight.

Breeds

Amongst the 309 dogs, 230 (74 %) were purebred. The most common breeds were Jack Russell terrier (7 %), Yorkshire terrier (6 %), and Chihuahua (6 %). According to the International Canine Federation breeds nomenclature, the most common breed groups were group 9 - Companion and toy dogs, comprising 18 % of the sample, followed closely by group 3 - Terriers, which represented 17 % of the sample (Table 1).

Dog's age and owner's age

The age distribution of the dogs was not Gaussian and showed that 50 % of them were between 1 and 4 years old, with a median age of 5 years [IQR 2.5–8.5]. The dogs were further classified into three age categories: 193 adults (62.4 %), 77 seniors (24.9 %), and 39 geriatrics (12.6 %) (Table 1). The most represented age class amongst the owners was 26 to 40 years old, corresponding to 38 % of owners. (Table 2).

Table 1
Dog related factors.

Characteristic	Underweight, N = 5[1]	Ideal, N = 195[1]	Overweight, N = 102[1]	Obese, N = 7[1]
Age (years)	1.5 (1.5, 1.5)	4.0 (2.0, 7.0)	7.0 (4.0, 9.4)	7.5 (5.0, 9.5)
Age category				
Adult	5 (100 %)	138 (71 %)	47 (46 %)	3 (43 %)
Senior	0 (0 %)	39 (20 %)	35 (34 %)	3 (43 %)
Geriatric	0 (0 %)	18 (9.2 %)	20 (20 %)	1 (14 %)
Male	2 (40 %)	115 (59 %)	38 (37 %)	3 (43 %)
Neutered	3 (60 %)	95 (49 %)	63 (62 %)	5 (71 %)
Sex and neutering				
Female	2 (40 %)	30 (15 %)	22 (22 %)	0 (0 %)
Male	0 (0 %)	70 (36 %)	17 (17 %)	2 (29 %)
Neutered female	1 (20 %)	50 (26 %)	42 (41 %)	4 (57 %)
Neutered male	2 (40 %)	45 (23 %)	21 (21 %)	1 (14 %)
Neutering age > 8 m	3 (75 %)	57 (58 %)	39 (63 %)	2 (40 %)
Pure breed	2 (40 %)	142 (75 %)	82 (80 %)	4 (57 %)
Breed group				
1	1 (20 %)	31 (16 %)	12 (12 %)	1 (14 %)
2	0 (0 %)	7 (3.7 %)	4 (3.9 %)	0 (0 %)
3	1 (20 %)	32 (17 %)	19 (19 %)	0 (0 %)
4	0 (0 %)	1 (0.5 %)	1 (1.0 %)	0 (0 %)
5	0 (0 %)	8 (4.2 %)	7 (6.9 %)	0 (0 %)
6	0 (0 %)	4 (2.1 %)	3 (2.9 %)	0 (0 %)
7	0 (0 %)	6 (3.2 %)	0 (0 %)	0 (0 %)
8	0 (0 %)	15 (7.9 %)	11 (11 %)	2 (29 %)
9	0 (0 %)	32 (17 %)	23 (23 %)	1 (14 %)
10	0 (0 %)	2 (1.1 %)	1 (1.0 %)	0 (0 %)
[X]	3 (60 %)	52 (27 %)	21 (21 %)	3 (43 %)
Gready	0 (0 %)	60 (33 %)	31 (34 %)	1 (17 %)

[1] n (%); Median (IQR)

Group 1: Herding Dogs (excluding Swiss Mountain and Cattle Dogs)
Group 2: Pinscher and Schnauzer type dogs - Molossoids - Swiss Mountain and Cattle Dogs and Other Breeds
Group 3: Terriers
Group 4: Dachshunds
Group 5: Spitz type dogs and Primitive type dogs
Group 6: Scenthounds, Bloodhounds, and Related Breeds
Group 7: Pointing Dogs
Group 8: Retrievers - Flushing Dogs - Water Dogs
Group 9: Companion and Toy Dogs
Group 10: Sighthounds
Group X: Cross breeds and breeds not recognized by the International Canine Federation

Home and environment description

The majority of the 309 dogs lived in a household with other people in addition to their owners (244 dogs, 79 %). Furthermore, 56 dogs (18 %) lived with a person over the age of 60 in the household. The most represented owners were people without professional activity (23 %, including 18 % students), followed by employees (20 %), intermediate professionals (17 %), and retired individuals (16 %). In terms of living arrangements, 52 % of the dogs lived in a flat, 47 % lived in a house, and

Table 2
Owners related factors.

Characteristic	Underweight, N = 5[1]	Ideal, N = 195[1]	Overweight, N = 102[1]	Obese, N = 7[1]
Owner age				
18-25	3 (60 %)	68 (35 %)	30 (30 %)	0 (0 %)
26-40	2 (40 %)	74 (39 %)	30 (30 %)	2 (29 %)
41-60	0 (0 %)	22 (11 %)	20 (20 %)	1 (14 %)
>60	0 (0 %)	28 (15 %)	21 (21 %)	4 (57 %)
Owner job category				
Artisan	1 (20 %)	13 (7.1 %)	4 (4.1 %)	0 (0 %)
Executive	1 (20 %)	22 (12 %)	10 (10 %)	0 (0 %)
Employee	1 (20 %)	31 (17 %)	26 (27 %)	2 (29 %)
Farmer	0 (0 %)	1 (0.5 %)	1 (1.0 %)	0 (0 %)
Intermediate	1 (20 %)	28 (15 %)	22 (22 %)	0 (0 %)
Laborer	0 (0 %)	10 (5.4 %)	5 (5.1 %)	0 (0 %)
Retiree	0 (0 %)	25 (14 %)	17 (17 %)	4 (57 %)
Without activity	1 (20 %)	54 (29 %)	13 (13 %)	1 (14 %)
Student owner	1 (20 %)	45 (24 %)	9 (9.2 %)	0 (0 %)
Owner perception				
A_bit_fat	0 (0 %)	14 (7.3 %)	34 (34 %)	6 (86 %)
Optimal	2 (40 %)	168 (88 %)	66 (65 %)	1 (14 %)
Skinny	3 (60 %)	9 (4.7 %)	0 (0 %)	0 (0 %)
Very_fat	0 (0 %)	0 (0 %)	1 (1.0 %)	0 (0 %)
Nb of weighings in a year				
None	0 (0 %)	16 (8.5 %)	11 (11 %)	0 (0 %)
One	1 (20 %)	75 (40 %)	46 (46 %)	4 (57 %)
Several	4 (80 %)	98 (52 %)	43 (43 %)	3 (43 %)
Location of weighings				
Home	2 (40 %)	50 (27 %)	22 (22 %)	2 (29 %)
Never	0 (0 %)	9 (4.8 %)	3 (3.0 %)	0 (0 %)
Vet	3 (60 %)	129 (69 %)	74 (75 %)	5 (71 %)
Regular internal parasite treatment	4 (80 %)	123 (68 %)	48 (49 %)	4 (57 %)

[1] n (%); Median (IQR)

1 % lived in other types of residences. It is noteworthy that more than half of the dogs (53 %) had access to a garden (Table 3).

Activity level

In the study, the dogs' activity level and social life were also evaluated. It was found that 7 % of dogs had less than 30 min of outdoor time on average per day, while 66 % had between 30 min and 2 h, and 27 % had more than 2 h. In terms of off-leash walking, 31 % had less than one hour per week and 28 % had more than six hours. Additionally, 20 % of the dogs were reported to be watchdogs or participate in a sport, such as agility or hunting. Almost half of the dogs (49 %) lived with at least another dog or a cat (Table 4).

Table 3
Environment related factors.

Characteristic	Underweight, N = 5[1]	Ideal, N = 195[1]	Overweight, N = 102[1]	Obese, N = 7[1]
Veterinary hospital				
Maisons-Alfort	2 (40 %)	117 (60 %)	69 (68 %)	4 (57 %)
Toulouse	3 (60 %)	78 (40 %)	33 (32 %)	3 (43 %)
Lives with owner only	0 (0 %)	43 (22 %)	21 (21 %)	1 (14 %)
Lives with children	2 (40 %)	52 (27 %)	29 (28 %)	2 (29 %)
Dwelling				
Flat	0 (0 %)	105 (55 %)	50 (49 %)	3 (43 %)
House	5 (100 %)	83 (44 %)	51 (50 %)	4 (57 %)
Other	0 (0 %)	2 (1.1 %)	1 (1.0 %)	0 (0 %)
Has to walk stairs	3 (60 %)	87 (47 %)	52 (53 %)	4 (57 %)
Outdoor access	5 (100 %)	126 (66 %)	73 (72 %)	5 (71 %)
Outside type				
Balcony	0 (0 %)	29 (22 %)	15 (20 %)	0 (0 %)
Garden	5 (100 %)	98 (75 %)	53 (70 %)	5 (100 %)
Kennel	0 (0 %)	4 (3.1 %)	8 (11 %)	0 (0 %)
Outdoor frequency				
Rarely	1 (20 %)	6 (3.2 %)	3 (3.0 %)	0 (0 %)
Sometimes	0 (0 %)	32 (17 %)	13 (13 %)	4 (57 %)
Once a day	3 (60 %)	36 (19 %)	24 (24 %)	1 (14 %)
Several times a day	1 (20 %)	115 (61 %)	60 (60 %)	2 (29 %)
Outdoor time per day				
< 30 min	0 (0 %)	14 (7.6 %)	6 (6.2 %)	1 (17 %)
0.5–2 h	2 (40 %)	114 (62 %)	74 (76 %)	3 (50 %)
> 2 h	3 (60 %)	57 (31 %)	17 (18 %)	2 (33 %)
Presence of another animal	4 (80 %)	94 (48 %)	49 (48 %)	3 (43 %)
Presence of another dog	2 (40 %)	67 (35 %)	31 (30 %)	1 (14 %)
Presence of cat	4 (80 %)	48 (25 %)	25 (25 %)	2 (29 %)
Sleeping place				
Bedroom	1 (20 %)	63 (45 %)	37 (45 %)	3 (43 %)
Garage	1 (20 %)	4 (2.9 %)	1 (1.2 %)	0 (0 %)
Kitchen	0 (0 %)	4 (2.9 %)	7 (8.4 %)	0 (0 %)
Living room	3 (60 %)	53 (38 %)	28 (34 %)	4 (57 %)
Special place	0 (0 %)	16 (11 %)	10 (12 %)	0 (0 %)
Sleeps outdoor	0 (0 %)	10 (5.3 %)	2 (2.0 %)	0 (0 %)
Fed outdoor	3 (60 %)	21 (12 %)	4 (4.3 %)	0 (0 %)
Sleeps in the bed	1 (20 %)	43 (22 %)	33 (32 %)	3 (43 %)

[1] n (%); Median (IQR)

Diet

The majority of dogs (82 %) were fed an exclusively processed diet, while only a small percentage (3 %) fed homemade diets. Fifteen percent of the dogs were fed a mix of both processed and homemade diets. Interestingly, 44 % of the homemade diets were not calculated by a

Table 4
Activity related factors.

Characteristic	Underweight, N = 5[1]	Ideal, N = 195[1]	Overweight, N = 102[1]	Obese, N = 7[1]
Walks duration in leash (by week)				
< 1h	1 (20 %)	59 (32 %)	33 (33 %)	1 (14 %)
1 - 4h	1 (20 %)	51 (28 %)	21 (21 %)	3 (43 %)
4 - 6h	3 (60 %)	31 (17 %)	24 (24 %)	2 (29 %)
> 6h	0 (0 %)	42 (23 %)	23 (23 %)	1 (14 %)
Walks duration unleashed (by week)				
< 1h	4 (80 %)	51 (27 %)	34 (35 %)	2 (33 %)
1 - 4h	1 (20 %)	46 (25 %)	22 (22 %)	2 (33 %)
4 - 6h	0 (0 %)	29 (16 %)	20 (20 %)	0 (0 %)
> 6h	0 (0 %)	60 (32 %)	22 (22 %)	2 (33 %)
Sport	1 (20 %)	42 (22 %)	18 (18 %)	1 (14 %)
Frequency of play sessions				
Rarely	0 (0 %)	8 (4.4 %)	8 (8.2 %)	0 (0 %)
Sometimes	1 (20 %)	25 (14 %)	23 (24 %)	2 (33 %)
Once a day	2 (40 %)	64 (35 %)	28 (29 %)	2 (33 %)
Several times a day	2 (40 %)	84 (46 %)	38 (39 %)	2 (33 %)
Plays with toys	5 (100 %)	142 (76 %)	75 (75 %)	2 (33 %)

[1] n (%); Median (IQR)

Table 5
Diet related factors.

Characteristic	**Underweight**, N = 5[1]	**Ideal**, N = 195[1]	**Overweight**, N = 102[1]	**Obese**, N = 7[1]
Bowl				
Classic	5 (100 %)	156 (82 %)	86 (86 %)	6 (86 %)
Slow-feed bowl	0 (0 %)	34 (18 %)	13 (13 %)	1 (14 %)
Dispenser	0 (0 %)	0 (0 %)	1 (1.0 %)	0 (0 %)
Diet type				
Industrial	5 (100 %)	165 (86 %)	76 (75 %)	4 (57 %)
Home made	0 (0 %)	4 (2.1 %)	5 (5.0 %)	0 (0 %)
Mix	0 (0 %)	22 (12 %)	20 (20 %)	3 (43 %)
Diet moisture				
Dry	5 (100 %)	165 (90 %)	77 (87 %)	6 (100 %)
Wet	0 (0 %)	5 (2.7 %)	5 (5.6 %)	0 (0 %)
Mix	0 (0 %)	13 (7.1 %)	7 (7.9 %)	0 (0 %)
Food store				
Supermarket	2 (40 %)	30 (17 %)	23 (27 %)	4 (67 %)
Pet shop	1 (20 %)	103 (60 %)	53 (62 %)	2 (33 %)
Vet	2 (40 %)	39 (23 %)	9 (11 %)	0 (0 %)
Diet “light”	0 (0 %)	37 (21 %)	23 (27 %)	1 (17 %)
Grain-free diet	0 (0 %)	13 (7.4 %)	10 (12 %)	0 (0 %)
Vegan diet	0 (0 %)	1 (0.6 %)	0 (0 %)	0 (0 %)
Meals frequency per day				
Once	2 (40 %)	36 (20 %)	22 (25 %)	0 (0 %)
Twice	2 (40 %)	113 (63 %)	49 (56 %)	3 (50 %)
Three to four times	0 (0 %)	6 (3.3 %)	1 (1.1 %)	0 (0 %)
Self-distribution	1 (20 %)	25 (14 %)	16 (18 %)	3 (50 %)
Quantity of food				
Ad libitum	2 (40 %)	41 (23 %)	17 (19 %)	2 (33 %)
Label instructions	1 (20 %)	87 (49 %)	43 (48 %)	2 (33 %)
Vet instructions	2 (40 %)	51 (28 %)	29 (33 %)	2 (33 %)
Method to quantify food				
None	1 (20 %)	45 (24 %)	26 (27 %)	3 (50 %)
Cup	4 (80 %)	124 (67 %)	57 (59 %)	3 (50 %)
Scale	0 (0 %)	16 (9 %)	13 (14 %)	0 (0 %)
Always fed by the same Person	3 (60 %)	62 (34 %)	36 (38 %)	2 (33 %)
Leftovers	2 (40 %)	85 (49 %)	49 (54 %)	5 (83 %)
Rewards	3 (60 %)	139 (77 %)	67 (74 %)	5 (100 %)
Energy by treats (%)	9.0 (3.0, 11.0)	5.0 (1.0, 9.0)	6.0 (3.0, 11.0)	11.0 (7.5, 11.0)

[1] n (%); Median (IQR)

veterinarian, but were recipes provided by the owner. Only two dogs were on a biologically appropriate raw food (BARF) diet, one consuming food prepared by its owner, the other eating a processed preparation purchased in pre-packaged trays. The feeding schedule varied among dogs, with 22 % being fed once a day, 60 % fed twice a day, and 2 % fed 3–4 times a day. Additionally, 16 % of the dogs were fed *ad-libitum*. More than half (59 %) of the food was bought from pet stores, 22 % from supermarkets, and 19 % from veterinary sources. It was found that 51 % of the dogs were fed leftovers, and 76 % received treats. A substantial proportion of dogs (32 %) were considered to eat too fast by their owners, the others were considered to eat “normally” or “slowly” (Table 5).

Veterinary care

In this study, 9 % of owners reported never weighing their dog, while 51 % reported weighing their dog once a year, and 40 % several times a year. Regular deworming is an essential part of preventive care, and 62 % of owners dewormed their dogs at least every 3 months (Table 2). This parameter was chosen as a representation of the level of veterinary care provided by the owners.

Factors associated with overweight

In the univariable analysis, several variables showed a significant association ($p < 0.05$) with a higher prevalence of overweight. These variables included: owner’s age over 40 years, female sex of the dog, neutering status, senior age group, sleeping in owner’s bed, consumption of a mixed diet (canned and dry food), eating food purchased in a supermarket, irregular treatment for internal parasites, frequent consumption of treats, and owner underestimating the dog’s body weight. In addition, variables with a p value lower than 0.25 were selected: elder people in the household, retired people in the household, time outdoor, play frequency, and method of food measurement. The significant results from the univariable analysis ($p < 0.05$) are presented

in Table 6.

After checking multicollinearity and a backwards elimination process, variables included in the binary logistic multivariable analysis were dog's age, sex, neutering status, sleeping in bed, time outdoors and owner's underestimation of dog's body condition. Finally, three variables were significantly associated with overweight: being senior (OR=4.91; 95 % CI: 2.07–12.2) or geriatric (OR=5.81; 95 % CI: 2.04–17.0), being female (OR=3.55; 95 % CI: 1.65–8.01) and having an owner underestimating dog's body condition (OR=74.1; 95 % CI: 29.8–215) (Table 7). The Area under ROC (0.92) indicated a high level of accuracy and the Dxy (0.83) a strong positive correlation between the predicted probability of a dog being overweight and the actual outcome.

Table 7
Results of the multivariate analysis, n = 288.

Variable	N	Odds Ratios	CI	p-value
Age category				
[Senior]	71	4.91	2.07–12.2	**<0.001**
[Geriatric]	38	5.81	2.04–17.0	**0.001**
Sex [Female]	139	3.55	1.65–8.01	**0.002**
Neutered [Yes]	156	2.04	0.93–4.66	0.079
Sleeping in bed [Yes]	78	2.01	0.93–4.42	0.077
Outdoor time [> 2h]	76	0.44	0.16–1.09	0.086
Owner perception				
[Underestimation]	80	74.1	29.8–215	**<0.001**
[Overestimation]	16	0.28	0.01–1.88	0.3

Discussion

This study revealed that 35.3 % of dogs had excess body weight, with 2.3 % of all dogs being obese. In order of importance, variables associated with overweight were found to be underestimation of dog's body condition by the owner, being geriatric, being senior, and being female.

Despite the relatively small sample size of 288 dogs in this study, reliability and robustness of the data collected was ensured by rigorous methodology, using standardized protocols, and validated measurement tools. The inclusion of a comprehensive multivariable analysis allowed for the simultaneous consideration of multiple factors, enabling the identification of independent associations with overweight. Although the study population consisted of dogs presented at veterinary university hospitals, which may not fully represent the general dog and owner population in France, many previous studies on the prevalence and factors associated with overweight in pets have focused on similar hospital-based populations, allowing for comparability.[9,12,19,41] Although causality cannot be established, investigating the variable of owner underestimation in this study holds value for several reasons. This knowledge raises awareness and underscores the importance of education and awareness among dog owners and veterinary professionals. This study also provides useful epidemiological information on the status of French dogs as there is a scarcity of scientific papers on canine nutrition in France. Notably, there has been a significant knowledge gap regarding the overweight and obesity prevalence in the French dog population since Colliard et al.'s study conducted in 2003.[19]

The prevalence of overweight and obesity reported in this study aligns with prevalence rates reported in previous European studies. For instance, a recent study conducted in veterinary practices in Denmark reported a prevalence of 46.6 % for excess body weight (BCS > 5) including 4 % obese (BCS 8–9).[18] In the last study conducted in France under similar conditions in 2003, the prevalence of overweight dogs was 38.8 %, including 5 % classified as obese.[19] Comparing these figures with the dogs of our study only from Maisons-Alfort (38.0 % excess body weight with 2.1 % obesity), overweight and obesity have not increased in almost 20 years, contrary to what it might have been expected.[42] There could be several possible explanations for this stabilization. One possibility is that there has been an increase in awareness and education about the negative health consequences of obesity in dogs, leading to more owners taking steps to manage their pets' weight. Additionally, veterinary professionals may be more proactive in discussing weight management with their clients and providing resources and support for achieving and maintaining a healthy weight. Another factor could be changes in dog food formulations and marketing, with emphasis on weight management.

Consistent with previous literature, age was significantly associated with overweight.[9,14] Here, senior and geriatric dogs had respectively 4.91 and 5.81 times greater odds of being overweight than adults, which is higher than reported in studies from the USA (OR 2.29) and China (OR 1.2)[9,37], but lower than a previous study conducted in France (OR 7.58 for dogs > 7-y-o and 11.75 for dogs > 12-y-o).[19] These findings suggest that the onset of obesity happens later or that senior dogs in France may be at a higher risk of becoming overweight compared to their counterparts in other countries. This may reflect differences in lifestyle, or more specifically different care for older dogs. It is commonly believed that the maintenance energy requirements (MER) of dogs decrease by 25 % as they age.[43] In fact, a study showed that a more accurate prediction of MER in dogs can be achieved by using an equation that incorporates the multiplication of metabolic weight by the exponent of age in years raised to the power of -0.05.[44] The progressive decline of MER with age is supported by the higher odds ratio observed for geriatric dogs compared to senior dogs in this study. Therefore, it is recommended to regularly weigh dogs from a young age to establish baseline weights and adjust their caloric intake as they age.[19]

The association between female dogs and overweight in this study was consistent with previous literature.[41,45] Here, the odds of being overweight for female dogs were 3.55 times greater than for males. This odds ratio is higher than those reported in current literature, which ranges from 1.1 to 2.45.[9,10] This association between female sex and overweight could be due to a lower basal metabolic rate or an increased food intake influenced by estrogen.[10] There are differences in body fat distribution between the sexes, with female dogs tending to deposit fat subcutaneously while male dogs tend to deposit fat viscerally. This could lead to biased estimates of body condition scores, which rely on visual and tactile assessment.[9]

Although spaying and neutering have been widely reported as risk factors for excess weight[19,46], this study did not find a significant association between neutering status and overweight in dogs. A tendency towards significance was shown in the multivariate analysis (p = 0.079), which suggests that further investigation with a larger sample size may be warranted. It is possible that the effect of neutering on overweight was masked by confounding factors, which is unlikely as multicollinearity between explanatory variables was checked. Another explanation for this finding is that given the well-established association

Table 6
Results of the univariate analysis, only significant variables shown.

Variable	Ideal, N = 195[1]	Overweight, N = 109[1]	p-value
Sex: Male	115 (59 %)	41 (38 %)	<0.001
Neutered	95 (49 %)	68 (62 %)	0.022
Age category			0.005
Adult	138 (71 %)	50 (46 %)	<0.001
Senior	39 (20 %)	38 (35 %)	
Geriatric	18 (9.2 %)	21 (19 %)	
Owner age > 40	50 (26 %)	46 (43 %)	0.003
Regular internal parasites treatment	123 (68 %)	52 (50 %)	0.003
Sleeping in bed	43 (22 %)	36 (33 %)	0.036
Diet type			0.026
Industrial	165 (86 %)	80 (74 %)	
Home made	4 (2.1 %)	5 (4.6 %)	
Mix	22 (12 %)	23 (21 %)	
Food store			0.009
Supermarket	30 (17 %)	27 (30 %)	
Pet shop	103 (60 %)	55 (60 %)	
Vet	39 (23 %)	9 (9.9 %)	

between neutering and excess weight in dogs, veterinarians and pet food manufacturers have placed significant emphasis on owner education and product formulations to prevent overweight in this at-risk population.

The factor with the strongest association with overweight in dogs is the underestimation of the dog's body condition, with dogs whose owners underestimate having 74.1 times higher odds of being overweight. This finding, supporting that owners of overweight dogs commonly underestimate their dogs' BCS, aligns with previous literature.[47,48] It is also consistent with studies conducted in cats, which highlight the significant impact of owner perception, although the odds ratios in previous cat studies were lower (10.41).[49] When owners are not aware of their pet's overweight status, they are less likely to initiate weight loss interventions and monitor risk factors. In a study on cats, it was found that most owners reported not being informed by their veterinarian about their pet's overweight condition.[50] Effective client education plays a crucial role in addressing pet overweight issues, and it is essential for veterinarians to educate owners on accurately assessing their pet's weight status. As professionals, it is the duty of veterinarians to provide informed consent.[51] Regularly recording body condition score and body weight at each visit, and monitoring weight trends should be part of every consultation, and owners should pay for this extra-time.[51] Ultimately, improving the quality of life for pets and reducing healthcare expenditures make this money investment invaluable.[51] Low confidence levels among owners interested in changing their dog's weight are linked to program discontinuation, highlighting the importance of a confident team that can provide nutrition advice.[52]

Remarkably, this study underlined a significant shift in dietary practices for dogs during COVID-19 pandemic. The consumption of only commercially manufactured dog food surged from 37.5 % in the pre-pandemic study conducted in France[19] to 82 % in this investigation, while the prevalence of homemade dog food plummeted from 14.1 % to a mere 3 %. This trend is noteworthy, particularly considering that one might have anticipated an increase in homemade dog food given the surge in home cooking among humans during the pandemic.[20] Equally intriguing is the transformation in feeding frequency, with twice-daily feedings surging from 30.8 % to 60 %, while the tradition of feeding dogs once a day dwindled from 45.6 % to 22 %. This shift in feeding patterns may be attributed to the increased availability of owners to provide meals, possibly due to the rise in sedentary lifestyle[21] or the rise of awareness about the risk of stomach dilatation associated with large volume meals.[53] Furthermore, it is notable that the demographic composition of dog owners seeking veterinary consultations remained relatively constant, with retirees comprising 16 % compared to 18.7 % in the previous study. This suggests that the pandemic did not deter elderly individuals from seeking veterinary care for their dogs, contrary to expectations that they might be more cautious about venturing out during this public health crisis.[54]

Conclusion

Despite some limitations, this study provides valuable insights into the prevalence of overweight and obesity in dogs presented to university veterinary hospitals in France during COVID-19 pandemic. The findings reveal that 35.3 % of these dogs were affected by excess body weight, including 2.3 % of all dogs being obese, indicating consistent prevalences over nearly two decades. The most significant factor associated with overweight in dogs was the underestimation of their condition by the owners. Educating owners about the importance of recognizing signs of overweight in their dogs and raising awareness about the associated risks is paramount, and it is the duty of veterinarians. The absence of small animal obesity clinics in France underscores the need for specialized services. By providing dedicated resources and interventions, veterinarians can contribute significantly to reducing the prevalence of pet obesity, improving the overall health of animals, and upholding their right to a healthy and fulfilling life. From pre-pandemic to the pandemic period, a noticeable shift in dietary habits was identified, marked by an increase in the consumption of exclusively commercial food and a majority of dogs now being fed two meals a day. It would be interesting to know if these shifts are observed in other countries. While no immediate impact on excessive body weight has been observed, continued monitoring and research over time are essential to ascertain the long-term effects of the pandemic.

Declaration of competing interest

Marco Fantinati works for the companion animals' pet food industry. This work was neither funded nor part of his work for the industry. The author has no conflict of interest.

Other authors have no conflict of interest to declare.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.tcam.2024.100875.

References

1. De Lorenzo A, Gratteri S, Gualtieri P, Cammarano A, Bertucci P, Di Renzo L. Why primary obesity is a disease? *J Transl Med*. 2019;17:169. https://doi.org/10.1186/s12967-019-1919-y.
2. Budsberg SC, Bartges JW. Nutrition and osteoarthritis in dogs: does it help? *Vet Clin N Am Small Anim Pract*. 2006;36:1307–1323. https://doi.org/10.1016/j.cvsm.2006.08.007.
3. Partington C, Hodgkiss-Geere H, Woods GRT, Dukes-McEwan J, Flanagan J, Biourge V, et al. The effect of obesity and subsequent weight reduction on cardiac structure and function in dogs. *BMC Vet Res*. 2022;18:351. https://doi.org/10.1186/s12917-022-03449-4.
4. Chandler ML. Impact of obesity on cardiopulmonary disease. *Vet Clin North Am Small Anim Pract*. 2016;46:817–830. https://doi.org/10.1016/j.cvsm.2016.04.005.
5. Glickman LT, Schofer FS, McKee LJ, Reif JS, Goldschmidt MH. Epidemiologic study of insecticide exposures, obesity, and risk of bladder cancer in household dogs. *J Toxicol Environ Health*. 1989;28:407–414. https://doi.org/10.1080/15287398909531360.
6. German AJ, Ryan VH, German AC, Wood IS, Trayhurn P. Obesity, its associated disorders and the role of inflammatory adipokines in companion animals. *Vet J*. 2010;185:4–9. https://doi.org/10.1016/j.tvjl.2010.04.004.
7. German AJ, Holden SL, Wiseman-Orr ML, Reid J, Nolan AM, Biourge V, et al. Quality of life is reduced in obese dogs but improves after successful weight loss. *Vet J*. 2012;192:428–434. https://doi.org/10.1016/j.tvjl.2011.09.015.
8. Salt C, Morris PJ, Wilson D, Lund EM, German AJ. Association between life span and body condition in neutered client-owned dogs. *J Vet Intern Med*. 2019;33:89–99. https://doi.org/10.1111/jvim.15367.
9. Chiang C-F, Villaverde C, Chang W-C, Fascetti AJ, Prevalence LJA. Risk Factors, and Disease Associations of Overweight and Obesity in Dogs that Visited the Veterinary Medical Teaching Hospital at the University of California, Davis from January 2006 to December 2015. *Top Companion Anim Med*. 2022;48, 100640. https://doi.org/10.1016/j.tcam.2022.100640.
10. Porsani MYH, Teixeira FA, Oliveira VV, Pedrinelli V, Dias RA, German AJ, et al. Prevalence of canine obesity in the city of S˜ao Paulo. *Brazil. Sci Rep*. 2020;10:14082. https://doi.org/10.1038/s41598-020-70937-8.
11. Courcier EA, Thomson RM, Mellor DJ, Yam PS. An epidemiological study of environmental factors associated with canine obesity. *J Small Anim Pract*. 2010;51:362–367. https://doi.org/10.1111/j.1748-5827.2010.00933.x.
12. Lund E, Armstrong J, Kirk C, Klausner JS. Prevalence and risk factors for obesity in adult dogs from private US veterinary practices. *Intern J Appl Res Vet Med*. 2006;4:177–186.

13. Lindåse S, Feltenmark T, Krantz M, So¨der J. Overweight in Swedish show dogs–prevalence and association with performance in competition. *Acta Vet Scand*. 2021;63:17. https://doi.org/10.1186/s13028-021-00582-2.
14. Suarez L, Bautista-Castan˜o I, Pen˜a Romera C, Montoya-Alonso JA, Corbera JA. Is Dog Owner Obesity a Risk Factor for Canine Obesity? A "One-Health" Study on Human-Animal Interaction in a Region with a High Prevalence of Obesity. *Vet Sci*. 2022;9:243. https://doi.org/10.3390/vetsci9050243.
15. Herwijnen IR, Corbee RJ, Endenburg N, Beerda B, Borg JAM. Permissive parenting of the dog associates with dog overweight in a survey among 2,303 Dutch dog owners. *PLoS One*. 2020;15, e0237429. https://doi.org/10.1371/journal.pone.0237429.
16. Kienzle E, Bergler R, Mandernach A. A comparison of the feeding behavior and the human-animal relationship in owners of normal and obese dogs. *J Nutr*. 1998;128: 2779S–2782S. https://doi.org/10.1093/jn/128.12.2779S.
17. Bland I, Guthrie-Jones A, Taylor R, Hill J. Dog obesity: owner attitudes and behaviour. *Prev Vet Med*. 2009;92. https://doi.org/10.1016/j.prevetmed.2009.08.016.
18. Bjornvad C, Gloor S, Johansen SS, Sandøe P, Lund T. Neutering increases the risk of obesity in male dogs but not in bitches- A cross-sectional study of dog- and owner-related risk factors for obesity in Danish companion dogs. *Prev Vet Med*. 2019;170, 104730. https://doi.org/10.1016/j.prevetmed.2019.104730.
19. Colliard L, Ancel J, Benet J-J, Paragon B-M, Blanchard G. Risk Factors for Obesity in Dogs in France. *J Nutr*. 2006;136:1951S–1954S. https://doi.org/10.1093/jn/136.7.1951S.
20. Balanza´-Martínez V, Kapczinski F, de Azevedo Cardoso T, Atienza-Carbonell B, Rosa AR, Mota JC, et al. The assessment of lifestyle changes during the COVID-19 pandemic using a multidimensional scale. *Rev Psiquiatr Salud Ment (Engl Ed)*. 2021; 14:16–26. https://doi.org/10.1016/j.rpsm.2020.07.003.
21. Romero-Blanco C, Rodríguez-Almagro J, Onieva-Zafra MD, Parra-Fern´andez ML, Prado-Laguna MDC, Hern´andez-Martínez A. Physical Activity and Sedentary Lifestyle in University Students: Changes during Confinement Due to the COVID-19 Pandemic. *Int J Environ Res Public Health*. 2020;17:6567. https://doi.org/10.3390/ijerph17186567.
22. Bussolari C, Currin-McCulloch J, Packman W, Kogan L, Erdman P. I Couldn't Have Asked for a Better Quarantine Partner!": Experiences with Companion Dogs during Covid-19. *Animals*. 2021;11:330. https://doi.org/10.3390/ani11020330.
23. Androutsos O, Perperidi M, Georgiou C, Chouliaras G. Lifestyle Changes and Determinants of Children's and Adolescents' Body Weight Increase during the First COVID-19 Lockdown in Greece: The COV-EAT Study. *Nutrients*. 2021;13:930. https://doi.org/10.3390/nu13030930.
24. Di Renzo L, Gualtieri P, Pivari F, Soldati L, Attina` A, Cinelli G, et al. Eating habits and lifestyle changes during COVID-19 lockdown: an Italian survey. *J Transl Med*. 2020;18:229. https://doi.org/10.1186/s12967-020-02399-5.
25. Lee H, Collins D, Creevy KE, Promislow DEL. Dog Aging Project Consortium. Age and Physical Activity Levels in Companion Dogs: Results From the Dog Aging Project. *J Gerontol A Biol Sci Med Sci*. 2022;77:1986–1993. https://doi.org/10.1093/gerona/glac099.
26. Linder DE, Santiago S, Halbreich ED. Is there a correlation between dog obesity and human obesity? preliminary findings of overweight status among dog owners and their dogs. *Front Vet Sci*. 2021;8, 654617. https://doi.org/10.3389/fvets.2021.654617.
27. Nijland ML, Stam F, Seidell JC. Overweight in dogs, but not in cats, is related to overweight in their owners. *Public Health Nutr*. 2010;13:102–106. https://doi.org/10.1017/S136898000999022X.
28. Fontbonne A, Currie A, Tounian P, Picot M-C, Foulatier O, Nedelcu M, et al. Prevalence of overweight and obesity in France: the 2020 Obepi-Roche study by the "Ligue Contre l'ob´esite´. *J Clin Med*. 2023;12. https://doi.org/10.3390/jcm12030925.
29. Chandler M, Cunningham S, Lund EM, Khanna C, Naramore R, Patel A, et al. Obesity and associated comorbidities in people and companion animals: a one health perspective. *J Comp Pathol*. 2017;156:296–309. https://doi.org/10.1016/j.jcpa.2017.03.006.
30. Hoummady S, Fantinati M, Maso D, et al. Comparison of canine owner profile according to food choice: an online preliminary survey in france. *BMC Vet. Res.* 2022;18:163. https://doi.org/10.1186/s12917-022-03258-9.
31. N R C (U.S.). *Nutrient requirements of dogs and cats*. editor.. Washington, D.C: National Academies Press; 2006. . Rev
32. Laflamme D. Development and validation of a body condition score system for dogs. *Canine Pract*. 1997 (Santa Barbara, Calif : 1990) (USA).
33. Brooks D, Churchill J, Fein K, Linder D, Michel KE, Tudor K, et al. 2014 AAHA weight management guidelines for dogs and cats*ψ. *J Am Anim Hosp Assoc*. 2014;50: 1–11. https://doi.org/10.5326/JAAHA-MS-6331.
34. WSAVA Nutritional Assessment Guidelines Task Force Members, Freeman L, Becvarova I, Cave N, MacKay C, Nguyen P, et al. WSAVA nutritional assessment guidelines. *J Small Anim Pract*. 2011;52:385–396. https://doi.org/10.1111/j.1748-5827.2011.01079.x.
35. Bellows J, Colitz CMH, Daristotle L, Ingram DK, Lepine A, Marks SL, et al. Defining healthy aging in older dogs and differentiating healthy aging from disease. *JAVMA*. 2015;246:77–89. https://doi.org/10.2460/javma.246.1.77.
36. Teng KT, Brodbelt DC, Pegram C, Church DB, O'Neill DG. Life tables of annual life expectancy and mortality for companion dogs in the United Kingdom. *Sci Rep*. 2022; 12:6415. https://doi.org/10.1038/s41598-022-10341-6.
37. Mao J, Xia Z, Chen J, Yu J. Prevalence and risk factors for canine obesity surveyed in veterinary practices in Beijing, China. *Prev Vet Med*. 2013;112:438–442. https://doi.org/10.1016/j.prevetmed.2013.08.012.
38. McHugh ML. The chi-square test of independence. *Biochem Med*. 2013;23:143–149. https://doi.org/10.11613/bm.2013.018 (Zagreb).
39. Stoltzfus JC. Logistic regression: a brief primer. *Acad Emerg Med*. 2011;18: 1099–1104. https://doi.org/10.1111/j.1553-2712.2011.01185.x.
40. German AJ. The growing problem of obesity in dogs and cats. *J Nutr*. 2006;136: 1940S–1946S. https://doi.org/10.1093/jn/136.7.1940S.
41. McGreevy PD, Thomson PC, Pride C, Fawcett A, Grassi T, Jones B. Prevalence of obesity in dogs examined by Australian veterinary practices and the risk factors involved. *Vet Rec*. 2005;156:695–702. https://doi.org/10.1136/vr.156.22.695.
42. Bomberg E, Birch L, Endenburg N, German AJ, Neilson J, Seligman H, et al. The financial costs, behaviour and psychology of obesity: a one health analysis. *J Comp Pathol*. 2017;156:310–325. https://doi.org/10.1016/j.jcpa.2017.03.007.
43. Laflamme DP, Martineau B, Jones W, Wilson R, Jones J. Effect of age on maintenance energy requirements and apparent digestibility of canine diets. *Compend Contin Educ Pract Vet*. 2000;22:113.
44. Divol G, Priymenko N. A new model for evaluating maintenance energy requirements in dogs: allometric equation from 319 pet dogs. *J Nutr Sci*. 2017;6:e53. https://doi.org/10.1017/jns.2017.50.
45. Sallander M, Hagberg M, Hedhammar A, Rundgren M, Lindberg JE. Energy-intake and activity risk factors for owner-perceived obesity in a defined population of Swedish dogs. *Prev Vet Med*. 2010;96:132–141. https://doi.org/10.1016/j.prevetmed.2010.05.004.
46. Pegram C, Raffan E, White E, Ashworth AH, Brodbelt DC, Church DB, et al. Frequency, breed predisposition and demographic risk factors for overweight status in dogs in the UK. *J Small Anim Pract*. 2021;62:521–530. https://doi.org/10.1111/jsap.13325.
47. Webb TL, du Plessis H, Christian H, Raffan E, Rohlf V, White GA. Understanding obesity among companion dogs: New measures of owner's beliefs and behaviour and associations with body condition scores. *Prev Vet Med*. 2020;180, 105029. https://doi.org/10.1016/j.prevetmed.2020.105029.
48. White GA, Hobson-West P, Cobb K, Craigon J, Hammond R, Millar KM. Canine obesity: is there a difference between veterinarian and owner perception? *J Small Anim Pract*. 2011;52:622–626. https://doi.org/10.1111/j.1748-5827.2011.01138.x.
49. Colliard L, Paragon B-M, Lemuet B, B´enet J-J, Blanchard G. Prevalence and risk factors of obesity in an urban population of healthy cats. *J Feline Med Surg*. 2009;11: 135–140. https://doi.org/10.1016/j.jfms.2008.07.002.
50. Arena L, Menchetti L, Diverio S, Guardini G, Gazzano A, Mariti C. Overweight in domestic cats living in urban areas of italy: risk factors for an emerging welfare issue. *Animals*. 2021;11:2246. https://doi.org/10.3390/ani11082246 (Basel).
51. Kipperman BS, German AJ. The responsibility of veterinarians to address companion animal obesity. *Animals*. 2018;8:143. https://doi.org/10.3390/ani8090143 (Basel).
52. Sutherland KA, Coe JB, O'Sullivan TL. Assessing owners' readiness to change their behaviour to address their companion animal's obesity. *Vet Rec*. 2023;192:e1979. https://doi.org/10.1002/vetr.1979.
53. Raghavan M, Glickman N, McCabe G, Lantz G, Glickman LT. Diet-related risk factors for gastric dilatation-volvulus in dogs of high-risk breeds. *J Am Anim Hosp Assoc*. 2004;40:192–203. https://doi.org/10.5326/0400192.
54. MacLeod S, Tkatch R, Kraemer S, Fellows A, McGinn M, Schaeffer J, et al. COVID-19 era social isolation among older adults. *Geriatrics*. 2021;6. https://doi.org/10.3390/geriatrics6020052.

CHAPTER 4

DISCUSSION

The present thesis explored the complex interplay between owner-related, environmental, and nutritional factors shaping the health and body condition of companion animals, gathering insights from French canine pet-owners. Across the three studies, the work aimed to characterize the "pet-parent" modern profile focusing on lifestyle, pet dietary choices, and the perception of body condition, to assess prevalence and determinants of overweight and obesity in dogs. Together, these studies contribute to a better understanding of how human attitudes, lifestyles, and beliefs directly affect pet nutrition and health, providing actionable insights for veterinary practice and preventive medicine.

The first study from 2022 revealed that pet-owners choosing non-conventional diets (NCD), such as BARF or homemade feeding, present distinct sociodemographic and behavioral characteristics compared with those using conventional diets (CD). NCD owners were more often younger, childless, and living outside large urban areas (i.e., Paris metropolitan area). They tended to walk their dogs more frequently and allow greater off-leash time, but they also dewormed less and sought nutritional information mainly online rather than from veterinarians. These findings emphasize a dual trend: while NCD owners appear to express greater attention to their dogs' ethological and environmental needs, they simultaneously exhibit reduced adherence to professional veterinary recommendations. This duality suggests a shift in the human-pet relationship, where autonomy and distrust toward professional figures coexist with a strong emotional bond and a quest for "natural". For veterinarians, this underlines the importance of tailored communication strategies and renewed trust-building efforts, particularly in nutrition counselling.

The second study from 2023 extended this exploration by analyzing how owners perceive their pets' body condition. The results demonstrated that approximately one-third of pet-owners underestimated their pet's body condition, a misperception particularly prevalent among overweight animals and owners with children. The presence of children in the household emerged as a consistent factor associated with underestimation in both dogs and cats, possibly reflecting the "normalization" of excess weight within family environments. The introduction of visual scales improved owners' accuracy but did not fully correct misperceptions, highlighting the need for enhanced educational tools. These findings reinforce that owner perception constitutes a critical barrier to effective obesity prevention. Misjudgment of body condition limits the likelihood of owners recognizing the problem and seeking veterinary guidance. Therefore, improving awareness

and visual literacy in pet body condition assessment should be a cornerstone of veterinary preventive medicine strategies.

The third study from 2024 quantified the prevalence of overweight and obesity in dogs attending French university veterinary hospitals. Approximately 35% of dogs were overweight, including 2% classified as obese. Risk factors positively associated with overweight were: female sex, senior and geriatric age, and owner underestimation of body condition. The latter emphasizes previous results on the importance of body condition awareness in pet health outcomes.

Viewed collectively, these studies outline a coherent narrative linking human lifestyle, beliefs, and perception to the nutritional health of companion animals. Owner demographics, values, and access to professional guidance jointly shape feeding choices, while perceptual biases determine how effectively weight-related problems are recognized and addressed. The work also highlights the cultural and societal dynamics underpinning these factors, such as growing anthropomorphism, the "natural" feeding movement, and the impact of digital information channels on veterinary communication. Moreover, the findings underscore that dogs' health status mirrors broader human lifestyle patterns, reinforcing the pertinence of a One Health perspective integrating human, animal, and environmental well-being previously described in other studies [9].

From a practical standpoint, this thesis underscores the central role of veterinarians not only as medical advisors but also as educators and communicators in an increasingly complex information landscape. There is a clear need for targeted interventions: Developing educational programs and visual tools to help owners better recognize overweight conditions. Enhancing veterinary curricula in nutrition and behavioral counselling to strengthen confidence and client trust. Promoting multidisciplinary "One Health" initiatives addressing shared determinants of obesity in humans and animals. Encouraging future research on digital communication strategies and social determinants influencing pet feeding choices.

In this moderna era of pet animal nutrition, under the science that should drive every decision, lies the power of "marketing". Nowadays, two distinguished concepts are driving the pet food market: humanization and anthropomorphism. Pet humanization, reflects how modern pet-owners increasingly treat animals as family members and seek pet foods that mirror human dietary trends (e.g., organic, non-GMO, gluten-free, or featuring superfoods such as quinoa or kale), thus driving the premiumization of pet food products. The second, anthropomorphism, refers to attributing human emotions, intentions and behaviors to pets: an approach leveraged in marketing through

imagery and narratives that show pets “smiling” or behaving like humans, thereby fostering emotional bonds with brands. While both trends can be beneficial in meeting consumer demands, they require distinct strategies: humanization demands ingredient transparency, health-benefit messaging and ethical sourcing, whereas anthropomorphism requires emotionally resonant branding without misrepresenting animal needs and behaviors. By clearly distinguishing these two concepts, pet-food manufacturers and marketers can more effectively align product formulation and messaging with evolving pet-owner values and expectations.

When integrated, the three studies describe a coherent pathway linking owner values and lifestyles to feeding decisions, perceptual biases, and ultimately canine overweight. Feeding practices influenced by humanization, anthropomorphism, and marketing narratives shape nutritional input, while owner misperception delays recognition of unhealthy weight gain and reduces the likelihood of corrective action. These dynamics are further amplified by digital information ecosystems, which increasingly compete with veterinary expertise and reshape how owners interpret nutritional health. In this context, canine obesity emerges as a socially mediated condition, reflecting broader human attitudes toward food, health, and care.

The findings also align with a One Health perspective, emphasizing that companion animal health mirrors human lifestyle patterns and societal trends. The normalization of excess weight, the valorization of “natural” foods without scientific validation, and the erosion of trust in professional guidance are phenomena shared across human and animal health domains [10, 11]. Addressing obesity in pets therefore requires interventions that extend beyond the individual animal to encompass owner education, communication strategies, and societal awareness [12].

From a clinical and educational standpoint, this thesis highlights the evolving role of veterinarians as not only medical experts but also communicators, educators, and mediators between science and consumer culture. Tailored communication strategies, enhanced nutritional education within veterinary curricula, and the development of intuitive, evidence-based assessment tools are essential to rebuild trust and support preventive care. Furthermore, interdisciplinary approaches integrating veterinary science, behavioral science, and public health may be necessary to effectively address the shared determinants of obesity in humans and animals[13].

Finally, the discussion of pet food marketing underscores the need to clearly distinguish between humanization and anthropomorphism in both industry practices and veterinary discourse [14]. While humanization reflects owner concern and demand for transparency and quality, anthropomorphism risks distorting biological realities when human emotions and values are

projected onto animals with distinct nutritional requirements. Recognizing and addressing this distinction is crucial to ensuring that evolving market trends support, rather than undermine, animal health.

CONCLUSION

In conclusion, this thesis provides an integrative view of the behavioral and perceptual dimensions underpinning pet nutrition and obesity in the sampled Franch population. It shows that canine overweight and obesity cannot be understood solely as biological phenomena but as outcomes of intertwined human-pet interactions shaped by social context, lifestyle, and beliefs. By bridging epidemiological data, owner psychology, and veterinary practice, this work contributes to advancing a more holistic, preventive approach to companion animal health, embracing the One Health paradigm linking humans and their animals in shared well-being.

This thesis demonstrates that overweight and obesity in companion animals are not isolated medical conditions but complex outcomes arising from intertwined human–animal interactions shaped by lifestyle, perception, and sociocultural context.

The findings emphasize that effective prevention of canine overweight requires early recognition, evidence-based feeding practices, and strong veterinarian–client partnerships grounded in trust and communication. By situating companion animal obesity within a broader One Health framework, this thesis reinforces the interconnectedness of human and animal well-being and highlights the need for preventive strategies that address shared behavioral and societal determinants. Ultimately, aligning scientific knowledge with evolving owner expectations represents both a challenge and an opportunity for veterinary medicine in the modern era.

BIBLIOGRAPHY

1. Bouma EMC, Dijkstra A, Arnt Rosa S. Owner's Anthropomorphic Perceptions of Cats' and Dogs' Abilities Are Related to the Social Role of Pets, Owners' Relationship Behaviors, and Social Support. Animals. 2023;13:3644. https://doi.org/10.3390/ani13233644.

2. Forbes SL. Pet Humanisation: What is it and Does it Influence Purchasing Behaviour? Journal of Dairy & Veterinary Sciences. 2018;5. https://doi.org/10.19080/JDVS.2018.05.555659.

3. Gmeiner MW, Gschwandtner A. The Value of Pets: The Quantifiable Impact of Pets on Life Satisfaction. Soc Indic Res. 2025;178:185–223. https://doi.org/10.1007/s11205-025-03574-1.

4. Zhao J, Koohsari MJ, Li J, Luo Y, Kaczynski AT, McCormack GR, et al. Beyond companionship: psycho-social benefits of pet ownership. BMC Public Health 2025 25:1. 2025;25:2320-. https://doi.org/10.1186/S12889-025-23464-Y.

5. Barcelos AM, Kargas N, Assheton P, Maltby J, Hall S, Mills DS. Dog owner mental health is associated with dog behavioural problems, dog care and dog-facilitated social interaction: a prospective cohort study. Sci Rep. 2023;13:21734. https://doi.org/10.1038/s41598-023-48731-z.

6. Viana LM, Mothé CG, Mothé MG. Natural food for domestic animals: A national and international technological review. Res Vet Sci. 2020;130:11–8. https://doi.org/10.1016/j.rvsc.2020.02.008.

7. Schleicher M, Cash SB, Freeman LM. Determinants of pet food purchasing decisions. The Canadian Veterinary Journal. 2019;60:644.

8. Ai C, Akaichi F, Glenk K, Revoredo-Giha C, Costa-Font M. What Drives Pet Food Choices? A Systematic Literature Review. Animals. 2025;15:3235. https://doi.org/10.3390/ani15223235.

9. Suarez L, Bautista-Castaño I, Romera CP, Montoya-Alonso JA, Corbera JA. Is Dog Owner Obesity a Risk Factor for Canine Obesity? A "One-Health" Study on Human–Animal Interaction in a Region with a High Prevalence of Obesity. Veterinary Sciences 2022, Vol 9, Page 243. 2022;9:243. https://doi.org/10.3390/VETSCI9050243.

10. Webb TL, du Plessis H, Christian H, Raffan E, Rohlf V, White GA. Understanding obesity among companion dogs: New measures of owner's beliefs and behaviour and associations with body condition scores. Prev Vet Med. 2020;180:105029. https://doi.org/10.1016/J.PREVETMED.2020.105029.

11. Kluess HA, Jones RL. A comparison of owner perceived and measured body condition, feeding and exercise in sport and pet dogs. Front Vet Sci. 2023;10. https://doi.org/10.3389/FVETS.2023.1211996.

12. Muñoz-Prieto A, Nielsen LR, Dąbrowski R, Bjørnvad CR, Söder J, Lamy E, et al. European dog owner perceptions of obesity and factors associated with human and canine obesity. Sci Rep. 2018;8. https://doi.org/10.1038/S41598-018-31532-0.

13. Sutherland KA, Coe JB, Janke N, O'Sullivan TL, Parr JM. Pet owners' and companion animal veterinarians' perceptions of weight-related veterinarian-client communication. J Am Vet Med Assoc. 2022;260:1697–703. https://doi.org/10.2460/JAVMA.22.03.0101.

14. Mota-Rojas D, Mariti C, Zdeinert A, Riggio G, Mora-Medina P, Reyes ADM, et al. Anthropomorphism and Its Adverse Effects on the Distress and Welfare of Companion Animals. Animals 2021, Vol 11, Page 3263. 2021;11:3263. https://doi.org/10.3390/ANI11113263.