

Survey of Opinions About Nutritional Requirements of Senior Dogs and Analysis of Nutrient Profiles of Commercially Available Diets for Senior Dogs

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ABSTRACT

A survey containing questions regarding respondents' background, dog ownership, and opinions regarding senior dogs' nutritional requirements was completed online by 1309 adults. Average nutrient analysis for calories, protein, fat, fiber, sodium, and phosphorus for senior canine diets also was obtained to determine whether respondent perceptions were consistent with actual profiles. Of respondents who owned a senior dog, 42.8% fed a senior diet. However, only 33.1% of these fed a senior diet based on a veterinarian's recommendation. From the options provided, 63% of respondents reported that ingredients were the most important factor in choosing a senior dog food. Most respondents answered that senior dogs have different nutritional needs than adults and that senior diets were lower in calories, fat, sodium, protein, and carbohydrates. Comparison of 37 commercial senior diets revealed wide variation in nutrient profiles which were not consistent with respondents'

opinions for all nutrients evaluated. These results highlight discrepancies between perceived needs of senior dogs and actual diet composition.

INTRODUCTION

Nutrition plays an important role in the health of elderly people and animals. In people, it is known that nutrient requirements change with aging. Animals have higher requirements for some nutrients and lower requirements for others.¹ As a result of the changes in nutrient requirements with aging, Daily Recommended Intakes (DRI) have separate age categories for people 51-70 years and >70 years.² Alterations in body weight, both weight gain and weight loss, also are especially common in aging people, with accompanying changes in individual body compartments.³ These changes may be the result of a variety of factors, such as reductions in energy requirements associated with aging, reduced food intake, and concurrent disease.⁴⁻⁷ More importantly, there is an age-related loss of lean body mass in people, termed sarcopenia, that is associated with increased mortality compared to those with

no sarcopenia.⁸⁻¹¹ The recognition of the value of maintaining optimal body weight and adequate muscle mass with age has led to research and programs involving diet and exercise aimed at preserving lean body mass.

Although it is anecdotally speculated that many aspects of human aging are similar in dogs and that their nutritional needs also change with age. There are few studies investigating this issue. Some studies have suggested that loss of lean body mass may also occur in dogs,¹²⁻¹⁴ but more research is needed. There is at least one study documenting increased digestibility in senior dogs compared to younger adult dogs,¹⁵ although another study found no difference in digestibility between young adult and senior dogs.¹⁶ However, little research has been published evaluating nutrient requirements in senior dogs. The Association of American Feed Control Officials (AAFCO), and the National Research Council (NRC) currently has no specific nutrient profiles for senior dogs and the recommended minimums (for AAFCO) or minimal requirements (for NRC) for senior dogs are based on minimum levels for adult dogs.^{17,18} For example, using the AAFCO nutrient profiles, the minimum protein level is 51 gm/1,000 kcal whether the dog is a young adult or senior dog.¹⁷

While many veterinarians and researchers anecdotally believe that senior dogs have different nutritional requirements when compared to adult dogs, and senior diets are currently being marketed specifically for senior dog owners, further research is necessary to identify senior dogs' true nutritional requirements on which to base these diets. In addition, many dog owners and veterinarians anecdotally report that they believe senior foods have specific guidelines or required nutrient modifications.

Despite a lack of specific regulatory guidelines for senior diets, some common themes have emerged among some commercial pet foods for senior dogs. Many canine senior diets are formulated to be

reduced in calories when compared to the same company's adult maintenance diets, but this depends upon the individual company and individual products. While this reduction in calories may be appropriate for some senior dogs, other senior dogs actually exhibit weight loss rather than gain because of a variety of factors, which may include a decrease in appetite, difficulty prehending food, changes in taste or smell sensation, or increased metabolic rate resultant from other underlying disease.¹⁹ These dogs would, therefore, benefit from a change to a diet that contains more calories per can or cup.

Another modification of many senior diets compared to adult maintenance diets is reduced protein based on research in other species that high protein diets could damage kidneys by increasing the workload, and that restriction would aid in preservation of renal function.^{20,21} Although studies in dogs have not shown similar results,^{22,23} some diets marketed for senior dogs are reduced in protein compared to that company's adult maintenance food. In addition, some studies have shown that healthy senior dogs may actually have higher protein requirements compared to younger adult dogs.^{24,25}

Unnecessary restriction of protein may actually exacerbate loss of lean tissue as multiple recent human studies have documented a correlation between maintenance of lean body mass and dietary protein intake in elderly men and women.²⁶⁻²⁸ The specific minimal and adequate protein requirements of senior dogs remain unknown, but long-term studies investigating the effects of dietary protein quantity and quality on muscle mass and overall health of senior dogs could help clarify the optimal protein content for dogs in this age group.

A variety of other nutrient modifications have been incorporated into some commercial senior diets for dogs compared to adult maintenance diets, including lower phosphorus and sodium levels, increased fiber levels, and the addition of certain nutrients, such as omega-3 fatty acids, joint supplements, antioxidants, and other supplements.

While the ideal diet for every senior dog is not the same, and is dependent on many critical factors that include body condition and underlying diseases, an evidence-based consensus on the minimal and adequate nutrient requirements are needed as a starting point to guide recommendations for healthy seniors.

Developing minimal and adequate nutrient requirements has the potential to contribute to optimizing body composition during aging, preventing nutrient deficiencies, and ultimately, enhancing the quality of life of senior dogs. The goals of this study were to evaluate the public's opinions of senior diets for dogs and determine whether respondent perceptions were consistent with current nutrient profiles of commercially available diets marketed for senior dogs. Investigating these issues can help to highlight discrepancies between perceived needs of senior dogs and actual diet composition. This information may also be used to identify important areas of client and veterinary education.

MATERIALS AND METHODS

Part 1

An 18-question web-based survey was developed containing questions regarding the participant's pet ownership, opinions regarding senior dogs and their appropriate diets, and participants' background questions including sex, age, geographic location, and level of education.^{a,b} Respondents were also asked to indicate if they were a veterinarian, veterinary technician, or dog breeder... this category is referred to as "professional category" hereafter. Pet ownership was not a requirement for participation in the study. Multiple types of questions were used, including multiple choice, closed-ended numerical, open-ended, and questions asking the respondent to identify his or her level of agreement with the statement (ie, strongly agree, agree, neither agree nor disagree, disagree, or strongly disagree). The study was

reviewed and approved by the University's Institutional Review Board.

The survey was posted online for public participation from October 26th, 2009, to February 2nd, 2010. The survey link was advertised on a flyer posted at local veterinary hospitals, pet stores, dog parks, libraries, and grocery stores. The link was also distributed via e-mail to American Kennel Club area breed clubs, was posted on pet-interest Facebook pages, and Craigslist, Twitter, and advertised in Your Dog Newsletter and the state Veterinary Medical Association Newsletter. No incentive was offered for participation in the survey, and all responses were anonymous.

Dogs owned by respondents were classified as "seniors" by two separate methods. First, respondents answered a question that asked if they owned a senior dog as part of the online survey. Secondly, the oldest dog in each respondent's household was classified as senior or non-senior based on recognized breed size (average weight) along with that dog's age. For mixed breed dogs, owners were asked to provide the dog's body weight along with age. Body weights were assigned to most breeds using average weights for the breed.²⁹

Breed weights not included in this list were obtained from the corresponding national breed club website associated with the American Kennel Club. Classifications of respondents' mix-breed dogs as senior/non-senior were discarded in cases in which owners did not include body weights. Information for these dogs, other than their weight category, was still included. Senior/non-senior classification was defined for this study using published categories based on four size categories:³⁰ Toy and small breed (<10 kg) dogs were classified as seniors at >12 years old, medium size breeds (>10 kg, <20 kg) were classified as seniors at >10 years old, large breeds (>20 kg, <45 kg) were classified as seniors at >9 years old, and giant breeds (>45 kg) were classified as

^a The full survey is available upon request from the corresponding author

^b Vovici Co., Dulles, VA

seniors at >7 years of age. Categorization of each dog based on this classification was then compared to owner response for agreement as to whether or not they thought their dog was a senior.

Data were examined graphically. Normally distributed descriptive data for the overall results are presented as mean (range), while skewed data are reported as median (range). Results were compared by subcategories using Chi-square analysis for the following categories: dog ownership, senior dog ownership, gender, age group (18-30 years, 31-45 years, 46-60 years, >60 years), level of education (non-high school diploma, high school diploma, Bachelor's degree, Master's/PhD/Doctorate degree), region of the country (Northeast, Midwest, South, West), community type (urban, rural, suburban), and whether the respondent was a veterinarian, veterinary technician, dog breeder, or other. Percent comparisons were calculated from the total survey respondents (1,309) unless otherwise stated. For those items which had numerical scores (eg, quality of dog food), mean scores were compared using independent t-tests (for two groups), or ANOVA (for more than two groups). All analyses were performed using commercial statistical software.^c

Part 2

Commercially available diets marketed for senior dogs were included in this study. Various locations in the authors' region were surveyed that reflected common locations at which consumers would be able to obtain diets designed for senior dogs, including two pet specialty stores, one discount mass merchandiser, and one supermarket. A range of label descriptions implying senior dogs was accepted, such as the terms "senior," "old," "mature," "maturity," and "longevity." Average nutrient analysis information for protein, fat, fiber, sodium, and phosphorus was obtained from the manufacturer for each diet on a gram or milligram per 100 kilocalorie basis. Calorie density of the diets (kilocalo-

ries per can or cup) also was obtained from the manufacturer. Finally, additives in each of the diets were noted (eg, antioxidants, glucosamine, or omega-3 fatty acids). Descriptive data for the diets is provided using median range. These results were compared to the AAFCO minimums for adult maintenance for each nutrient and also a commonly sold over-the-counter dog food marketed primarily for adults from 1-7 years of age (although it has undergone AAFCO feeding trials for all life stages [ie, growth, reproduction, and adult maintenance]).^d

RESULTS

Part 1

The survey was completed by 1,309 adults from 45 US states and six countries. All respondents provided answers to at least 80% of the questions and, therefore, none were excluded from analysis. Most respondents (1,209; 92.4%) were dog owners, with a mean of three dogs per household (range, 1-28). More than 100 breeds were represented. Most respondents (1,154; 88.2%) were female and the age groups represented included 18-30 years (110), 31-45 years (385), 46-60 (580), and >60 years (224). Education level reported included non-high school diploma (7; 0.5%), high school diploma (270; 20.6%), Bachelor's degree (562; 42.9%), and Master's/PhD/Doctorate (457; 34.9%). Six hundred seventy-eight people reported living in a suburban community but 419 reported a rural community and 196 reported an urban community. Two-hundred eighty-two (21.5%) people reported being a breeder, 128 (9.8%) were veterinarians and 101 (7.7%) were veterinary technicians. Most people reported hearing about the survey by electronic contact (e.g., email, Twitter, Facebook, or a website). A smaller proportion of people (<5%) learned of the survey from a newsletter or a flyer.

Respondents who were dog owners were asked to report the age and breed (or weight, if not a purebred) for the oldest dog in their

^c SPSS 16.0, SPSS, Chicago, IL

^d Purina[®] Dog Chow[®] Complete & Balanced, Nestle Purina PetCare, St Louis, MO

Table 1: Number of respondents (top section) and mean (\pm SD) respondent dog food quality scores (bottom section; means calculated out of total survey respondents; n= 1309)

	Very High	High	Average	Below Average	Low
Grocery Store	22	103	565	253	312
Pet Store	390	593	250	16	28
Veterinary Hospital	411	385	293	96	59
Large Retailer	21	92	501	333	283

	Grocery Store	Pet Store	Veterinary Hospital	Large Retailer
Dog Owners	2.39 \pm 1.01 [†]	4.03 \pm 0.87	3.76 \pm 1.14 [‡]	2.36 \pm 0.98 [‡]
Non-Dog Owners	2.88 \pm 0.81	3.93 \pm 0.73	4.35 \pm 0.79	2.73 \pm 0.89
Senior Dog Owners	2.32 \pm 1.05 [‡]	4.04 \pm 0.89	3.66 \pm 1.15 [‡]	2.29 \pm 1.00
Non-Senior Dog Owners	2.55 \pm 0.92	4.00 \pm 0.82	3.98 \pm 1.06	2.48 \pm .93
Male	2.71 \pm 0.99 [‡]	4.04 \pm 0.86	4.08 \pm 0.95 [†]	2.68 \pm 1.01
Female	2.38 \pm 1.00	4.02 \pm 0.87	3.76 \pm 1.14	2.34 \pm .96
Veterinarian	3.12 \pm 0.85 [‡]	4.02 \pm 0.64	4.56 \pm 0.61 [‡]	2.86 \pm .90 [‡]
Veterinary Technician	2.46 \pm 0.82	3.84 \pm 0.87	4.04 \pm 1.13	2.49 \pm 0.86
Breeder	2.10 \pm 1.03	4.02 \pm 0.92	3.29 \pm 1.14	2.18 \pm 0.97
Other	2.42 \pm 0.98	4.04 \pm 0.87	3.82 \pm 1.10	2.36 \pm 0.98
18-30 yrs	2.59 \pm 0.93	3.88 \pm 0.74	4.08 \pm 1.01 [†]	2.50 \pm 0.93
31-45 yrs	2.41 \pm 1.00	3.99 \pm 0.85	3.87 \pm 1.13	2.38 \pm 0.96
46-60 yrs	2.34 \pm 1.03	4.06 \pm 0.91	3.71 \pm 1.17	2.32 \pm 1.00
60+ yrs	2.55 \pm 0.97	4.05 \pm 0.85	3.74 \pm 1.00	2.47 \pm 0.94
Non-HS Diploma	3.14 \pm 1.22 [†]	3.86 \pm 1.35	3.86 \pm 1.35 [†]	3.29 \pm 1.38*
HS Diploma	2.41 \pm 1.00	4.05 \pm 0.89	3.72 \pm 1.01	2.45 \pm 1.02
Bachelor's Degree	2.32 \pm 0.99	4.02 \pm 0.87	3.69 \pm 1.21	2.31 \pm 0.94
Master's/PhD/Dr	2.53 \pm 1.01	4.00 \pm 0.85	3.96 \pm 1.06	2.42 \pm 0.97

Dog food quality scale: 1= Low, 2= Below Average, 3= Average, 4= High, 5= Very High

* $P < 0.05$ significant difference in comparison among the 2-4 subcategories of respondents (e.g., 18-30 yrs vs 31-45 yrs vs 46-60 yrs vs 60+ years)

[†] $P < 0.01$ significant difference in comparison among the 2-4 subcategories of respondents

[‡] $P < 0.001$ significant difference in comparison among the 2-4 subcategories of respondents

household. The mean age of the oldest dog was 8.6 years (range, 1-19 years), with 698 (57.7%) of all dog owners stating that they owned a “senior” dog. Based on the study criteria for categorizing dogs as seniors, 41.7% (482/1157) of dogs for which there was sufficient information provided were seniors. Two-hundred twelve respondents reported that their dogs were seniors when they were not according to study criteria while 13 answered that their dogs were not seniors when it was based on study criteria. The median number of visits per year to the

veterinarian for that dog was 2 (range, 0-30). When asked at what age they considered dogs to become a senior, the most common responses were 10 years for small breed dogs (362; 27.7%), 8 years for medium breed dogs (337; 25.7%), and 7 years for large breed dogs (380; 29.0%). However, the responses ranged from 5 years to >10 years for each size category.

Among the 698 respondents who reported owning a senior dog, 299 (42.8%) reported that they fed a senior diet. Of owners feeding a senior diet, 99/299 (33.1%)

were feeding a senior diet based on the recommendations of their veterinarian. Most respondents (1106; 84.5%) reported strong agreement or agreement with the statement, "Senior dogs have different nutritional needs compared to adult dogs."

In response to the question about quality of dog foods available at various locations, most respondents reported a very high or high quality for pet stores (983; 75.1%), and veterinary hospitals (796; 60.8%), but average quality or lower for large retailers (1117; 85.3%) or grocery stores (1130; 86.3%; Table 1). There was a significant difference in mean perceived quality of dog food that could be purchased at grocery stores between respondent subcategories including

dog ownership ($p < 0.001$), senior dog ownership ($p = 0.003$), sex ($p < 0.001$), professional category ($p < 0.001$), and level of education ($p = 0.002$). There was also a significant difference in mean perceived quality of dog food that could be purchased at veterinary hospitals between respondent subcategories including dog ownership ($p < 0.001$), senior dog ownership ($p < 0.001$), sex ($p = 0.002$), professional category ($p < 0.001$), age (0.006), and level of education ($p < 0.001$), as well as a significant difference in mean perceived quality of dog food at large retailers between categories of dog ownership ($p = 0.001$), professional category ($p < 0.001$), and level of education ($p = 0.01$).

The survey also asked about the most

Table 2: Number of responses (and percentages) that each factor is most important when choosing a senior dog food (numbers are out of total number of respondents; $n = 1309$)

	Recommendations by a veterinarian	Price	Convenience	Ingredients	Label
Overall Responses	341 (26.1 %)	11 (0.8 %)	8 (0.6 %)	823 (62.9 %)	110 (8.4 %)
Dog owner †	306 (23.4 %)	9 (0.7 %)	7 (0.5 %)	783 (59.8 %)	95 (7.3 %)
Non-dog owner	35 (2.7 %)	2 (0.2 %)	1 (0.08 %)	34 (2.6 %)	14 (1.1 %)
Senior-dog owner †	137 (10.5 %)	4 (0.3 %)	3 (0.2 %)	510 (39 %)	41 (3.1 %)
Non-senior dog owner	197 (15.0 %)	8 (0.6 %)	5 (0.4 %)	277 (21.2 %)	65 (5.0 %)
Male *	48 (3.7 %)	4 (0.3 %)	3 (0.2 %)	79 (6 %)	11 (0.8 %)
Female	291 (22.2 %)	7 (0.5 %)	5 (0.4 %)	742 (56.7 %)	99 (7.6 %)
Veterinarian †	73 (5.6 %)	1 (0.08 %)	4 (0.3 %)	34 (2.6 %)	13 (1.0 %)
Veterinary Technician	36 (2.8 %)	2 (0.2 %)	2 (0.2 %)	51 (3.9 %)	10 (0.8 %)
Breeder	19 (1.5 %)	0 (0 %)	0 (0 %)	252 (19.3 %)	9 (0.7 %)
Other	213 (16.3 %)	8 (0.6 %)	2 (0.2 %)	486 (37.1 %)	78 (6.0 %)
18-30 yrs old †	50 (3.8 %)	4 (0.3 %)	1 (0.08 %)	44 (33.6 %)	11 (0.8 %)
31-45 yrs old	121 (9.2 %)	2 (0.2 %)	5 (0.4 %)	226 (17.3 %)	30 (2.3 %)
46-60 yrs old	123 (9.4 %)	5 (0.4 %)	1 (0.08 %)	392 (29.9 %)	51 (3.9 %)
>60 yrs old	43 (3.3 %)	0 (0 %)	1 (0.08 %)	158 (12.1 %)	18 (1.4 %)
Non-diploma †	0 (0 %)	1 (0.08 %)	0 (0 %)	6 (0.5 %)	0 (0 %)
High school Diploma	54 (4.1 %)	1 (0.08 %)	2 (0.2 %)	187 (14.3 %)	22 (1.7 %)
Bachelor's	142 (10.8 %)	3 (0.2 %)	2 (0.2 %)	369 (28.2 %)	44 (3.4 %)
Master's/PhD/Doctorate	143 (10.9 %)	6 (0.5 %)	4 (0.3 %)	254 (19.4 %)	43 (3.3 %)

* $P < 0.01$ significant difference in comparison among subcategories of respondents

† $P < 0.001$ significant difference in comparison among subcategories of respondents

important factor when choosing a dog food. Most people reported that ingredients were the most important factor (823; 62.9%; Table 2). Responses to this question with specific reference to choosing a food for a senior dog were similar with 62.9% of people (823) responding ingredients as the most important factor, with recommendations by a veterinarian (341; 26.1%), the label statement (110; 8.4%), price (11; 0.8%), and convenience (8; 0.6%). There was a significant difference in the factor perceived to be most important when choosing a senior dog food between all subcategories of respondents including dog ownership ($p < 0.001$), senior dog ownership ($p < 0.001$), sex ($p = 0.001$), professional category ($p < 0.001$), age ($p < 0.001$) and level of education ($p < 0.001$).

Respondents were also asked to compare certain nutritional properties of a senior dog food compared to an adult diet (Table 3). Most respondents answered that a senior diet was lower in calories (1065; 81.4%), fat (979; 74.8%), sodium (878; 67.1%), protein (665; 50.8%), and carbohydrates (638; 48.7%) but higher in fiber (931; 71.1%). Most respondents did not know whether phosphorus was lower or higher in senior diets (719; 54.9%). There was a

significant difference between responses from senior dog owners and non-senior dog owners when questioned whether senior diets are lower/higher in calories, protein, fat, carbohydrates, and phosphorous, with more senior dog owners responding that senior diets were modified in nutrients than non-senior dog owners. There were also significant differences in responses to the question whether senior diets should be modified in nutrients within other subcategories of respondents, including comparison by gender [calories ($p = 0.03$), protein ($p = 0.009$)], age [calories ($p = 0.001$), protein ($p < 0.001$), fiber ($p = 0.009$)], level of education [calories ($p = 0.04$), fat ($p = 0.03$), phosphorus ($p = 0.02$)], and professional category [calories ($p = 0.03$), protein ($p < 0.001$), fat ($p = 0.006$), carbohydrate ($p = 0.003$), sodium ($p = 0.002$), phosphorus ($p < 0.001$)]. Respondents who categorized themselves as breeders were significantly more likely to respond that senior diets were lower in protein, fat, and phosphorus compared to those categorized as “other” (not veterinarians or veterinary technicians)

The majority of respondents (1028; 78.5%) answered that senior dogs should receive a dietary supplement, with the high-

Table 3: Responses to the survey question asking about specific nutrient modifications in senior canine diets compared to diets designed for adult dogs. The total number of responses for each nutrient (out of 1309 total responses) as well as the percentage (in parentheses) is reported based on the three options for answers provided.

	Nutrient is lower in senior diets	Nutrient is higher in senior diets	Respondent does not know
Calories ^{a,b,c,d}	1065 (81.4%)	77 (5.9%)	135 (10.3%)
Protein ^{a,b,c}	665 (50.8%)	384 (29.3%)	218 (16.7%)
Fat ^{a,d,e}	979 (74.8%)	108 (8.3%)	180 (13.8%)
Carbohydrates ^{a,e}	638 (48.7%)	283 (21.6%)	332 (25.4%)
Fiber ^{c,e}	77 (5.9%)	931 (71.1%)	257 (19.6%)
Sodium ^e	878 (67.1%)	17 (1.3%)	367 (28.0%)
Phosphorus ^{a,d,e}	342 (26.1%)	186 (14.2%)	719 (54.9%)

a $p < 0.05$ between senior dog owners versus non-senior dog owners

b $p < 0.05$ between male versus female

c $p < 0.05$ between age categories

d $p < 0.05$ between education levels

e $p < 0.05$ between professional categories (veterinarian, veterinary technician, breeder, other)

Table 4: Number of respondents (and percentages) answering whether specific vitamins or other supplements respondents believed should be given to senior dogs (numbers are out of total number of respondents; n= 1309)

	Fatty Acids	Joint Supplements	Multivitamins	Antioxidants	Other
Number of respondents answering senior dogs should receive a supplement	821 (62.7 %)	962 (73.5 %)	466 (35.6 %)	623 (47.6 %)	127 (9.7 %)
Dog Owners	761 (58.1 %)	895 (68.4 %)	433 (33.1 %)	577 (44.1 %)	148 (11.3 %)
Non-Dog Owners	50 (38.2 %)	55 (4.2 %)	29 (2.2 %)	40 (3.1 %)	8 (0.6 %)
Senior-dog owner	443 (33.8 %)	518 (39.6 %)	218‡ (16.7 %)	327 (25.0 %)	97* (7.4 %)
Non-senior dog owner	346 (26.4 %)	402 (30.7 %)	232 (17.7 %)	275 (21.0 %)	53 (4.0 %)
Male	79 (6.0 %)	86* (6.6 %)	55 (4.2 %)	56 (4.3 %)	6† (0.5 %)
Female	736 (56.2 %)	867 (66.2 %)	409 (31.2 %)	564 (43.0 %)	152 (11.6 %)
Veterinarian	84* (6.4 %)	87 (6.6 %)	19‡ (1.5 %)	52* (4.0 %)	7* (0.5 %)
Veterinary Technician	63 (4.8 %)	76 (5.8 %)	23 (1.8 %)	24 (1.8 %)	10 (0.8 %)
Breeder	179 (13.7 %)	211 (16.1 %)	97 (7.4 %)	143 (11.0 %)	40 (3.1 %)
Other	451 (34.5 %)	582 (44.5 %)	327 (25.0 %)	385 (29.4 %)	101 (7.7 %)
18-30 yrs old	65 (5.0 %)	82 (6.2 %)	38 (2.9 %)	43* (3.3 %)	15 (1.1 %)
31-45 yrs old	257 (19.6 %)	294 (22.5 %)	150 (11.5 %)	198 (15.1 %)	46 (3.5 %)
46-60 yrs old	372 (28.4 %)	428 (32.7 %)	207 (15.8 %)	291 (22.2 %)	71 (5.4 %)
>60 yrs old	120 (9.2 %)	147 (11.2 %)	70 (5.3 %)	87 (6.6 %)	25 (1.9 %)
Non-diploma	2 (0.2 %)	2 (0.02 %)	2 (0.02 %)	1 (0.08 %)	2 (0.02 %)
High school Diploma	163 (12.5 %)	210 (16.0 %)	99 (7.6 %)	129 (10.9 %)	38 (2.9 %)
Bachelor's	357 (27.3 %)	408 (31.2 %)	214 (16.3 %)	274 (21.0 %)	59 (4.5 %)
Master's/PhD/Doctorate	287 (22.0 %)	328 (25.1 %)	149 (11.4 %)	211 (16.1 %)	57 (4.4 %)

* $P < 0.05$ significant difference in comparison among subcategories of respondents within each category of supplement

† $P < 0.01$ significant difference in comparison among subcategories of respondents within each category of supplement

‡ $P < 0.001$ significant difference in comparison among subcategories of respondents within each category of supplement

Table 5: Average nutrient analysis for key nutrients in 37 commercial over-the-counter diets marketed for senior dogs (median, range). Association of American Feed Control Officials (AAFCO) minimums for each nutrient for adult maintenance are provided.¹⁷

	AAFCO Minimum	Representative Adult Diet ^d	Senior Diets (n=37)
Kilocalories per: Cup (n=25) Can (n=10) Pouch (n=2)	---	433	336 (246-408) 365 (312-411) 104 (100-108)
Protein (g/100 kcal)	5.1	5.9	6.9 (4.8-13.1)
Fat (g/100 kcal)	1.4	3.4	3.4 (2.4-6.3)
Crude fiber (g/100 kcal)	---	0.4	0.9 (0.2-2.9)
Sodium (mg/100 kcal)	20	105	89 (33-412)
Phosphorus (mg/100 kcal)	140	243	264 (134-412)

est number of responses for joint supplements, fatty acids and antioxidants, followed by multivitamins and other supplements (Table 4). When questioned whether senior dogs should receive a fatty acid or joint supplement, there was only a significant difference in responses among the subcategory for the professional ($p=0.03$) and sex ($p=0.006$) categories. Overall, there was a significant difference among subcategories of senior dog ownership ($p<0.001$), as well as the professional category ($p<0.001$) for multivitamin supplementation of senior dogs. Overall, there was also a significant difference among subcategories of respondents that felt senior dogs should receive antioxidants including professional category ($p=0.045$) and age ($p=0.03$). Lastly, there was a significant difference in respondents who thought senior dogs should receive other dietary supplements among the subcategories of sex ($p=0.002$) and the professional category ($p=0.02$).

Part 2

Thirty-seven over-the-counter commercial diets were identified that were marketed for senior dogs (Table 5). Calories ranged from 246-408 kcals/cup in the 25 dry foods evaluated (median, 336 kcals/cup), while the 10 canned foods ranged from 312-411 kcals/can (median, 365 kcals/can). Protein (4.8-13.1 g/100 kcal), fat (2.4-6.3 g/100 kcal), crude fiber (0.2-2.9 g/100 kcal), sodium (33-412 mg/100 kcal), and phosphorus (134-412 mg/100 kcal) varied widely among the 37 diets. All diets compared had label claims for supplementation of additional nutrients, such as fatty acids (25), added vitamins (25), antioxidants (24), and joint supplements (22). The age at which the labels for these diets stated that dogs become "seniors" ranged from 5 years of age to greater than 8 years of age.

DISCUSSION

While rate of aging is not consistent between all individuals of any species, consideration of seniors is further complicated in the canine population, by differences in the rate of aging among different sizes of dogs.^{31,32}

Results of the current study revealed a large variation among respondents' opinions about when a dog becomes a senior. In general, respondents were aware that larger breed dogs age more quickly than smaller breeds, but for all sizes of dogs, responses ranged from 5 years to greater than 10 years of age. There was also some discrepancy between the number of respondents who answered that they owned a senior dog and the number of senior dogs based on the study criteria, with more owners incorrectly concluding that their dog was a senior. These discrepancies may be the result of variable marketing from the pet food companies, which classified dogs as seniors as early as 5 years of age to greater than 8 years of age. With the inconsistencies among definitions of when a dog becomes a senior between dog owners, pet food companies, and even the veterinary community, it is not surprising that other factors such as what the nutritional requirements are for our senior dog population have yet to be clearly identified.

While the nutritional requirements of senior dogs have not been investigated thoroughly, and have yet to be set by the National Research Council or AAFCO, most respondents (84.5%) in the current study answered that senior dogs have different nutritional needs when compared to adult dogs. Furthermore, most respondents thought that senior diets should be reduced in calories, protein, fat, and sodium, and should contain increased amounts of fiber. Few respondents reported knowing whether phosphorus should be increased or decreased in a senior diet. Respondents' opinions on these nutrient modifications were not necessarily reflected in the nutrient profiles of the 37 surveyed commercial dog foods marketed for seniors, given the wide variation found. For example, most respondents answered that senior diets should be lower in protein. Nonetheless, most of the 37 senior dog food surveyed in this study had higher protein concentrations than the AAFCO minimum or compared to a representative adult dog food. This likely reflects the fact that most recent research suggests that senior dog pro-

tein requirements are either similar or higher than younger adult dogs.^{13,24} This suggests that additional research as well as client education would be beneficial.

While sodium restriction is not necessary for the healthy senior dog, it can be important for dogs with cardiac disease³³ The dietary content of the 37 senior diets surveyed ranged widely from 33-412 mg/100 kcal. Given that most owners (and veterinarians) responded that senior diets were lower in sodium compared to diets designed for adult dogs, this may result in confusion or inappropriate feeding of diets if an older dog requires a reduced sodium diet and a senior diet assumed to be low in sodium is recommended. For example, diets designed for dogs with cardiac disease range from 17-50 mg/100 kcal (although this degree of restriction is not required for dogs with asymptomatic cardiac disease). Similar results were found with phosphorus, restriction of which appears to be beneficial in kidney disease (diets designed for canine renal disease range in phosphorus from 55-120 mg/100 kcal).^{34,35} The diets surveyed had a three-fold difference in phosphorus, therefore not all senior diets can be considered to be phosphorus restricted. All diets evaluated were lower in calories than a representative adult dog food but the range was also wide (i.e., 246-408 kcals/cup). This could result in a dog increasing or decreasing its calorie intake when switching to a senior diet, often unbeknownst to the owner or to the veterinarian. Depending on the body condition of the individual dog, this change could be beneficial or detrimental.

Many respondents in the current study (79%) answered that senior dogs should receive dietary supplements, such as fatty acids, joint supplements, antioxidants, and multivitamins. All 37 senior diets included in the survey had label claims containing one or more of these supplements in the diet, with almost all diets having label claims for added fatty acids or vitamins. Whether the inclusion of these supplements is due to consumer demand or whether respondents'

answers were the result of marketing for these diets which provides justification for their use cannot be determined from the design and results of this study, but may warrant further research.

In spite of the large majority of responses that senior dogs have different nutritional needs than adult dogs, fewer than half of the respondents who owned a senior dog actually fed a senior diet. This discrepancy may be due to concern about deviating from a diet the dog has been eating, because owners are unsure of what nutrient modifications are truly needed for their aging dog, or because of limited veterinary recommendations on feeding senior dogs (in this study only 33.1% of those feeding a senior diet said it was based on their veterinarian's recommendations). This limited veterinary input into dietary selection also was reflected in the fact that respondents, in general, did not choose their dog food based on the recommendations of a veterinarian (only 17% of dog owners and 26% of senior dog owners). Most respondents reported that, of the choices provided, the ingredients were the most important factor when choosing a dog food. This may be the result of limited attention to this topic during veterinary visits or the paucity of information available on nutrient requirements of senior dogs. The results of this study suggest that veterinarians appeared to have similar opinions to other respondents on a variety of other questions, such as nutrient modifications of senior dog foods, senior dogs requiring supplements, and the primary importance of ingredients. These findings offer opportunities for future research, as well as enhancing the education of veterinarians and the general public about pet food.

Throughout the survey there were several significant differences in responses between categories of respondents, which may be useful in uncovering some issues behind the perceptions of senior dog nutritional needs. For example, as level of education increased, opinion that the recommendations of a veterinarian were the most important

factor when choosing a dog food for senior dogs also increased. Another example was that as respondent age increased, pet foods obtained from a veterinary hospital were thought to be of lower quality. Some of the other differences among subcategories of individuals in perceived quality of pet food purchased from various locations may warrant further research.

Although having the survey online allowed for a relatively large pool of respondents, there are some inherent limitations when utilizing a electronic survey. Respondents were primarily recruited through e-mail and other electronic techniques, limiting those respondents to individuals with computer and internet access. As this was a voluntary survey, people that chose to respond to the survey may have been those with a stronger opinion about pet foods. Furthermore, a larger proportion of respondents were dog owners than non dog owners, and of dog owners, a large proportion were owners of senior dogs, both of which may have contributed to bias. Owner-reported body weights and breeds also may have been inaccurate. Lastly, the categorization method used to classify mix breed dogs based on body weight may have led to misclassification of dogs not in optimal body condition. The diets available in the authors' region may be more extensive or different from those available in other areas of the country. These limitations all may reduce the relevance of these results for other populations. Nonetheless, these findings concerning differences in perceived and actual nutritional attributes of senior dog foods identify important issues and gaps in the current nutritional information available for dogs.

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