

STANDARD ARTICLE

Evaluation of nutrient content and caloric density in commercially available foods formulated for senior cats

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Funding information

Colorado State University, Grant/Award Number: Young Investigator Award CSU; Winn Feline Foundation, Grant/Award Number: # MTW18-001-" Evaluation of commercial feline diets for calcium, phosphorous and the calcium to phosphorous ratio in commercial cat foods

Abstract

Background: Cat foods marketed for senior cats (≥ 7 years) are available to owners. The variability in the nutritional content of these foods is unknown.

Objectives: To measure the caloric density and caloric distribution of crude protein, crude fiber, crude fat, phosphorus, calcium, magnesium, sodium, potassium, and vitamin D3 in commercially available foods for senior cats and to compare nutrient content with foods for adult cats.

Samples: Thirty-one senior and 59 adult commercial nontherapeutic cat food products.

Methods: Descriptive study. Crude protein, crude fiber, and crude fat were measured using Dumas nitrogen combustion, Ankom filter bag technique, and acid hydrolysis, respectively. Mineral concentrations were measured using inductively coupled argon plasma-optical emission spectroscopy. Vitamin D3 was determined by liquid chromatography with tandem mass spectrometry. Caloric density was calculated using modified Atwater values.

Results: The evaluated nutrient concentrations in all foods for senior cats met the values of the Association of American Feed Control Officials Cat Food Nutrient Profile for adult maintenance. Foods for senior cats had significantly higher crude fiber content when compared to foods for adult cats ($P < .0001$). No significant difference in crude protein, crude fat and mineral concentrations was found between foods for senior and adult cats.

Conclusions and Clinical Importance: Foods marketed for senior cats are highly variable in their caloric density and nutrient content and, except for crude fiber, are similar to foods for adult cats. Veterinarians should avoid broad recommendations regarding commercially available foods for senior cats, and dietary recommendations should reflect the patient's individual needs.

KEYWORDS

commercial, diets, feline, foods, mature, phosphorus, protein, senior

Abbreviations: Ca:P, calcium-to-phosphorus; IRIS, International Renal Interest Society; ME, metabolizable energy; MER, maintenance energy requirement.

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1 | INTRODUCTION

According to the American Veterinary Medical Association, in 2016 approximately 32% of client-owned cats were >6 years of age (6-10 years, 27%; 11-15 years, 15%; ≥ 16 years, 4%).¹ Although the definition of "senior" is subjective, some consider cats as mature at ≥ 7 years and senior at ≥ 11 years of age.² Older cats are at increased risk of several age-related disorders, and nutritional requirements likely change with increasing age in cats.^{3,4} In addition to providing a complete and balanced food with adequate digestibility, the expected goals for the use of foods labeled for cats ≥ 7 years are to slow down or prevent the progression of negative metabolic changes associated with aging, improve health, and increase the longevity of the cat.

Although specific nutrient ranges are recommended by the Association of American Feed Control Officials (AAFCO; for commercial foods)⁵ and the National Research Council (NRC; for nutritional requirements)⁶ for cats at maintenance, growth, and during reproduction, no established guidelines or requirements are available for senior cats. Foods for senior pets typically adhere to the nutrient guidelines for adult maintenance, and each pet food manufacturer may interpret the needs for senior cats differently. Considering the effects of aging and age-related disease, modifications most often are focused on caloric density as well as protein, fat, and phosphorus concentrations. Although foods for senior cats often are considered to be moderately decreased in protein, senior cats may have decreased ability to digest protein and altered protein metabolism, and therefore may require higher dietary protein to maintain lean body mass.⁷ The prevalence of overweight and obesity is highest for middle-aged cats (5-11 years) because many aging cats are less active. After 11 years of age, the prevalence of overweight and obesity for cats decreases, and some senior cats may be underweight.⁸ Therefore, a higher fat and caloric density food may be beneficial depending on individual needs.³

Despite the lack of defined nutritional guidelines for older cats, several commercial nontherapeutic foods are marketed for mature or senior cats. Variability in the nutritional content of these foods is likely, but remains uncharacterized. Therefore, our primary objective was to assess the caloric density and the concentrations of crude protein, crude fiber, crude fat, phosphorus, calcium, magnesium, sodium, potassium, and vitamin D3 in commercially available foods marketed for senior cats. Our secondary objective was to compare caloric density and selected nutrient concentrations of these products with foods marketed for adult cats. Our hypothesis was that caloric density and the evaluated nutrient concentrations would vary greatly among commercial foods for senior cats but would exceed AAFCO Cat Food Nutrient Profile established minimums for maintenance of healthy adult cats. In addition, we hypothesized that the measured values would not be significantly different in foods targeted for senior cats as compared with foods for adult cats.

2 | MATERIALS AND METHODS

In this descriptive study, all pet foods labeled for senior (≥ 7 years) cats available at 3 local pet food stores in the Fort Collins, Colorado

(United States) area were purchased. The following label descriptors implying foods for senior cats were used: senior, mature, adult 7+, and adult 11+. When available, 2 lot numbers were purchased for each food. The samples were aliquoted into numbered containers before analysis. The aliquot containers were coded so that laboratory technicians were masked to the product name and other labeling information. Samples were shipped on ice overnight to a commercial laboratory (Midwest Laboratory, Omaha, Nebraska) for analysis. Values from a subset of adult cat foods (1 lot number per food; $n = 59$) described in a previous publication were used for comparison.⁹

2.1 | Food analysis

The food samples were homogenized before analysis. Methods previously validated by the Association of Official Agricultural Chemists (AOAC) International were used.¹⁰ Moisture, crude protein, crude fiber, crude fat, and ash were measured using AOAC official method 930.15, AOAC 990.03 (Dumas nitrogen combustion method), AOAC Ba 6a-05 (Ankom filter bag technique), AOAC 954.02 (acid hydrolysis), and AOAC 942.05, respectively. Minerals (phosphorus, calcium, magnesium, potassium and sodium) were analyzed using inductively coupled argon plasma-optical emission spectrometry using a wet digest procedure (AOAC 985.01). Vitamin D3 concentrations in a subset of the dry foods for senior cats were measured by liquid chromatography with tandem mass spectrometry. The carbohydrate content of the foods was calculated by difference (100 minus crude protein, crude fiber, crude fat, ash, and moisture). To allow for comparisons among study foods, measured vitamin D3, crude protein, crude fiber, crude fat, phosphorus, calcium, magnesium, potassium, and sodium percentages were converted to unit/1000 kcal on a metabolizable energy (ME) basis using modified Atwater factors¹¹ applied to measured protein, fat, and carbohydrate concentrations. Caloric density (kcal/100 g) was calculated in a similar manner, based on measured moisture content (reported as dry matter [DM]).

2.2 | Statistical analysis

Data were analyzed using statistical software (GraphPad, Prism version 8.3.0, San Diego, California). For the foods marketed for senior cats, the average for the 2 lot numbers when available was used for descriptive statistics and group comparisons. Normality of the data was tested using the Shapiro-Wilk test. Data were log transformed to meet the assumption of normality. If the assumption was not met, a nonparametric test was performed on raw data. Descriptive data were calculated for crude protein, crude fiber, crude fat, phosphorus, calcium, magnesium, potassium, sodium concentrations (g/1000 kcal ME), and vitamin D3 concentrations (IU/1000 kcal ME). Nutrient concentrations then were compared to the AAFCO Nutrient Profile minimum concentration for adult maintenance. Descriptive data are presented as median (range). The concentrations of crude protein,

crude fiber, crude fat, phosphorus, calcium, calcium-to-phosphorus (Ca:P) ratio, magnesium, potassium, and sodium were compared between food formats (dry, canned) and when available, age category designated on the label (≥ 7 years and ≥ 11 years) using unpaired Student's *t* test or Mann-Whitney test. A similar analysis was used to compare nutrient concentrations between foods for senior and adult cats. One-way analysis of variance (ANOVA) with Tukey's post hoc analysis or Kruskal-Wallis test with Dunn's post hoc analysis was used to compare nutrient concentrations between foods for senior cats, foods for adult cats formulated for maintenance, and foods for adult cats formulated for all life stages. Vitamin D3 data were available for a subset of dry foods for senior cats ($n = 16$) and not available for any foods for adult cats. A paired Student's *t* test or Wilcoxon matched-pairs signed rank test was used to compare the nutrient concentrations between the 2 lot numbers for the foods for senior cats when available. A *P* value $< .05$ was considered significant.

3 | RESULTS

3.1 | Food description

Thirty-one foods marketed for senior cats (dry, $n = 19$; canned, $n = 12$) were included. Two lot numbers were available for 26/31 (84%) foods, for a total of 57 senior foods purchased for analysis. Thirteen pet food manufacturing companies were represented. Of the 31 foods, 39% (12/31) were canned and 61% (19/31) were dry extruded kibble, 1 of which contained freeze-dried raw pieces. The majority of the food labels designated a specific age group; 55% (17/31) were for cats ≥ 7 years and 16% (5/31) were for cats ≥ 11 years. The main protein source in the majority of foods was poultry (chicken, $n = 22$; duck, $n = 1$; turkey, $n = 1$) followed by fish (tuna, $n = 2$; salmon, $n = 2$; unspecified ocean fish, $n = 1$) and pork ($n = 2$). Ten foods (10/31; 32%) were grain-free. Thirteen foods (13/31; 42%) contained at least 1 of the following inorganic phosphorus additives: dicalcium phosphate, monosodium phosphate, phosphoric acid, potassium phosphate, sodium phosphate, sodium tripolyphosphate, and tricalcium phosphate. According to label information, all foods for senior cats were complete and balanced based on formulation to meet the AAFCO Cat Food Nutrient Profiles for adult maintenance (see the Appendix).

Fifty-nine foods marketed for adult cats were included for comparison and represented 23 pet food manufacturing companies. Twenty-nine foods for adult cats (49%) were canned and 30 (51%) were dry extruded kibble, 2 of which contained freeze-dried raw pieces. The main protein source in the majority of foods for adult cats was poultry (chicken, $n = 10$; turkey, $n = 7$; by-product, $n = 5$) followed by fish (salmon, $n = 10$; tuna, $n = 2$; mackerel, $n = 1$; sardine, $n = 1$; unspecific fish, $n = 1$), beef ($n = 7$), duck ($n = 6$), lamb ($n = 3$), rabbit ($n = 2$), venison ($n = 2$), quail ($n = 1$), and pork ($n = 1$). Forty-three foods contained at least 1 of the following inorganic phosphorus additives: dicalcium phosphate, l-ascorbyl-2-polyphosphate, phosphoric acid, sodium acid pyrophosphate, sodium hexametaphosphate, sodium

phosphate, sodium tripolyphosphate, tetrasodium pyrophosphate, and tricalcium phosphate. According to label information, foods for adult cats were complete and balanced based on formulation to meet the AAFCO Cat Food Nutrient Profiles for all life stages (28/59; 47%) or adult maintenance (31/59; 53%).

Measured nutrient concentrations and calculated caloric density in the foods for senior and adult cats are presented in Table 1. No significant differences in nutrient concentrations were found between the 2 lots numbers (26/31 foods for senior cats) for crude fat, crude protein, crude fat, phosphorus, calcium, magnesium, potassium, and sodium. A complete list of products is provided in Supplemental Information.

3.2 | Proximate analysis

All foods for senior cats had crude protein and crude fat concentrations above the AAFCO Cat Food Nutrient Profile minimum value for adult maintenance (Appendix). Fiber is not an essential nutrient, and a minimum value is not specified in the AAFCO Cat Food Nutrition Profile. Crude protein ($P = .3$), crude fat ($P = .1$), and crude fiber ($P = .8$) concentrations did not differ between the foods for senior cats labeled for 7+ years and the foods labeled for 11+ years. Crude fat was higher in canned foods for senior cats (66.0 [42.1-78.8] g/1000 kcal ME) when compared to dry foods for senior cats (41.5 [33.3-52.3] g/1000 kcal ME; $P < .0001$). Crude protein ($P = .7$) and

TABLE 1 The caloric density and nutrient content of commercially available cat foods labeled for senior or adult cats. Average of values for 2 lot numbers was used for 26/31 senior foods

	Senior foods, n = 31	Adult foods, n = 59
Caloric Density kcal/100 g dry matter	406 (337-505)	413 (359-635)
Crude protein g/1000 kcal ME	94 (77-139)	100 (50-173)
Crude fat g/1000 kcal ME	46 (33-79)	48 (26-90)
Crude fiber g/1000 kcal ME	7.0 (0-33.6)*	1.2 (0-13.1)*
Phosphorus g/1000 kcal ME	3.2 (1.5-4.4)	3.1 (0.9-5.8)
Calcium g/1000 kcal ME	3.7 (1.9-5.7)	3.9 (0.8-8.7)
C:P ratio	1.3 (0.9-1.6)	1.3 (0.8-1.7)
Magnesium g/1000 kcal ME	0.28 (0.12-0.56)	0.27 (0.06-0.54)
Potassium g/1000 kcal ME	2.3 (1.7-3.6)	2.2 (1.2-3.9)
Sodium g/1000 kcal ME	1.1 (0.7-2.7)	1.1 (0.5-3.9)
Vitamin D3 ^a IU/1000 kcal ME	305.7 (155.7-478.6)	—

Abbreviation: ME, metabolizable energy.

^a $n = 16$ dry foods.

*Significant $P < .05$;

crude fiber ($P = .2$) were not significantly different between canned and dry foods for senior cats.

Foods for senior cats had significantly higher crude fiber content as compared to foods for adult cats ($P < .0001$; Table 1). When the foods for adult cats were separated into 2 groups according to the nutritional adequacy statement (all life stages versus adult maintenance), this finding remained true. Foods for senior cats (7.0 [0-33.6] g/1000 kcal ME) had significantly higher fiber content compared to foods marketed for adult cats and formulated for adult maintenance (2.0 [0-13.1] g/1000 kcal ME; $P = .001$) as well as for foods marketed for adult cats and formulated for all life stages (0.6 [0-11.6] g/1000 kcal ME; $P = .001$). No significant differences were found in crude protein ($P = .2$) and crude fat ($P = .5$) between the foods for senior and adult cats, which remained true when the foods for adult cats were grouped separately based on the nutritional adequacy statement: crude protein ($P = .07$) and crude fat ($P = .08$) in foods for senior cats were the same compared to foods for adult cats and formulated for maintenance or for all life stages, respectively.

3.3 | Caloric density

The caloric density of foods for senior cats was highly variable (range, 337-505 kcal/100 g DM). Foods for senior cats labeled for ≥ 11 years (429 [414-436] kcal/100 g DM) had higher caloric density when compared to those labeled for ≥ 7 years (399 [379-505] kcal/100 g DM; $P = .03$). Canned foods for senior cats (459 [399-505] kcal/100 g DM) had higher caloric density when compared to dry foods (392 [337-422] kcal/100 g DM; $P < .0001$). The caloric density of foods for senior cats did not differ significantly when compared to foods for adult cats ($P = .2$; Table 1) and when compared to foods for adult cats formulated for adult maintenance ($P = 1.0$) or for all life stages ($P = .2$). The caloric density as fed (kcal/100 g) for canned and dry foods for adult and senior cats is provided in Supplemental Table S1.

3.4 | Mineral analyses

All foods for senior cats had phosphorus, calcium, magnesium, potassium, and sodium concentrations above the AAFCO Cat Food Nutrient Profile minimum value for adult maintenance (Appendix). No significant difference in phosphorus concentrations was found between foods for senior cats labeled for ≥ 7 years and those labeled for ≥ 11 years ($P = .1$) and between canned and dry foods ($P = .1$). The concentrations of all minerals (including phosphorus) did not differ between foods for senior and adult cats ($P = .7$ for phosphorus; Table 1). The phosphorus concentrations were also not significantly different among foods for senior and adult cats formulated for adult maintenance, and foods for adult cats formulated for all life stages ($P = .5$). Ten foods for senior cats (10/31; 32%) had phosphorus concentrations ≥ 3.6 g/1000 kcal ME, 2 of which had Ca:P ratios < 1.0 (0.96 and 0.88).

No significant differences in calcium concentrations and Ca:P ratio were found between foods for senior cats labeled for ≥ 7 years

and those labeled for ≥ 11 years ($P = .1$ and $P = .6$, respectively) and between canned and dry foods ($P = .4$ and $P = .1$, respectively). Foods for senior cats did not have significantly different calcium concentrations or Ca:P ratios when compared to foods for adult cats ($P = .6$ and $P = .6$, respectively). The calcium concentrations and Ca:P ratios also were not significantly different among foods for senior cats, foods for adult cats formulated for maintenance, and foods for adult cats formulated for all life stage ($P = .5$ and $P = .7$, respectively).

Although overlaps occurred in the ranges, magnesium concentration was higher in foods for senior cats labeled for ≥ 7 years (0.29 [0.16-0.39] g/1000 kcal ME) when compared to those labeled for ≥ 11 years (0.23 [0.12-0.26] g/1000 kcal ME; $P = .02$) and higher in dry foods for senior cats (0.35 [0.24-0.56] g/1000 kcal ME) when compared to canned foods (0.23 [0.12-0.28] g/1000 kcal ME; $P < .0001$). No significant difference was found when foods for senior cats were compared to foods for adult cats ($P = .6$; Table 1). The magnesium concentration also was not significantly different among foods for senior cats, foods for adults formulated for maintenance, and foods for adults formulated for all life stages ($P = .7$).

Potassium and sodium concentrations were not significantly different between foods labeled for ≥ 7 years and those labeled for ≥ 11 years ($P = .6$ and $P = .2$, respectively). Potassium concentrations between canned and dry foods for senior cats were not significantly different ($P = .3$). Sodium concentrations were significantly higher in canned foods for senior cats (1.4 [0.93-2.7] g/1000 kcal ME) when compared to dry foods for senior cats (1.1 [0.73-1.7] g/1000 kcal ME; $P = .05$). Potassium and sodium concentrations were not significantly different between foods for senior and adult cats ($P = .1$ and $P = .9$, respectively; Table 1). The potassium and sodium concentrations also were not significantly different among foods for senior cats, foods for adult cats formulated for maintenance, and foods for adult cats formulated for all life stages ($P = .3$ and $P = .6$, respectively).

3.5 | Vitamin D3 analysis

Vitamin D3 concentrations were measured in 16 dry cat foods for senior cats (305.7 [155.7-478.6] IU/1000 kcal ME) and concentrations for all foods were above the AAFCO Cat Food Nutrient Profile minimum value and below the maximum value for adult maintenance (Appendix).

4 | DISCUSSION

Our goal was to characterize cat foods labeled for senior cats and assess their variability in nutritional content and suitability for the nutritional management of cats ≥ 7 years of age. We found that foods marketed for senior cats have a highly variable nutrient content and caloric density, which is attributed to the lack of defined nutritional guidelines for senior cats. We also found that foods for senior cats in general have a nutrient content and caloric density similar to those of foods for adult cats. These were expected findings because of the lack of specific nutritional guidelines for senior cats. All foods for senior cats in our study were

formulated to meet the AAFCO Cat Food Nutrient Profiles for adult maintenance based on the nutritional adequacy statement. It often is assumed by cat owners and veterinarians that foods for senior cats provide a unique nutritional profile, but this assumption is not supported by our findings. Individual needs vary in senior cats based on lifestyle, age, and comorbidities. Therefore, specific food recommendations should be based on the individual needs of the cat. Certainly, some aspects that might be relevant to foods for senior cats such as digestibility and palatability were not evaluated in our study, and these factors may provide specific benefits in senior pets.

Chronic kidney disease (CKD) is a common cause of illness and death in geriatric cats.¹²⁻¹⁴ The current International Renal Interest Society (IRIS) guidelines support feeding cats with stage 2 to 4 disease a food designed for patients with kidney disease.¹⁵ Relative to maintenance foods, renal therapeutic foods have decreased protein concentrations (65-95 g/1000 kcal ME) and are restricted in phosphorus concentrations (0.9-1.3 g/1000 kcal ME) to decrease the incidence of uremic crisis and regulate blood phosphorus concentrations. Because dysrexia (anorexia and hyporexia) is a common management challenge in cats with CKD, owners may choose to feed maintenance foods for all or part of the diet, which is suboptimal for the management of this disease.¹⁴ In addition, commercial maintenance foods marketed for senior cats also are often perceived by veterinarians to be adequately restricted in protein and phosphorus. In fact, the International Society of Feline Medicine (ISFM) guidelines recommend that cats with IRIS CKD stages 2 to 4 be fed exclusively a renal therapeutic food, consistent with IRIS guidelines. However, in cases of poor intake of the renal therapeutic food by the cat, the ISFM panel of experts recommends a food for senior cats rather than a maintenance food for adult cats.¹⁶ This recommendation is supported by a recent publication¹⁷ showing that healthy senior cats (≥ 9 years) fed a specific food formulated for senior cats and with moderate protein and phosphorus restriction (76 g and 1.6 g/1000 kcal, respectively) had improved calcium-phosphate homeostasis compared to those fed a specific control food (protein 86 g/1000 kcal and phosphate 2.6 g/1000 kcal). Notably, our results indicate that phosphorus (range, 1.5-4.4 g/1000 kcal) and protein (range, 77-139 g/1000 kcal ME) concentrations in foods for senior cats are highly variable. Only 3 foods for senior cats (9.7%; 3/31) included in our study had an average phosphorus concentration (based on analysis of 2 lot numbers) ≤ 1.6 g/1000 kcal ME with protein concentrations in these foods ranging 85 to 112 g/1000 kcal ME. Therefore, most foods for senior cats are not low in phosphorus as would be indicated for cats with CKD. Because of the lack of discrete guidelines and nutrient variability, caution should be taken when making broad recommendations for the use of commercially available foods for senior cats.

One-third of the foods for senior cats had phosphorus concentrations ≥ 3.6 g/1000 kcal ME, similar to the proportion of foods for adult cats exceeding this concentration in a previously reported nutritional analysis of 81 foods.⁹ This value is of concern considering that a previous study found an association between high phosphorus intake in cats with CKD before diagnosis compared to a group of control cats,¹⁸ and foods with excessive inorganic phosphorus (>3.6 g/1000 kcal ME of total phosphorus, with ≥ 1.5 g/1000 kcal ME as inorganic phosphorus) have been shown to promote ultrasonographic renal changes and

renolith formation in healthy cats.^{19,20} Therefore, the foods for senior cats with this excessive concentration of phosphorus are likely not ideal for healthy cats as well as for cats with CKD. Unlike in the foods for adult cats, however, none of the foods for senior cats had a phosphorus concentration ≥ 4.8 g/1000 kcal, a concentration shown to induce rapid renal damage in healthy cats.²⁰

Foods for senior cats had higher crude fiber content when compared to foods for adult cats. A possible explanation for this finding is that manufacturers are attempting to dilute caloric density of foods for senior cats to limit unwanted weight gain. Similar to dogs, evidence suggests that middle-aged cats (7-11 years of age) tend to have decreased maintenance energy requirements (MER) and a high proportion of overweight cats are middle-aged.^{1,8} An additional reason for the higher crude fiber content in foods for senior cats is to provide support of gastrointestinal health and motility. Crude fiber, however, is a rough assessment of insoluble fiber only and does not represent the total content of fiber in the food.²¹ The higher crude fiber content in foods for senior cats may also negatively impact digestibility while increasing fecal DM, which would be a concern if decreased nutrient digestibility is an important concern in senior cats as previously proposed.^{7,22} In addition, we found that foods for senior cats labeled for cats ≥ 11 years had significantly higher caloric density compared to those labeled for cats ≥ 7 years. A likely reason for this finding is that manufacturers aim to match MER increases after the age of 11 years with the largest increase occurring after 13 years of age in cats.^{23,24}

We found nutritional differences according to food form, with canned foods for senior cats having higher caloric density, fat, and sodium concentrations and lower magnesium concentrations when compared to dry foods for senior cats. In addition, foods for senior cats labeled for ≥ 11 years had higher caloric density and lower magnesium concentrations when compared to those labeled for ≥ 7 years. Although these findings do not apply to all food products for senior cats individually, these findings can be used by veterinarians as a guide when making specific dietary recommendations for senior cats. Assuming that adequate amounts of a higher moisture food can be consumed, canned foods may be helpful for ensuring appropriate intake in a senior cat with dysrexia or unintentional weight loss. In that case, veterinarians or pet owners may opt to evaluate the nutritional content of canned foods for senior cats labeled for cats ≥ 11 years of age, which may have higher caloric densities likely because of a higher fat content.

When available, 2 foods with different lot numbers were purchased for each food product for senior cats to determine variability between lot numbers. The difference in nutrient concentrations between the 2 foods was small overall and not significant. Any small differences possibly reflect variability in raw materials and manufacturing process.

Our study had some limitations. We included only over-the-counter foods for senior cats available for purchase within the Fort Collins, Colorado area, and therefore the sample population best represents the products that are available for the local cat owner. We could not evaluate the digestibility or bioavailability of the nutrients or evaluate any possible clinical consequences of our findings. Further research is

needed to determine the clinical implications of our findings. Additional research into the nutritional requirements of senior cats also is required, and it may inform future nutritional guidelines.

In conclusion, foods marketed for senior cats are highly variable in their nutrient content and caloric density. The concentrations of phosphorus and protein generally were higher compared to therapeutic renal foods. Therefore, general recommendations for the use of commercially available foods for senior cats is not advised, and veterinarians should make dietary recommendations based on the individual needs of the senior cat.

ACKNOWLEDGMENT

An abstract was presented at the 2020 American College of Veterinary Internal Medicine (ACVIM) Forum On Demand.

CONFLICT OF INTEREST DECLARATION

Authors declare no conflict of interest.

OFF-LABEL ANTIMICROBIAL DECLARATION

Authors declare no off-label use of antimicrobials.

INSTITUTIONAL ANIMAL CARE AND USE COMMITTEE (IACUC) OR OTHER APPROVAL DECLARATION

Authors declare no IACUC or other approval was needed.

HUMAN ETHICS APPROVAL DECLARATION

Authors declare human ethics approval was not needed for this study.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

How to cite this article: Summers SC, Stockman J, Larsen JA, Sanchez Rodríguez A, Zhang L. Evaluation of nutrient content and caloric density in commercially available foods formulated for senior cats. *J Vet Intern Med*. 2020;34:2029–2035. <https://doi.org/10.1111/jvim.15858>

**APPENDIX. CURRENT NUTRITIONAL GUIDELINES FOR
 SELECTED NUTRIENTS IN FOODS FORMULATED FOR
 ADULT MAINTENANCE IN CATS A.**

	Adult maintenance			
	NRC 2006 ⁵ minimum requirement/ adequate intake	NRC 2006 ⁵ safe upper limit	AAFCO 2019 ⁴ minimum concentration	AAFCO 2019 ⁴ maximum concentration
Protein (g/1000 kcal ME)	40	n/a	65	n/a
Fat (g/1000 kcal ME)	22.5	82.5	22.5	n/a
Carbohydrate (g/ 1000 kcal ME)	n/a	n/a	n/a	n/a
Phosphorus (g/ 1000 kcal ME)	0.35	n/a	1.25	n/a
Calcium (g/1000 kcal ME)	0.4	n/a	1.5	n/a
Magnesium (g/ 1000 kcal ME)	0.05	n/a	0.1	n/a
Potassium (g/ 1000 kcal ME)	1.3	n/a	1.5	n/a
Sodium (mg/ 1000 kcal ME)	160	>15 g/ kg dry matter	500	n/a
Iron (mg/1000 kcal ME)	20	n/a	20	n/a
Manganese (mg/ 1000 kcal ME)	1.2	n/a	1.9	n/a
Copper (mg/ 1000 kcal ME)	1.2	n/a	1.25	n/a
Zinc (mg/1000 kcal ME)	18.5	>600 mg/kg dry matter	18.8	n/a
Vitamin D3 (IU/ 1000 kcal ME)	56	7520	70	7520