

Feeding practices of dog breeders in the United States and Canada

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Objective—To determine the proportion of dog breeders who fed diets meeting the Association of American Feed Control Officials regulations for nutritional adequacy for reproduction and growth and to investigate factors that influenced feeding practices of breeders.

Design—Web-based cross-sectional survey.

Sample—2,067 dog breeders from the United States and Canada.

Procedures—A self-administered, anonymous, Web-based questionnaire was used to collect information on breeder demographics and feeding practices during 3 life stages of dogs: adult maintenance for nonpregnant dogs, gestation-lactation, and puppy growth. Appropriateness of commercial diets for each life stage was determined by respondent-reported nutritional adequacy statements on product labels. Data were also collected regarding breeder criteria for diet selection and sources of nutrition information.

Results—A substantial number of breeders reported feeding commercial diets not intended for that life stage during gestation-lactation (126/746 [16.9%]) and puppy growth (57/652 [8.7%]). Additionally, approximately one-seventh of breeders reported feeding home-prepared diets for ≥ 1 life stage. Unsubstantiated health and marketing information influenced diet selection of many breeders. Veterinarians, although generally viewed as a trusted source of nutrition information, were consulted by only 823 of 1,669 (49.3%) breeders and were viewed less favorably by breeders feeding home-prepared diets, compared with the opinion of breeders feeding commercial diets.

Conclusions and Clinical Relevance—Veterinarians should consider taking a more proactive role in directing dog breeders and other pet owners toward scientifically substantiated sources of diet information and in explaining the importance of current nutritional standards for reproduction and early development of dogs. (*J Am Vet Med Assoc* 2014;245:669–676)

A sound feeding strategy is considered essential for optimizing fertility, litter size, neonatal survival rate, and lactation in dogs.¹ Obesity reportedly is associated with reductions in fertility and litter size and increases in dystocia risk in dogs¹; however, these associations may have been extrapolated from data in humans or other animals. Undernourished dogs can have a decrease in fertility, lower puppy birth weight, poor lactation, and decreases in neonatal survival rate.^{2,3} Feeding of nutritionally incomplete diets during the growth period has been associated with developmental abnormalities in puppies and can even lead to death of puppies.^{4–8}

Nutritional demands during reproduction and growth differ appreciably, both in calories and individual nutrient requirements, from those for maintenance of adult dogs. Gestating and lactating bitches can have energy requirements more than double those for maintenance of an adult dog. Lactating bitches also require more protein, fatty acids, calcium, and phosphorus.^{1,9} Similarly, growing puppies have macronutrient and

ABBREVIATIONS

AAFCO	Association of American Feed Control Officials
AKC	American Kennel Club
CI	Confidence interval

micronutrient requirements that differ from those of adult dogs. Puppies require proportionally higher intakes of protein, fat, calcium, and total energy, with particular emphasis on sufficient amounts of essential amino acids and fatty acids.⁹

Recognizing the differences in nutritional demands attributable to reproduction, AAFCO publishes separate nutrient profiles for growth-reproduction and maintenance, with separate feeding trial protocols for maintenance, growth, and gestation-lactation.¹⁰ Commercial pet foods that are marketed as being complete and balanced diets (ie, containing all essential nutrients) must state on the label the life stage or stages for which the diet is designed and whether the diet was formulated to meet published nutrient profiles or has undergone feeding tests for that life stage. If the nutritional adequacy statement for a diet states that it is formulated to meet AAFCO nutrient profiles for all life stages, then the nutrient concentrations must meet at least the growth-reproduction minimums, and if the statement includes mention of feeding trials for all life stages, the product has undergone feeding trials for gestation-lactation and growth.

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Owner feeding patterns for adult and senior dogs and cats have been elucidated in several studies.^{11–13} However, the feeding practices of breeders with puppies and bitches during gestation-lactation have not been adequately described. Dog breeders are responsible for the nutrition of puppies in utero and during the immediate postnatal period. Additionally, breeders are often regarded as an important source for nutrition and care information by the subsequent owners of those puppies. For these reasons, it is important to determine the ability of dog breeders to navigate the growing knowledge base on nutrition and whether their attitudes toward nutrition and reproduction are consistent with scientifically validated feeding paradigms. A better understanding of feeding practices of dog breeders will help veterinarians who wish to take a more proactive role in ensuring reproductive and overall health of dogs. Therefore, the objective of the study reported here was to determine the proportion of dog breeders who fed diets that met the AAFCO nutritional adequacy standards for reproduction and growth and to investigate factors that influenced feeding practices of breeders. We hypothesized that a substantial number of dog breeders would be unfamiliar with AAFCO standards and would be feeding diets inappropriately formulated for animals during growth and reproduction.

Materials and Methods

Survey participants—Dog breeders were recruited to participate by posting an electronic link to a survey on social media sites associated with the Tufts Cummings School of Veterinary Medicine and the authors. Additional participants were recruited through email contact with each of the National Breed Clubs registered with the AKC; faculty, staff, students, and clients of the Tufts Cummings School of Veterinary Medicine and the Foster Hospital for Small Animals; and local veterinarians. Distribution of the electronic link to the survey was not restricted; any person who used the link was able to begin the survey and complete all questions if they met the inclusion criteria. Everyone contacted was encouraged to share the link and survey advertisement with their friends and colleagues.

Survey design—A self-administered, Web-based survey^a was used to collect information on breeder demographics and feeding practices during 3 life stages: adult maintenance for nonpregnant dogs, gestation-lactation, and puppy growth. The questionnaire was anonymous, although respondents were given the option of providing contact information for follow-up questions by telephone or email. The survey was developed and administered with assistance from the Tufts University Office of Institutional Research and Evaluation. Survey questions and recruitment materials were reviewed and granted an exemption by the Tufts University Institutional Review Board.

The survey consisted of 4 initial questions to screen for inclusion criteria. Those criteria were that breeders were from the United States or Canada, were 18 years old or older, had a bitch that had given birth to at least 1 litter, and had a bitch or bitches that had given birth to at least 1 litter every 2 years (ie, 0.5 litters/y). Participants

deemed eligible on the basis of the responses to those initial questions were then asked to provide answers for up to 48 multiple-choice questions, some of which included the option to provide additional information (eg, allowed respondents to type in the name of the commercial diet they were feeding). Answers to some questions influenced the total number and selection of questions each participant answered because some subsets of questions were specific to a feeding strategy or requested additional information only if a participant answered a specific question in the affirmative.

The survey consisted of 3 sections. The first section had questions on breeder demographic information (age, gender, postal code, highest level of education obtained, years of dog breeding experience, and total number of litters bred) and primary dog breed of interest.

The second section included up to 29 questions on feeding practices during 3 life stages (adult maintenance for nonpregnant dogs, gestation-lactation, and puppy growth) for the most recent litter. Participants were instructed to classify the diet that provided the majority (> 50%) of calories at each of these life stages into 1 of 6 categories: commercial kibble (dry) diets, commercial canned diets (which also included pouches and tubs), commercial raw diets (frozen or dehydrated), commercial dry premix diets (dehydrated products to which water and meat or other ingredients are added to produce a complete diet), raw home-prepared diets (containing raw animal protein), or cooked home-prepared diets (all animal products are cooked).

Breeders who fed commercial diets were given instructions to locate and report the AAFCO nutritional adequacy statement (AAFCO statement) as it appeared on the label of each commercial product that represented the main source of calories for each life stage. Exact wording for the AAFCO statements as well as photographs of actual AAFCO statements on pet food labels were provided to aid breeders in locating the statement on product labels. Breeders who fed home-prepared diets were asked whether they used a recipe to prepare the diet and, if so, to provide the source of the recipe (but not the recipe itself). Participants were also asked about any supplement-type products that might have been used. Participants were asked about recommendations they made regarding diet to new dog owners. Breeders of large- or giant-breed dogs were asked questions about the feeding practices specific to large-breed puppies.

The third section of the survey included up to 5 questions regarding factors that may have influenced diet perception and selection. Participants were asked to indicate their use and trust of various sources of nutrition information (eg, their veterinarian, the Internet, or pet food store employees), their agreement with a set of statements that are commonly used in pet food marketing and discussion (eg, statements implying reduced nutritive value of ingredients such as grains or by-products and statements regarding food safety), and their criteria for selecting a commercial product or their reason for feeding home-prepared diets (when applicable).

Data collection—An Internet-based survey package was used for data collection.^b This provided an

interface for validated data entry and export to an external statistics package. To preserve anonymity, personal contact information, when provided, was collected and maintained separately from survey responses. To encourage participation, a lottery for a \$100 gift certificate was offered as incentive to all participants who completed the last question of the survey and provided contact information. The survey link was active from May 16 to July 5, 2012. Potential duplicate entries were identified by the software on the basis of Internet protocol addresses and were also screened by the authors. Multiple entries from the same address were considered unique if they differed by the primary breed and demographic information.

Statistical analysis—Each of the 3 sections of the survey (demographics, feeding practices, and feeding influences) was considered completed if all questions in that section had been answered. Only completed sections were included in the data analysis. Nutritional adequacy of commercial diets was determined on the basis of respondent-reported AAFCO statements on product labels. Diets fed for maintenance were considered adequate if they passed feeding tests conducted by use of AAFCO protocols or were formulated to meet AAFCO nutrient profiles for adult maintenance, growth, gestation-lactation, or all life stages. Gestation-lactation and puppy growth diets were considered adequate if they had passed AAFCO feeding tests for the appropriate life stage or were formulated to meet AAFCO profiles for growth and reproduction or all life stages.

Postal codes were used to identify the location of each breeder on the basis of US census geographic regions (Northeast, South, Midwest, or West) or Canada. Descriptive statistics were calculated from categorical data frequencies and reported as the percentage of respondents who selected each response. All proportions represented the number of respondents who answered in a specific manner for a question divided by the total number of respondents who answered that question; each respondent did not answer every question. Relationships between demographic data, feeding practices, and influences on feeding practices were evaluated by use of χ^2 analysis with commercial statistics packages.^{c,d} Odds ratios and CIs were calculated for significant associations by use of a Web-based statistics program.^e Values of $P \leq 0.05$ were considered significant.

Results

Survey participants—During the 7 weeks of data collection, 2,411 respondents began the survey. A total of 2,067 dog breeders met the inclusion criteria, with 1,855 (89.7%) completing the last question. For incomplete questionnaires (212 [10.3%]), sections that were completed were included in the data analysis. Thus, 1,855 breeders completed the section on demographics (section 1), 1,913 breeders completed the section on feeding practices (section 2), and 1,855 breeders completed the section on feeding influences (section 3).

Most of the breeders who completed the survey were female, > 40 years old, and had attended some college classes, even if they did not earn their de-

gree (Table 1). Respondents were from 49 US states and Canada. The majority (1,240/1,855 [66.8%]) of respondents were caring for a pregnant or lactating bitch or puppies at the time of survey completion, and 1,761 (94.9%) had 3 or more adult dogs in their care. Respondents included breeders of 151 AKC-recognized breeds as well as 46 non-AKC-recognized purebred and mixed-breed dogs. Breeders of the 10 most represented breeds in the survey (Labrador Retriever, Golden Retriever, Beagle, German Shepherd Dog, Boxer, Chihuahua, Australian Shepherd, Bulldog, Dachshund, and Rottweiler) comprised 691 of 1,855 (37.3%) respondents. These 10 breeds closely aligned with the 10 most popular AKC-recognized breeds, as determined on the basis of registration data.¹⁴

Feeding practices—Most breeders reported that they fed a commercial diet (canned, kibble, raw, or

Table 1—Demographics of 1,855 dog breeders from the United States and Canada who completed the demographics section of a survey on feeding practices of breeders.

Variable	No. of breeders	%
Gender		
Female	1,543	83.2
Male	312	16.8
Age (y)*		
18–29	139	7.5
30–39	272	14.7
40–49	402	21.7
50–59	619	33.4
60–69	339	18.3
> 70	84	4.5
Region*		
Northeast	369	19.9
South	676	36.4
Midwest	429	23.1
West	297	16.0
Canada	84	4.5
Education		
Did not complete high school	16	0.9
High school or equivalent	260	14.0
Some college	723	39.0
Bachelor degree	438	23.6
Graduate degree	418	22.5
Experience		
No. of litters*		
1–3	309	16.7
4–8	389	21.0
> 8	1,157	62.4
No. of years*		
< 1	18	1.0
1–3	154	8.3
4–8	387	20.9
9–12	272	14.7
13–15	180	9.7
> 15	844	45.5
Litters/y		
0.5	570	30.7
1–2	839	45.2
3–5	319	17.2
> 5	127	6.9
Size of dog (kg [lb])†		
Toy (≤ 4.1 [≤ 9])	272	14.7
Small (4.5–10.9 [10–24])	427	23.0
Medium (11.4–22.3 [25–49])	522	28.1
Large (22.7–40.5 [50–89])	917	49.4
Giant (> 40.9 [> 90])	290	15.6

Regions in the United States were determined on the basis of US census geographic regions. *Percentage does not sum to 100% because of rounding. †Breeders could select > 1 category.

other) at each life stage (Figure 1). Only 217 of 1,913 (11.3%) breeders fed exclusively home-prepared diets for all 3 life stages. A number of breeders categorized their diets as raw commercial or dry premix commercial but indicated a brand of diet that was only available as dry or canned food. In these situations whereby the self-categorized commercial diet type and brand were inconsistent (288 for adult maintenance of nonpregnant dogs, 371 for lactation-gestation, and 349 for puppy growth), the diets were categorized as other commercial. These data were included in analysis of diet adequacy if the breeder provided the AAFCO statement from the product label. Most breeders (1,513/1,913 [79.1%]) reported that they fed the same type of diet (eg, commercial or home-prepared) for all 3 life stages, and 895 of 1,913 (46.8%) breeders fed their dogs the same commercial product or home-prepared recipe when not pregnant and during gestation-lactation. Most breeders (1,267/1,913 [66.2%]) reported that they weaned their puppies onto the same formula or recipe as was fed to the lactating dam. Almost all breeders (1,851/1,913 [96.8%]) indicated that they made specific diet recommendations to clients who purchased their puppies.

Significant associations were detected between diet type (eg, commercial vs home-prepared) and breeder gender (Table 1). Female breeders were 5.6 times as likely (95% CI, 2.7 to 11.5 [$P < 0.001$]) to exclusively feed home-prepared diets, compared with the likelihood for male breeders. There was regional variation in the types of diets fed. Home-prepared diets were fed most frequently ($P < 0.001$) by Canadian breeders (30/84 [35.7%]) fed exclusively home-prepared diets and fed least frequently by breeders from the Southern United States (44/676 [6.5%]) fed exclusively home-prepared diets). The proportion of breeders who fed exclusively home-prepared diets differed significantly ($P < 0.001$) by the level of education, with 1 of 16 (6.3%) among breeders who did not complete high school, 29 of 260 (11.2%) among breeders who completed high school, 57 of 723 (7.9%) among breeders who attended some college classes, 72 of 438 (16.4%) among breeders with a bachelor degree, and 48 of 418 (11.5%) among breeders with a graduate degree. When stratified by breed size, breeders of giant-breed dogs fed exclusively home-prepared diets significantly ($P = 0.01$) more frequently than did breeders of smaller breeds, and breeders of toy breeds fed home-prepared diets significantly ($P = 0.003$) less frequently than did breeders of larger breeds. There were no significant as-

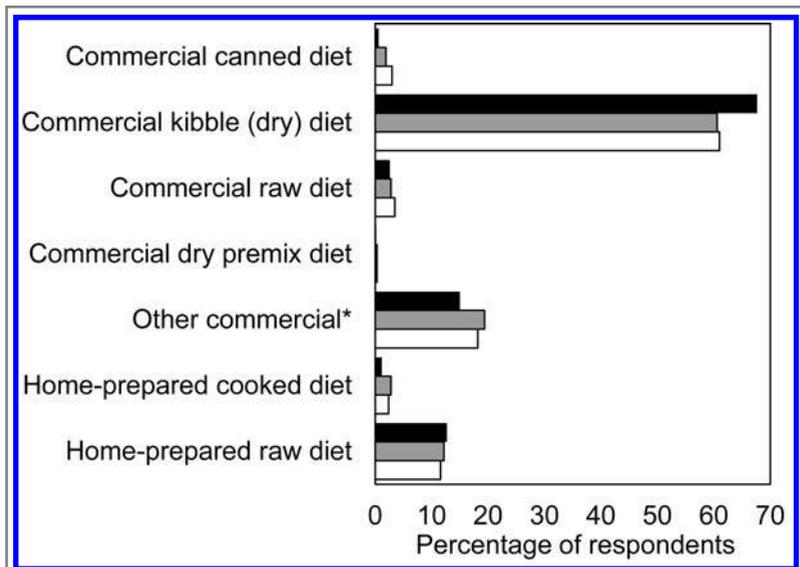


Figure 1—Primary sources of nutrition, by diet type, fed by dog breeders (n = 1,913) during each of 3 life stages: adult maintenance for nonpregnant dogs (black bars), gestation-lactation (gray bars), and puppy growth (white bars). Values reported are the percentage of breeders who reported feeding each diet type. *Some breeders fed a commercial premix or raw diet but indicated a known brand of dry or canned food; because the diet type could not be reliably determined, these responses were classified as other commercial.

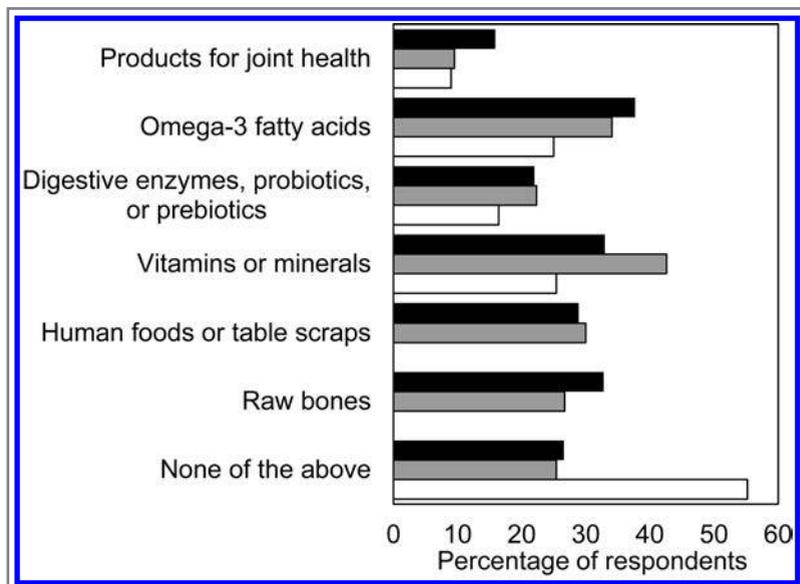


Figure 2—Sources of supplemental nutrients fed by dog breeders (n = 1,913) during each of 3 life stages (adult maintenance for nonpregnant dogs, gestation-lactation, and puppy growth). See Figure 1 for remainder of key.

sociations between diet type and age of breeder or years of dog breeding experience.

There were 1,115 of 1,913 (58.3%) breeders who added additional vitamins, minerals, omega-3 fatty acids, or products designed to support joint or digestive health to the main diet of nonpregnant adult dogs (Figure 2). Similar dietary supplementation during gestation-lactation was reported by 1,174 of 1,913 (61.4%) breeders. Many breeders (857/1,913 [44.8%]) reported that they recommended new owners supplement puppy diets with 1 or more vitamin-mineral, omega-3, joint health, or di-

gestive health products. Breeders who fed home-prepared diets were significantly more likely than were breeders who fed commercial diets to supplement the diets of their dogs during gestation-lactation (OR, 3.2; 95% CI, 2.3 to 4.3 [$P < 0.001$]) and the diets of their adult nonpregnant dogs (OR, 4.1; 95% CI, 3.0 to 5.8 [$P < 0.001$]), and breeders who fed home-prepared diets were 4.1 times as likely (95% CI, 3.0 to 5.4 [$P < 0.001$]) to recommend similar products and foods to the new owners of their puppies, compared with the likelihood for breeders who fed commercial diets.

The majority (1,124/1,855 [60.6%]) of breeders indicated they bred large- or giant-breed dogs and provided complete feeding and demographic information. Most (574/1,124 [51.1%]) of these breeders of large- and giant-breed dogs reported that they recommended large-breed puppy diets to new owners of their puppies. Many (670/1,124 [59.6%]) of these breeders of large- or giant-breed dogs recommended switching large- or giant-breed puppies to adult food before they were 12 months old, with 533 of 1,124 (47.4%) recommending switching them to an adult diet when they were ≤ 6 months old.

Nutritional adequacy—Nutritional adequacy was determined for commercial diets at each life stage on the basis of AAFCO statements on product labels. For commercial diets for adult maintenance of nonpregnant dogs, 868 of 1,086 (79.9%) breeders were able to report the AAFCO statement after being shown photographic examples of the statements from commercial product labels and being provided with the exact wording required on the label. On the basis of statements reported by breeders, 14 of 868 (1.6%) breeders fed commercial diets designated for intermittent or supplemental feeding to nonpregnant adult dogs. Of the 746 breeders who provided AAFCO statements for their commercial diets fed during gestation-lactation, 126 (16.9%) fed diets that were not nutritionally adequate for use in reproducing animals (ie, fed diets that were designated for adult maintenance of nonpregnant dogs or for intermittent and supplemental feeding). The majority (81/126 [64.3%]) of these breeders reported that they fed their pregnant or lactating dogs the same product that they fed for adult maintenance of nonpregnant dogs. For 652 breeders who provided the AAFCO statement from the commercial food fed to their growing puppies, 57 (8.7%) fed diets that were not designated to be nutritionally adequate for puppy growth. In most (51/57

[89.5%]) of these situations, puppies were fed the same diet as that of the lactating dam, which was designated for adult maintenance or intermittent or supplemental feeding rather than for growth and reproduction.

Nutritional adequacy of home-prepared diets was not determined because of the requirement for analytical or computer analysis of finished diets or diet recipes. There were many breeders who indicated that they did not use a specific recipe to prepare home-prepared diets (101/266 [38.0%]) for adult maintenance of nonpregnant dogs, 107/288 [37.2%] during gestation-lactation, and 102/269 [37.9%] for puppy growth). Depending on the life stage, breeders who fed home-prepared diets (21/269 [7.8%] for puppy growth to 23/266 [8.6%] for adult maintenance of nonpregnant dogs) reported consulting a PhD-trained animal nutritionist or board-certified veterinary nutritionist regarding their diet recipe. Similar numbers of breeders (18/266 [6.8%] for adult maintenance of nonpregnant dogs, 19/288 [6.6%] for gestation-lactation, and 20/269 [7.4%] for puppy growth) reported that they had consulted with someone who was not a board-certified veterinary nutritionist or a PhD-trained animal nutritionist.

Feeding influences—Breeders reported that veterinarians were the most trustworthy source of information on nutrition; however, less than half of the breeders reported consulting a veterinarian for diet information (Table 2). The type of diet fed by a breeder (home-prepared vs commercial) was significantly associated with breeder trust for all sources of information on nutrition. Breeders who exclusively fed home-prepared diets were 8.6 times as likely (95% CI, 1.0 to 12.1; $P < 0.001$) to rate veterinarians as not very trustworthy or not at all trustworthy as sources of nutrition information, compared with the likelihood for breeders who fed commercial diets. Compared with those who fed commercial diets, breeders who fed home-prepared diets significantly ($P < 0.001$) more frequently rated nonveterinarian websites, books, or email groups as very trustworthy or somewhat trustworthy sources of nutrition information. The majority (1,354/1,855 [73.0%]) of breeders reported that they were aware that veterinarians could be board-certified in veterinary nutrition.

Breeders were asked about factors that affected their decision to feed a particular diet type (commercial or home-prepared). Criteria for diet selection were reported for breeders who fed commercial diets (Tables 3 and 4). For the 322 breeders who fed home-prepared diets, the most com-

Table 2—Trust of various sources of nutritional information among dog breeders in the United States and Canada.

Source	No. of respondents	Very trustworthy	Somewhat trustworthy	Neutral	Not very trustworthy	Not at all trustworthy	Use this source*
Veterinarian	1,669	602 (36.1)	548 (32.8)	322 (19.3)	135 (8.1)	62 (3.7)	823 (49.3)
Website (nonveterinarian)†	1,638	97 (5.9)	553 (33.8)	677 (41.3)	212 (12.9)	99 (6.0)	630 (38.5)
Friend or family member‡	1,591	252 (15.8)	510 (32.1)	577 (36.3)	159 (10.0)	93 (5.9)	546 (34.3)
Book or magazine not written by veterinarian	1,620	89 (5.5)	541 (33.4)	720 (44.4)	197 (12.2)	73 (4.5)	502 (30.1)
Email group†	1,566	96 (6.1)	471 (30.1)	656 (42.0)	225 (14.4)	118 (7.5)	472 (30.1)
Pet store employee	1,586	29 (1.8)	188 (11.9)	554 (34.9)	417 (26.3)	398 (25.1)	209 (13.2)

Values reported are number (percentage).
*Each respondent often used multiple sources. †Value in row does not sum to 100% because of rounding.

mon reasons cited for feeding this type of diet were more control of dietary ingredients (164 [50.9%]), the perception that home-prepared diets were healthier (70 [21.7%]), and distrust of the commercial pet food industry (66 [20.5%]).

Most breeders agreed with unsubstantiated marketing statements that suggested grains, corn, and meat by-products are not healthy sources of nutrients in pet foods (Table 5). Agreement of breeders with these and 3 other statements regarding pet nutrition was not significantly associated with age, breeder experience, or education but was often associated with the breeder choice to feed home-prepared versus commercial diets. Breeders who used the

2 diet strategies (home-prepared vs commercial) responded significantly ($P < 0.001$) differently to statements about the safety of human food versus pet food and the nutrient qualities of by-products. In both cases, the majority (132/207 [63.8%] and 154/207 [74.4%], respectively) of breeders who fed exclusively home-prepared diets agreed, whereas the plurality (663/1,648 [40.2%] and 891/1,648 [54.1%], respectively) of breeders who fed commercial diets disagreed. Compared with breeders who fed commercial diets, breeders who exclusively fed home-prepared diets also were significantly ($P < 0.001$) more likely to agree with unsubstantiated marketing statements regarding corn and were significantly ($P < 0.001$) less likely to agree that raw diets posed risks for healthy pets.

Table 3—Criteria used by dog breeders ($n = 1,648$) for selection of a commercial diet.

Criterion	No. of breeders	%
Manufacturer's reputation or experience	1,053	63.9
Information on diet label, manufacturer website, television, or print material	738	44.8
Cost	675	41.0
Convenience and availability	667	40.5
Recommendation by friend or colleague	629	38.2
Diet is based on current research	529	32.1
Recommendation by veterinarian	403	24.5
Country of origin of ingredients or manufacturing	364	22.1
Recommendation by independent website or blog	126	7.7
Recommendation by pet store employee	43	2.6
None of the above	72	4.4

Each breeder often used multiple criteria for selection of a commercial diet.

Table 4—Criteria used for purchase of commercial diets among dog breeders ($n = 1,648$) who fed commercial diets during at least 1 life stage.

Criterion	No. of breeders	%
Meat is the primary ingredient	1,011	61.3
Contains no grain, corn, soy, or wheat	468	28.4
Contains human-grade ingredients	355	21.5
Contains no meat by-products	310	18.8
Natural or organic	278	16.9
Raw or minimally processed	138	8.4
Holistic	128	7.8
Low carbohydrate	89	5.4
None of the above	367	22.3

Each breeder often used multiple criteria for selection of a commercial diet.

Discussion

The study reported here provided some thought-provoking insights into feeding practices, and the factors that influence those practices, of dog breeders in the United States and Canada. One of the more concerning findings of the study was that 126 of 746 (16.9%) breeders who fed commercial diets reported feeding a commercial diet not intended for gestation-lactation to gestating and lactating bitches, and 57 of 652 (8.7%) breeders weaned puppies onto a diet not intended for puppy growth. These numbers likely underrepresented the total scope of the problem because not all breeders were able to provide AAFCO statement information. In addition, these data do not include breeders of large- or giant-breed puppies who fed puppy diets that might have been too high in calcium or energy for large- or giant-breed puppies. Currently, the AAFCO does not separate the needs of small dogs from those of large dogs, so it was not possible to determine whether the diets fed to large- or giant-breed puppies were appropriate for their size on the basis of the AAFCO statement alone. These data also do not take into account breeders who switched puppies to adult maintenance diets before the end of the growth period.

In most of the cases whereby the diets fed were not designated for the specific life stage, the issue resulted from the failure to switch from an adult maintenance diet to a diet designed for reproducing animals. Although the reason that breeders failed to switch was not specifically determined in the present study, lack of knowledge about the meaning or importance of the AAFCO statements on pet food labels as well as difficulty finding the statements may have contributed to

Table 5—Agreement of dog breeders ($n = 1,855$) with various nutrition statements.

Statement	Strongly agree	Somewhat agree	Neutral	Somewhat disagree	Somewhat disagree
Grain-free diets are healthier than diets containing grains.	442 (23.8)	507 (27.3)	566 (30.5)	233 (12.6)	107 (5.8)
Corn is a poorly digested filler when included in pet foods.	839 (45.2)	462 (24.9)	363 (19.6)	129 (7.0)	62 (3.3)
Meat by-products are poor sources of nutrients in pet foods.	443 (23.9)	468 (25.2)	514 (27.7)	306 (16.5)	124 (6.7)
Healthy adult dogs and puppies are at risk of illness from eating raw meat diets.	258 (13.9)	386 (20.8)	444 (23.9)	256 (13.8)	511 (27.6)
Human foods are generally safer from contamination with bacteria or toxins than commercial dry or canned foods.	199 (10.7)	366 (19.7)	597 (32.2)	443 (23.9)	250 (13.5)
Dietary supplements for dogs are regulated by the government to ensure quality and safety.	81 (4.4)	222 (12.0)	624 (33.6)	425 (22.9)	503 (27.1)

Values reported are number (percentage).

the number of breeders who fed inadequate diets. Increased client education and potentially standardized or more prominent placement of the AAFCO statement on pet food packaging would make this information more accessible to pet owners and help them to make better food choices.

A surprisingly large percentage (14.0% to 15.1%, depending on life stage) of breeders fed home-prepared diets to their reproducing animals and puppies. The nutritional adequacy of these diets could not be determined from the analysis; however, it is likely that most of these diets did not contain appropriate amounts of all essential nutrients. Almost one-third of breeders did not use a recipe to prepare their diets; of the 266 breeders who did use a recipe, only a small number (23 [8.6%]) consulted with a board-certified veterinary nutritionist or an individual with a PhD in animal nutrition when designing their diets. Similar numbers of breeders consulted with other individuals who were not PhD-trained animal nutritionists or board-certified veterinary nutritionists, which could suggest that PhD-trained animal nutritionists or board-certified veterinary nutritionists are not readily available to many pet owners. However, awareness seems less likely a factor because many respondents reported being aware of board-certified veterinary nutritionists. These results could also suggest that pet owners may not appreciate the potential advantages of collaborating with individuals with advanced training in nutrition inherent in board-certification or postgraduate studies in animal nutrition. The infrequency with which breeders consult nutritionists with advanced training for diet information is concerning because there is evidence that the source of a diet recipe can be important. Investigators in previous studies¹⁵⁻²⁰ have found that almost all published recipes for home-prepared diets fail to meet current nutrient recommendations for adult maintenance (and thus, by default, gestation-lactation and growth). Interestingly, in 1 study,¹⁵ only 9 of 200 recipes met AAFCO nutrient profiles for adult maintenance; these 9 included the only 4 diets formulated by board-certified veterinary nutritionists. Data from multiple case reports^{4,7,8,20,21} and the authors' clinical experience would suggest that improperly prepared home-prepared diets can rapidly lead to developmental abnormalities in growing dogs. The data in the present study underscore the importance of obtaining a recipe from a qualified source, keeping the recipe updated, and strictly adhering to the recipe when a breeder is unwilling to feed a nutritionally adequate commercial diet.

Up to one-third of respondents fed raw diets or bones. This rate is slightly higher than was reported in a 2008 survey¹¹ of dog owners in the United States and Australia in which 16.2% of dogs frequently consumed raw meat or bones. The proportion of breeders who fed raw meats or bones in the present study is of concern because this practice may increase the risk of infection from several clinically important pathogens and parasites, including *Salmonella* spp, *Campylobacter* spp, *Neorickettsia* spp, shiga toxin- and hemorrhagic *Escherichia coli*, *Toxoplasma* spp, *Trichinella* spp, and others.²²⁻²⁶ Additionally, the nutritional adequacy of many raw meat diets (commercial and home-prepared) is of

concern, and the 3 life stages used in the present study are times when nutritional deficiencies or excesses can have dire consequences.^{20,27}

More breeders fed supplement-type products in the study reported here than was reported in another study¹¹ of dog owners in which 9% reportedly fed supplement-type products. The high proportion of breeders who fed added nutrients via concentrated supplement-type products may pose a problem. Although adequate macronutrient and micronutrient nutrition is requisite for proper reproduction and development, provision of additional nutrients without evidence of deficiency, especially for some vitamins and minerals with narrow safety ranges (eg, selenium, vitamin A, vitamin D, and calcium for large-breed puppies), may lead to adverse effects.⁹

Although the amount of trust breeders had in veterinarians as nutrition experts was encouraging, less than half consulted with veterinarians for diet information. Considerably more breeders were influenced by recommendations from friends or colleagues or by information from a manufacturer's website or product label. Ingredient composition also appeared to influence breeders who fed commercial diets, with most having strong opinions on the nutritional value of select diet ingredients (such as corn, grains, or meat by-products) in pet foods. Not surprisingly, in the authors' experience, unsubstantiated statements regarding the merits or dangers of select dog food ingredients have been used to advertise specific dog food brands and have been used as rating criteria by pet food rating websites and publications for many years. Investigators of other studies^{11,28} have reported similar attitudes on pet foods and sources of nutrition information for pet owners in general. This highlights the importance of efforts by veterinarians to educate pet owners and assist them in distinguishing marketing claims and nutritional myths from nutritional facts.

The present study had some limitations. The use of a Web-only survey and electronic recruitment through social media sites may have led to bias by an underrepresentation of breeders who did not use these resources. Nutritional adequacy was determined only via the AAFCO statement for the diet that provided most of the calories; however, many respondents reported adding additional foods, including treats, human foods, and concentrated supplement-type products, which could have altered the appropriateness of the diets via nutrient dilution or as excessive amounts of nutrients. Home-prepared diets were fed by many breeders, including a large number who did not use a specific recipe. Additionally, a substantial percentage of breeders were unable to provide the AAFCO statement from the label of their commercial foods. Thus, it is likely that the results reported here underestimated the true incidence of inadequate nutrition for reproducing and growing animals.

There also were some issues with how the commercial diet categories were interpreted by some of the respondents. The dry premix category was intended to include commercial diet products formulated from dehydrated ingredients and that require the addition of water and a raw or cooked protein source. Howev-

er, most of the breeders who reported that they fed a dry premix product identified the brand of their diet as one that included only kibble (dry) or canned food. In these cases, breeders may have mischaracterized a diet in which they mixed a commercial dry or canned food with another protein source as a dry premix diet. Because many of these breeders provided the AAFCO statement for these diets, they were included in the analysis of nutritional adequacy for commercial diets. However, it was not possible to determine the additional ingredients a breeder may have fed along with the premix diet, and the proportion of breeders who fed raw foods may have been underestimated.

Despite these limitations, a concerning proportion of dog breeders surveyed in the present study fed their reproducing and growing dogs diets that did not meet AAFCO model regulations for nutritional adequacy of 1 or more life stages. Additional studies are needed to better understand the true prevalence of feeding nutritionally inadequate diets and the reasons for these practices. However, a lack of full understanding of nutritional adequacy standards, the failure to recognize the special nutritional needs of gestating-lactating bitches and puppies (especially large- or giant-breed puppies), or excessive use of treats, table foods, and concentrated supplement-type products may all have contributed to this pattern. In addition, up to 15% of breeders fed home-prepared foods to reproducing and growing dogs, which also raises substantial concerns about nutritional adequacy. Almost all breeders made recommendations regarding feeding practices to new dog owners, which can perpetuate misinformation. Veterinarians, as a generally trusted source of nutrition information, should consider taking a more proactive role in directing dog breeders and their clients toward scientifically substantiated sources for nutrition information and in making specific nutritional recommendations for dogs of various life stages. Additionally, both pet owners and veterinarians would likely benefit from greater access to board-certified veterinary nutritionists and PhD-trained animal nutritionists, particularly for clients determined to feed home-prepared diets.

- Survey is available from the corresponding author on request.
- Qualtrics Survey Research Suite, Qualtrics, Provo, Utah.
- Minitab, version 16, Minitab Inc, State College, Pa.
- SPSS Statistics, version 22, IBM, Armonk, NY.
- VassarStats: website for statistical computation. Available at: www.vassarstats.net. Accessed Nov 13, 2013.

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