

## Dog Age and Breeds Associated with High Plasma Cholesterol and Triglyceride Concentrations

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**ABSTRACT.** The objectives of this study were to set specific dog breed and sex standards for total cholesterol (T-Cho) and total triglyceride (T-TG) concentrations in dogs and to quantify the associations between dog age and concentrations of both lipids for different breeds. Increased age was associated with higher T-Cho and T-TG concentrations in all five breed groups ( $P < 0.05$ ); T-Cho concentrations increased by 62.5 mg/dl between 9 and 16 years of age, and T-TG concentrations increased by 4.8 mg/dl per year of age ( $P < 0.05$ ). Miniature Schnauzers had the highest T-Cho concentrations of the studied breeds, while Miniature Dachshunds had the lowest concentrations ( $P < 0.05$ ). Veterinarians should consider dog age and breed when they use the lipid concentrations for diagnostic purposes.

**KEY WORDS:** breeds, canine, cholesterol, triglycerides.

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Total cholesterol (T-Cho) and total triglyceride (T-TG) concentrations in dogs are routinely measured during health checks in small animal clinics [1]. Higher concentrations of T-Cho and T-TG can result from high fat diets, diseases and obesity [2], and the development of diseases and obesity are influenced by dog characteristics, such as age, breeds, sex and de-sexing status [4, 7]. Therefore, concentrations of both lipids could differ depending on these dog characteristics.

Higher lipid concentrations are relatively uncommon in dogs and are usually associated with specific breeds [17]. Genetic or idiopathic high concentrations of T-Cho and T-TG have been reported to be familial in certain pure breeds, such as Miniature Schnauzers and Shetland Sheepdogs [17]. Additionally, the magnitude of the abnormal T-Cho and T-TG levels in these breeds tends to differ with dog age and sex. A previous study has reported that older Miniature Schnauzers were more likely to have moderate to severe hypertriglyceridemia than younger dogs [18]. Also, female Miniature Schnauzers experienced more severe hyperlipidemia than the males [13].

Many studies have quantified associations between the T-Cho and T-TG concentrations and dog characteristics, but few studies have established a set of standards for these lipid concentrations. Therefore, the objectives of the present study were to set standards for T-Cho and T-TG concentrations based on specific breeds, sex and de-sexing status and also

to quantify the associations between age and concentrations of both lipids by breeds.

Data were obtained on dogs that were treated by a veterinary clinic between January and August 2012. The clinic collected blood samples from dogs that had initially visited the clinic to be checked for microfilariasis prior to the administration of prophylactic agent. Plasma T-Cho and T-TG concentrations in samples were determined by the clinic using an automated spectrophotometric analyzer (DRI-CHEM3000V, Fujifilm Inc., Tokyo, Japan). The clinic also collected information about each dog including age, breed, sex and de-sexing status and also gave each dog a five-point body condition score (BCS). Website information and brochures on the BCS scale system are widely available in Japanese veterinary clinics, provided by PFI (Washington, D.C., WA, U.S.A.) and a nutrition company (Hill's-Colgate (JAPAN) Ltd., Tokyo, Japan).

Dogs were classified into sex groups (male dogs or female dogs) and de-sexing status groups (intact dogs or de-sexed dogs). The dogs were also classified into five breed groups, based on two previous studies: Miniature Schnauzers, Labrador Retrievers, Miniature Dachshunds, Shiba Inus and a group of other breeds that comprised all the remaining dogs. Miniature Schnauzers and Labrador Retrievers are reportedly at greater risk of having higher cholesterol or triglyceride concentrations [14]. Also, Miniature Dachshunds and Shiba Inus have been found to have the lowest concentrations of T-Cho among 21 breeds [12].

All statistical analyses were performed using SAS software (SAS Int. Inc., Cary, NC, U.S.A.). A general linear model with a Tukey-Kramer multiple comparisons test was performed to investigate associations between concentrations of T-Cho and T-TG and dog characteristics. The outcome variable in the model was T-Cho or T-TG concentrations. Explanatory variables in the model were dog age, breed, sex

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and de-sexing status. Quadratic expressions of age and possible two-way interactions between explanatory variables were examined in the model, but were then removed from the model if they were not significant ( $P \geq 0.05$ ). Additionally, normality of the residuals in each of the final models was evaluated by using normal probability plots [8].

The initial data comprised 500 dogs from 51 breeds. There were no dogs that showed basic symptoms of diseases, such as diabetes mellitus, hypothyroidism or hyperadrenocorticism, all of which are related to hyperlipidemia [18]. In our study, we excluded the data of obese dogs (BCS=5) [3]. Thus, the final data used in the present study consisted of 487 dogs from 51 breeds. Mean age (range) was 6.3 years (0 to 16 years old; Table 1), and mean ( $\pm$  SEM) T-Cho and T-TG concentrations were  $204.7 \pm 3.26$  and  $85.7 \pm 3.40$  mg/dl, respectively. Relative frequencies (% dogs) of concentrations of both lipids are shown in Fig. 1.

Higher T-Cho concentrations were associated with increased age, a quadratic expression of the age and breeds ( $P < 0.05$ ), but not with sex ( $P = 0.98$ ) or de-sexing status ( $P = 0.87$ ; Table 2). Miniature Schnauzers had higher T-Cho concentrations than Miniature Dachshunds ( $P < 0.05$ ; Table 3). In Miniature Schnauzers, the T-Cho concentrations increased from 264.4 to 326.9 mg/dl, as dog age rose from 9 to 16 years old (Fig. 2). In Miniature Dachshunds, there was a

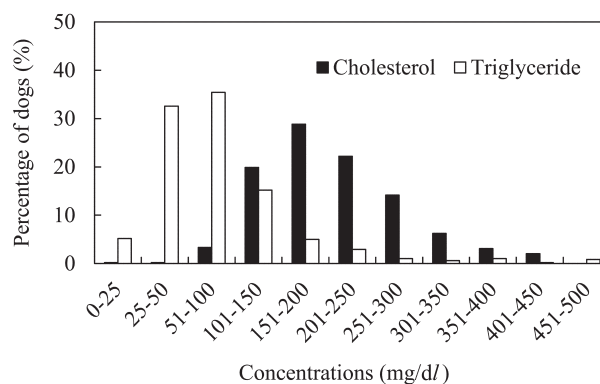


Fig. 1. Frequency distributions of total cholesterol and triglyceride concentrations in studied dogs.

similar increase in T-Cho concentrations (168.0 to 230.5 mg/dl) over the same age range. No two-way interactions were found for T-Cho concentrations between age, breed, sex or de-sexing status ( $P > 0.18$ ).

Higher T-TG concentrations were also associated with increased age ( $P < 0.05$ ), but not with breed ( $P = 0.09$ ), sex ( $P = 0.67$ ) or de-sexing status ( $P = 0.27$ ; Table 2). The T-TG

Table 1. Age, total cholesterol and total triglyceride concentrations in 487 studied dogs

Measurements	N	Mean $\pm$ SEM	Percentile	
			5th	95th
Age, years*	453	6.3 $\pm$ 0.18	1	13
Total cholesterol concentrations, mg/dl	487	204.7 $\pm$ 3.26	108	345
Total triglyceride concentrations, mg/dl	487	85.7 $\pm$ 3.40	25	222

\*34 dogs (487 - N) did not have age information.

Table 2. Parameter estimates ( $\pm$  SE) for the explanatory variables in the final models for total cholesterol and total triglyceride concentrations with R-squared values

Explanatory variables	Total cholesterol concentrations		Total triglyceride concentrations	
	Estimate ( $\pm$ SE)	P-value	Estimate ( $\pm$ SE)	P-value
Intercept	206.62 (11.37)	<0.01	64.64 (9.51)	<0.01
Age	-4.15 (3.07)	0.17	4.75 (0.94)	<0.01
Age $\times$ age	0.52 (0.22)	0.01		0.69
Breed		<0.01		0.09
Miniature Schnauzer	52.11 (20.69)		30.55 (21.19)	
Labrador Retriever	11.68 (17.11)		-27.52 (17.50)	
Miniature Dachshund	-44.23 (9.82)		-18.63 (10.04)	
Shiba Inu	-17.86 (15.80)		-4.34 (16.18)	
Other breeds	0		0	
Sex status		0.98		0.67
Male dogs	0.15 (6.62)		-2.89 (6.78)	
Female dogs	0		0	
De-sexing status		0.87		0.27
Intact dogs	1.14 (7.02)		-7.85 (7.19)	
De-sexed dogs	0		0	
R-squared	0.09		0.07	

Table 3. Comparisons of total cholesterol concentrations between dog breed groups

Breed groups	Total cholesterol concentrations, mg/dl	
	N	Mean $\pm$ SE*
Miniature Schnauzer	13	261.1 $\pm$ 20.3 <sup>a)</sup>
Labrador Retriever	18	220.7 $\pm$ 16.7 <sup>a)</sup>
Miniature Dachshund	65	164.8 $\pm$ 9.1 <sup>b)</sup>
Shiba Inu	23	191.1 $\pm$ 15.4 <sup>a,b)</sup>
Other breeds	363	209.0 $\pm$ 3.9 <sup>a)</sup>

a, b) Means within a column with different letters differ ( $P < 0.05$ ). Mean and SE were estimated by a generalized linear model.

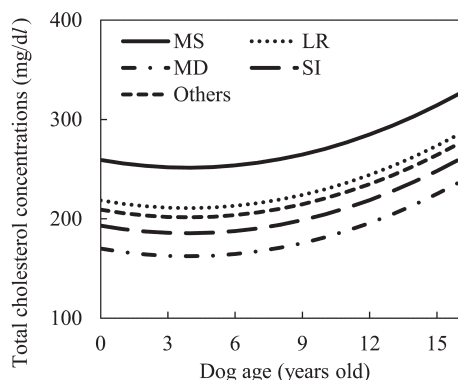


Fig. 2. Estimated total cholesterol concentrations of dog breed groups\* by age. \*Abbreviations: Miniature Schnauzer (MS), Labrador Retriever (LR), Miniature Dachshund (MD), Shiba Inu (SI) and other breeds (Others).

concentrations increased by 4.8 mg/dl for each increased year of age, but no relationship with a quadratic expression of age was found for T-TG concentrations ( $P = 0.69$ ). Also, there were no two-way interactions between age, breed, sex or de-sexing status ( $P > 0.06$ ).

The R-squared values for each model are shown in Table 2. Also, a list of the 15 breeds of dogs studied with the highest concentrations of T-Cho and T-TG is shown in the Appendix, for practicing veterinarians to use as a reference.

Our study quantified the associations between higher lipid concentrations (T-Cho and T-TG) and increased age and showed that T-Cho concentrations increased rapidly, particularly from 9 years of age. Increased age is related to decreasing physical activity [7] and with increased risk of developing health abnormalities associated with higher T-Cho and T-TG concentrations [4–6]. Our present data have confirmed the results of a previous study which showed that increased age raises the risk of hyperlipidemia and hypertriglyceridemia in dogs [17].

Our results showed that the highest T-Cho concentrations were found in Miniature Schnauzers, and this indicates that high T-Cho concentrations are related with specific breeds. Other studies have also shown that Miniature Schnauzers have innately higher T-Cho concentrations than other breeds [2, 13]. These data suggest that the concentration of T-Cho

in the blood is genetically related. However, our study found no association between T-TG concentrations and breed, in contrast to a previous study showing that there were differences in T-TG concentrations between breeds [13].

De-sexed dogs tend to exhibit lower physical activity, higher food consumption and lower metabolic rates than intact dogs [3, 15]. Also, the metabolic rate is generally higher in male dogs than female dogs [10, 11]. However, in our study, there were no associations between either sex or de-sexing status and T-Cho or T-TG concentrations. It is known that cholesterol and triglycerides are transported by lipoproteins in the blood [9, 17]. In a previous study, we found that lipoprotein cholesterol and triglyceride concentrations differed between intact and de-sexed dogs [16]. In veterinary clinics, total concentrations of both lipids are routinely measured as a first step to indicate health abnormalities [1]. However, our study suggests that T-Cho and T-TG concentrations do not explicitly indicate the possible health problems in different sex or de-sexing status groups. Therefore, we recommend that veterinarians conduct more detailed analysis and examine the concentrations of cholesterol and triglycerides in each of the different classes of lipoproteins in order to help identify appropriate therapies.

In conclusion, it is recommended that veterinarians consider dog age and breeds when they use the T-Cho and T-TG concentrations for diagnostic purposes. However, measuring T-Cho and T-TG concentrations in dogs is just the first step to indicate the possibility of health problems. The relatively low R-squared values in our study indicate that other variables which we did not measure are also associated with lipid concentrations, e.g. dog rearing environment and body weight.

It should be noted that there are some limitations in the present study because it was an observational study performed by collecting data from blood samples from only one veterinary clinic in Tokyo over one 8 month period. Additionally, only one analyzer was used to measure T-Cho and T-TG concentrations. Finally, since the dogs that were studied had come in for a microfilariasis test, this meant that the dogs had not fasted before blood sample collection. However, even with such limitations, this research provides valuable information for veterinarians about the factors related to T-Cho and T-TG concentrations in dogs.

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