

Association between breed, gender and age in relation to cardiovascular disorders in insured dogs in Japan

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ABSTRACT. The association between breed, gender and age and cardiovascular disorders in the insured dog population in Japan was investigated, using multiple logistic regression analysis and data from 299,555 dogs insured between April 2010 and March 2011. The overall annual prevalence of cardiovascular disorder diagnosis was 2.1%. Using the Miniature Dachshund as the reference breed, Cavalier King Charles Spaniel had the highest odds of cardiovascular disorder with a ratio of 16.2 (95% confidence interval: 14.4–18.2), followed by Maltese, Pomeranian, Chihuahua and Shih Tzu. Male dogs had increased odds of 1.2 (1.1–1.3). The dogs had increased odds of having cardiovascular disorder by 1.5 times as their age increased by one year.

KEY WORDS: canine, cardiovascular disorder, insurance, multiple logistic regression analysis

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Knowing the risk factors of disease occurrence is important to maintain the health and prevent diseases in companion animals. Estimating the effect of breed, gender and age on disease occurrence in a population provides owners of companion animals, veterinarians, breeders and researchers with useful information. However, in most countries, there is no disease database of companion animals, and little information is available about the risk factors of companion animal diseases.

Cardiovascular disorders in the dog are of major importance in terms of animal health and welfare. Much literature supports the predisposition of dogs to cardiovascular disorders by breed, gender and age [3, 7, 11]. Several epidemiological studies have been conducted in this respect: A study has been conducted to describe the gender, age and breed pattern of diagnoses including cardiovascular disorders in insured dogs in Sweden [5] and to investigate the association between breed, gender and cardiovascular disorders in the U.K. [12]. Also, using insured dog data in Sweden, cardiac-related mortality for dogs by breed and gender has been estimated [6], and the prevalence of chronic valvular disease in Cavalier King Charles Spaniels in comparison with other breeds has been studied [8]. In this study, we assessed the effect of breed, gender and age on the prevalence of cardiovascular disorders in dogs insured by Anicom, using multiple logistic regression analysis.

The Anicom pet insurance program covers veterinary care costs. Healthy dogs younger than 11 years old are eligible to enter the Anicom insurance program. The insurance policy term is one year from the enrolment date, and the owner can choose to renew the policy at the end of each policy year until the dog dies. The insurance claims are settled by the attending veterinarians, who submit the claims to the insurance company. Basic data about the dog, such as the date of birth, breed and gender, are submitted at the time of enrolment into the insurance program. The date of visit to the veterinarian, amount paid for the treatment and reason for the claim are submitted with the claim.

Data on all dogs aged 0–18 years that entered an insurance program or renewed the insurance policy during fiscal year 2010 (1 April 2010–31 March 2011) were entered into a database for this study. These dogs were observed for one year from the date of entrance into, or renewal of, the insurance program. The variables included in the database were breed, gender and age at entrance into or renewal of the insurance program. Data on claims for veterinary care, including the reasons for claims, were entered into the database. The reasons for claims stated on the claim form were used as diagnostic information and were divided into one of the 18 diagnostic categories by type of disease or body system according to the standardized list of diseases developed by this insurance company [1]. If an owner cancelled the insurance program during the observation period, data were excluded from the study. A total of 299,555 dogs were observed for one year and subjected to the analysis in this study. Their distributions by gender, age and breed are shown in Table 1. Data of these 299,555 dogs were analyzed with respect to breed, gender and age. A total of 6,211 dogs had at least one claim for cardiovascular disorder, representing 2.1% of the study population (annual prevalence).

Those dogs that had at least one claim for cardiovascular

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Table 1. Summary statistics for the insured dog population used in the analysis

	Number of dogs in the population	%	Number of dogs that had at least one claim for cardiovascular disorders (annual prevalence in %)	
Total	299,555	100.0	6,211	(2.1)
<i>Gender</i>				
Male	158,058	52.8	3,535	(2.2)
Female	141,497	47.2	2,676	(1.9)
<i>Breed</i>				
Miniature Dachshund	50,323	16.8	682	(1.4)
Chihuahua	46,414	15.4	1,066	(2.3)
Toy Poodle	45,382	15.1	366	(0.8)
Shiba	14,647	4.9	118	(0.8)
Yorkshire Terrier	10,622	3.6	286	(2.7)
Pomeranian	9,365	3.1	298	(3.2)
Pembroke Welsh Corgi	9,031	3.0	80	(0.9)
Papillon	8,965	3.1	170	(1.9)
Shih Tzu	8,239	2.8	569	(6.9)
Miniature Schnauzer	8,123	2.7	187	(2.3)
French Bulldog	6,804	2.3	52	(0.8)
Labrador Retriever	6,422	2.1	123	(1.9)
Cavalier King Charles Spaniel	5,743	1.9	779	(13.6)
Golden Retriever	5,377	1.8	143	(2.7)
Maltese	5,056	1.7	296	(5.9)
Pug	4,245	1.4	48	(1.1)
Jack Russell Terrier	3,840	1.3	34	(0.9)
Beagle	3,379	1.1	93	(2.8)
Miniature Pinscher	3,152	1.1	34	(1.1)
Others	44,426	14.8	787	(1.8)
<i>Age</i>				
0	59,116	19.7	256	(0.4)
1	46,712	15.6	173	(0.4)
2	28,700	9.6	130	(0.5)
3	34,064	11.4	217	(0.6)
4	31,142	10.4	299	(1.0)
5	28,078	9.4	418	(1.5)
6	24,357	8.1	598	(2.5)
7	17,248	5.8	702	(4.1)
8	10,594	3.5	666	(6.3)
9	7,051	2.4	634	(9.0)
10	5,228	1.7	609	(11.6)
11	3,363	1.1	562	(16.7)
12+	3,902	1.3	947	(24.3)

disorder were considered to have that disorder. We estimated the odds ratios for cardiovascular disorder using multiple logistic regression analysis. The independent variables used were breed, gender and age. We selected the top 19 represented breeds including Miniature Dachshund, Toy Poodle, Shiba, Yorkshire Terrier, Pomeranian, Pembroke Welsh Corgi, Papillon, Shih Tzu, Miniature Schnauzer, French Bulldog, Labrador Retriever, Cavalier King Charles Spaniel, Golden Retriever, Maltese, Pug, Jack Russel Terrier, Beagle and Miniature Pinscher. We placed all other breeds and

crossbreeds as 'other breeds'. To represent the 19 breeds and 'other breeds', we used 19 dummy variables (binary variables that take on the value 0 or 1 for some categorical effect, in this case, breed effect). We used Miniature Dachshund (the breed with the highest frequency) as the reference dog breed. We used the age as a linear variable after comparing between a model with the age as linear variable and a model with the age as categorical variable using the Akaike information criterion (AIC).

We performed the statistical analysis using StatTools Version 6 (Palisade, Ithaca, NY, U.S.A.). Table 2 shows the effect of gender, age and breed on the annual prevalence of cardiovascular disorder. Using the Miniature Dachshund as the reference breed, Cavalier had the highest odds of cardiovascular disorder with a ratio of 16.2 (95% confidence interval: 14.4–18.2), followed by Maltese, Pomeranian, Chihuahua and Shih Tzu. Male dogs had increased odds of 1.19 (1.13–1.25). The odds ratio of the linear variable age was 1.50 (1.49–1.52). This indicates that the odds of dogs having cardiovascular disorder increased 1.5 times as their age increased by one year.

We also predicted the annual prevalence using the logistic regression model and the obtained odds ratios as input variables. To incorporate the uncertainty of the model results arising from the uncertainty of input variables, we used Monte Carlo simulation and ran 10,000 iterations. The simulations were performed using software @Risk 6.3 (Palisade) added into the spreadsheet software Excel 14.0 (Microsoft Corporation, Redmond, WA, U.S.A.). Figure 1 shows the predicted annual prevalence of cardiovascular disorder for different genders of the reference breed (Dachshund) and three breeds with highest odds ratios (Cavalier King Charles Spaniel, Maltese and Pomeranian). The annual prevalence of cardiovascular disorder actually observed was mostly within the 95% confidence interval of the predicted annual prevalence, indicating the validity of the logistic regression model that we used.

In generalizing the results of a study using the insured dog population in Japan, there are some potential biases that we should keep in mind [9]. They are age distribution (biased toward younger ages, because the insurance process is relatively new) [1, 10]; breed distribution (pure breeds are over-represented compared to the general population) [1, 10]; accessibility to veterinary care (insured dogs are more likely to receive expensive veterinary care); and habitat (dogs living in urban areas are over-represented compared to those living in rural areas) [1]. The first two potential biases are corrected in the present study by using multiple logistic regression analysis. To account for other potential sources of bias, further studies are needed with additional information on these sources.

In the present study, we used the age, breed and gender as independent variables for the analysis, because they are the only risk factors on which information was available using the insurance database. However, there are other potential risk factors that might affect the occurrence of cardiovascular disorders, such as obesity, diet, exercise and habitat.

To account for other potential risk factors, further studies

Table 2. Effect of age, gender and breed on the prevalence of cardiovascular disorders

Variable	Coefficient	Odds ratio	(95% CI)	P value
Constant	-6.89	—		<0.0001
Age	0.41	1.50	(1.49, 1.52)	<0.0001
<i>Gender</i>				
Female (reference)	0.00	1.00		
Male	0.17	1.19	(1.13, 1.25)	<0.0001
<i>Breed</i>				
Min. Dachshund (reference)	0.00	1.00		
Chihuahua	1.34	3.81	(3.44, 4.21)	<0.0001
Poodle, Toy	0.51	1.66	(1.46, 1.90)	<0.0001
Shiba	-0.21	0.81	(0.67, 0.99)	0.0438
Yorkshire Terrier	0.82	2.27	(1.96, 2.63)	<0.0001
Pomeranian	1.39	4.02	(3.47, 4.65)	<0.0001
Pembroke Welsh Corgi	-0.65	0.52	(0.41, 0.66)	<0.0001
Papillon	0.42	1.52	(1.27, 1.81)	<0.0001
Shih Tzu	1.22	3.38	(2.99, 3.82)	<0.0001
Miniature Schnauzer	0.81	2.24	(1.89, 2.66)	<0.0001
French Bulldog	0.30	1.34	(1.01, 1.79)	0.0435
Labrador Retriever	-0.31	0.74	(0.60, 0.90)	0.0026
Cavalier King Charles Spaniel	2.78	16.2	(14.4, 18.2)	<0.0001
Golden Retriever	0.26	1.30	(1.07, 1.57)	0.0069
Maltese	1.70	5.48	(4.71, 6.38)	<0.0001
Pug	0.14	1.15	(0.85, 1.56)	0.3582
Jack Russell Terrier	0.23	1.25	(0.88, 1.78)	0.2073
Beagle	0.35	1.43	(1.13, 1.79)	0.0025
Miniature Pinscher	0.40	1.49	(1.04, 2.13)	0.0279
Others	0.40	1.49	(1.34, 1.65)	<0.0001

are needed with additional information on these factors.

The odds ratios that we obtained for different breeds were consistent with our previous study using the same data, in which increased annual prevalence was observed for cardiovascular disorders in Cavalier King Charles Spaniel, Maltese, Chihuahua, Pomeranian and Shi Tzu [9]. Our results were mostly consistent with the results of previous studies in other countries: Egenvall *et al.* [5] reported that, using data of insured dogs in Sweden, Cavalier King Charles Spaniel, Irish Wolfhound, St. Bernard, Pekingese and Great Dane have the highest risk of cardiovascular disorders (In our study, the last four breeds were classified as 'other breeds'). Thrusfield *et al.* [12] conducted an observational study of a veterinary clinic population in the United Kingdom and concluded that Miniature Pinscher, Standard Poodle, King Charles Spaniel, Miniature Poodle, Toy Poodle and Chihuahua had higher odds of having canine heart valve incompetence than other breeds and that males were more susceptible than females to this disease. Evangell *et al.* [6], using the data of insured dogs in Sweden, estimated the cardiac-related mortality for dogs less than 10 years of age by breed and gender and concluded that some breeds, including Irish Wolfhound, Cavalier King Charles Spaniel and Great Dane, had higher cardiac-related mortality than other breeds. Häggström *et al.* [8] also using data of insured dogs in Sweden, studied the prevalence of chronic valvular disease in Cavalier King Charles Spaniels and found that this breed had claims for veterinary care or death or euthanasia five times more than dachshunds.

Among cardiovascular disorders, heart valve incompetence, cardiomyopathy and patent ductus arteriosus (PDA) are relatively common to companion dogs, and hemangiosarcoma to some breeds, such as Golden Retriever and German Shepherds [2, 4, 13]. In the present study, no distinction was made between these diseases. However, the effect of age, gender and breed might be different between these diseases. Further studies are needed to identify and quantify the risk factors for these diseases.

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REFERENCES

1. Anicom Insurance Inc. *White Paper on Household Animals 2014* (in Japanese). http://www.anicom-page.com/hakusho/book/pdf/book_201411.pdf.
2. Aronsohn, M. 1985. Cardiac hemangiosarcoma in the dog: a review of 38 cases. *J. Am. Vet. Med. Assoc.* **187**: 922–926. [Medline]
3. Asher, L., Diesel, G., Summers, J. F., McGreevy, P. D. and Collins, L. M. 2009. Inherited defects in pedigree dogs. Part 1: disorders related to breed standards. *Vet. J.* **182**: 402–411. [Medline] [CrossRef]
4. Côté, E. 2010. *Clinical Veterinary Advisor: Dogs and Cats*, 2nd Edition. Elsevier, London.
5. Egenvall, A., Bonnett, B. N., Olson, P. and Hedhammar, A. 2000.

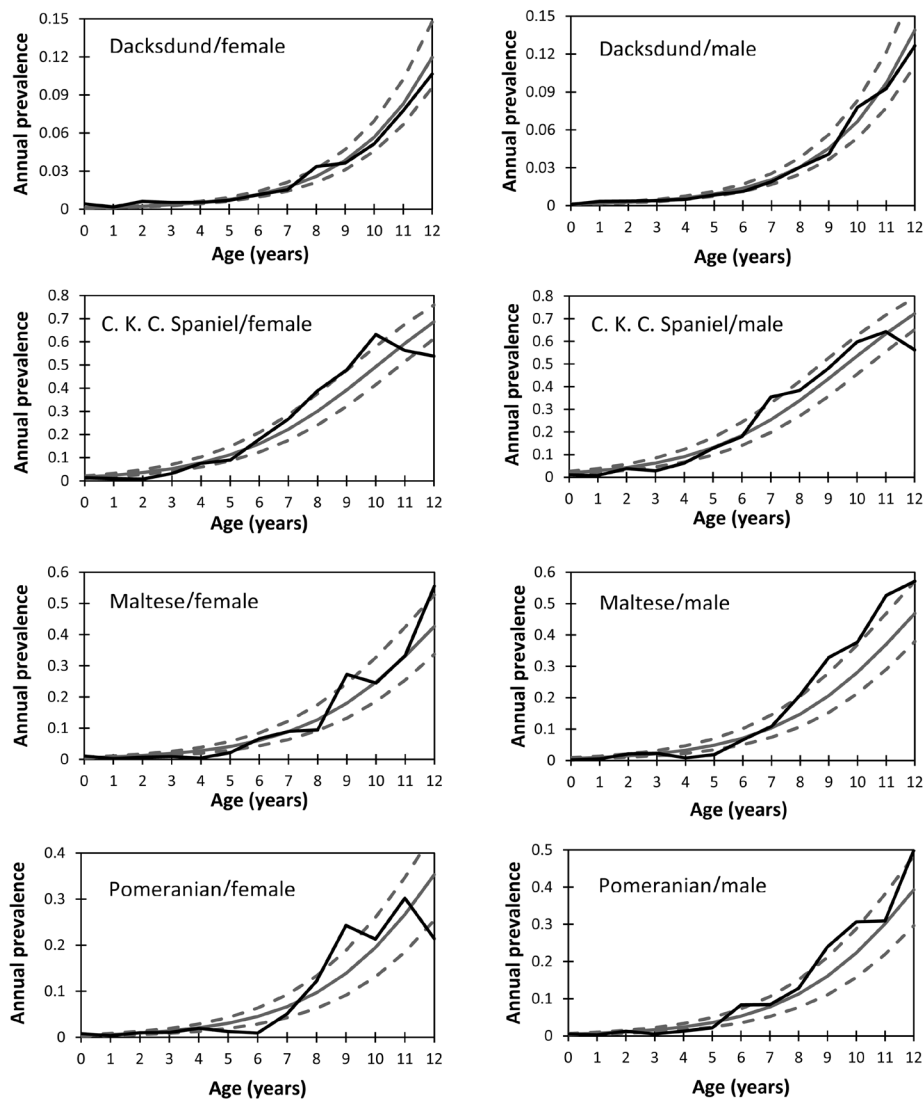


Fig. 1. Predicted annual prevalence of cardiovascular disorder for different genders of four breeds. Gray solid lines indicate the mean estimates, and gray dashed lines 95% confidence intervals. Solid lines indicate the annual prevalence actually observed.

- Gender, age and breed pattern of diagnoses for veterinary care in insured dogs in Sweden during 1996. *Vet. Rec.* **146**: 551–557. [Medline] [CrossRef]
6. Egenvall, A., Bonnett, B. N. and Häggström, J. 2006. Heart disease as a cause of death in insured Swedish dogs younger than 10 years of age. *J. Vet. Intern. Med.* **20**: 894–903. [Medline] [CrossRef]
 7. Gough, A. and Thomas, A. 2010. Breed Predispositions to Disease in Dogs and Cats-2nd ed. Wiley-Blackwell, Chichester.
 8. Häggström, J., Hansson, K., Kvart, C. and Swenson, L. 1992. Chronic valvular disease in the cavalier King Charles spaniel in Sweden. *Vet. Rec.* **131**: 549–553. [Medline]
 9. Inoue, M., Hasegawa, A., Hosoi, Y. and Sugiura, K. 2015. Breed, gender and age pattern of diagnosis for veterinary care in insured dogs in Japan during fiscal year 2010. *Prev. Vet. Med.* **119**: 54–60. [Medline] [CrossRef]
 10. Japan Pet Food Association. National Survey on Dog and Cat Population (in Japanese). <http://www.petfood.or.jp/data/chart2014/index.html>.
 11. Summers, J. F., Diesel, G., Asher, L., McGreevy, P. D. and Collins, L. M. 2010. Inherited defects in pedigree dogs. Part 2: Disorders that are not related to breed standards. *Vet. J.* **183**: 39–45. [Medline] [CrossRef]
 12. Thrusfield, M. V., Aitken, C. G. G. and Darker, P. G. G. 1985. Observations on breed and sex in relation to canine heart valve incompetence. *J. Small Anim. Pract.* **26**: 709–717. [CrossRef]
 13. Yamamoto, S., Hoshi, K., Hirakawa, A., Chimura, S., Kobayashi, M. and Machida, N. 2013. Epidemiological, clinical and pathological features of primary cardiac hemangiosarcoma in dogs: a review of 51 cases. *J. Vet. Med. Sci.* **75**: 1433–1441. [Medline] [CrossRef]