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# Sex, Size, and Breed as Risk Factors in Canine Patellar Dislocation

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## SUMMARY

Cases of canine patellar dislocation (CPD) (542) were matched against all canine patients (69,245) reported to a multisource veterinary clinical data collection system in order to determine separate effects of sex, size, and breed on occurrence of the defect. Risk of CPD for females was more than 1½ times that of males. Small dogs had a risk approximately 12 times that of large dogs. Pomeranians, Yorkshire Terriers, Chihuahuas, Miniature and Toy Poodles, and Boston Terriers were all at significantly increased risk for CPD.

CANINE PATELLAR dislocation, considered one of the 5 most important hereditary defects in dogs at a 1962 symposium on abnormalities,<sup>2</sup> has been the subject of few reports other than those concerned with surgical aspects.

The defect has been described as a unilateral or bilateral tibiofemoral joint deformity, mainly affecting miniature breeds, usually becoming evident at 4 to 6 months, and likely to be of hereditary origin.<sup>2,4,5</sup> A brief summary of the case series reported here was included as part of a general report on congenital defects.<sup>8</sup> The purpose of this study was to examine the sex, size, and breed distributions of dogs with CPD in order to determine (1) if there was a sex predisposition to CPD; and (2) if recent breed and size distributions of patients with CPD were consistent with those previously described.

## Methods

Cases of CPD<sup>a</sup> and the total clinic-hospital "populations" were tabulated by breed, sex, and size from the stored information collected from 10 colleges of veterinary medicine<sup>b</sup> in the United States and Canada participating in the Veterinary Medical Data Program, the details of which have been reported.<sup>7</sup> All comparisons were made, using the Mantel-Haenszel (M-H) procedure, which provides for computation of estimated relative risk (*R*) and chi-square values for any test factor when the effect of any other factor, or group of factors, is held constant.<sup>6</sup> The use of *R* with the congenital defect file from which the CPD series was taken has been described.<sup>8</sup> Relative risk relates the occurrence of disease in a test group to a comparison group. For example, an *R* of 1 would indicate that the

<sup>a</sup> Cases of dislocation of the patella present at birth were not distinguished from those occurring later, but likely due to a congenital joint deformity. Medial and lateral luxations likewise were not separated in the reports.

<sup>b</sup> University of California, University of Georgia, University of Guelph (Ontario), University of Illinois, Iowa State University, Kansas State University, Michigan State University, University of Minnesota, University of Missouri, and Purdue University.

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risk was the same in the test group as in the comparison group, an *R* of 0.5 that the test group was at only half the risk of the comparison group, and an *R* of 4 suggests a fourfold risk in the test group.

Using the M-H procedure, the independent effects of sex or specific breed (or weight category) on the occurrence of CPD were determined. In addition, analyses were adjusted for differences in the distribution of cases and reference populations among the 10 contributing veterinary school clinics.

TABLE 1—Number of Cases of Canine Patellar Dislocation Reported to the Veterinary Medical Data Program, March, 1964–January, 1969, by Breed and Sex

Breed	Adult weight category*	Male	Female	Total
Afghan Hound	L	1	3	4
Basset Hound	L	0	1	1
Beagle	M	3	2	5
Black and Tan Coonhound	L	1	0	1
Boston Terrier	S	7	16	23
Boxer	L	1	0	1
Brittany Spaniel	M	1	2	3
Bulldog	L	3	3	6
Cairn Terrier	S	0	1	1
Chihuahua	S	22	21	43
Chow Chow	L	0	1	1
Cocker Spaniel	M	4	9	13
Collie	L	1	2	3
Dachshund	M	2	4	6
Doberman Pinscher	L	2	1	3
English Setter	L	0	1	1
Fox Terrier	S	2	8	10
Keeshond	M	0	2	2
Labrador Retriever	L	1	2	3
Maltese	S	0	2	2
Manchester Terrier	S	3	4	7
Norwegian Elkhound	L	2	0	2
Pekingese	S	7	4	11
Pomeranian	S	11	26	37
Poodle, Standard	L	7	8	15
Poodle, Miniature or Toy	S	83	160	243
Pug	S	2	2	4
St. Bernard	G	0	3	3
Scottish Terrier	M	0	2	2
Shetland Sheepdog	S	1	0	1
Siberian Husky	L	1	2	3
Weimaraner	L	1	0	1
Yorkshire Terrier	S	8	10	18
Other purebred**	U	8	10	18
Crossbred	U	16	29	45
Total		201	341	542

\* S (small) =  $\leq 9.0$  kg.; M (medium) = 9.1 to 18.1 kg.; L (large) = 18.2 to 36.2 kg.; G (giant) =  $\geq 36.3$  kg.; U = unknown. \*\* Includes some breeds not recognized by the American Kennel Club.

The level of statistical significance, *i.e.*, the probability that the confidence limits for a given *R* excluded 1, was set at 0.1% because of the many factors tested and study limitations. American Kennel Club standards for adult weight were used to classify breeds in 5 categories: (1) 9.0 kg. or less (small); (2) 9.1 to 18.1 kg. (medium); (3) 18.2 to 36.2 kg. (large); (4) 36.3 kg. or greater (giant); and (5) unknown.

## Results

From March, 1964, through January, 1969, 542 of 69,245 canine patients were reported to have CPD. The cases are categorized by breed and sex (Table 1).

The results of risk analysis for each of the 3 risk factors—sex, size, and breed—are given (Table 2).

The *R* for females was more than 1½ times that for males.

Breeds of the unknown weight category (mostly crossbreds) were used as

TABLE 2—Estimated Relative Risk (*R*\*) for Canine Patellar Dislocation by Sex, Size, and Breed\*\* (Veterinary Medical Data Program, March, 1964 through January, 1969)

Risk category	No. of cases	<i>R</i>
<b>Sex</b>		
Female	341	1.6
Male	201	1
<b>Adult weight</b>		
Small ( $\leq 9.0$ kg.)	400	6.6
Medium (9.1–18.1 kg.)	31	0.7
Large (18.2–36.2 kg.)	45	0.5
Giant ( $\geq 36.3$ kg.)	3	0.5
Weight not specified	63	1
<b>Breed</b>		
Pomeranian	37	8.1
Yorkshire Terrier	18	7.6
Chihuahua	43	5.1
Poodle, Miniature or Toy	243	4.2
Boston Terrier	23	2.1
Pekingese	11	1.8
Poodle, Standard	15	1.8
Fox Terrier	10	1.4
All breeds combined	542	1
Cocker Spaniel	13	0.6
Crossbred	45	0.4
Beagle	5	0.2
Dachshund	6	0.2
Collie	3	0.2
Labrador Retriever	3	0.2
Boxer	1	0.1
German Shepherd Dog	0	0.0

\* Adjustment made for institution in all determinations; for size in determining sex *R*; and for sex in determining size and breed *R*. Italic type indicates *R* significantly ( $P \leq 0.001$ ) different from  $R = 1$ . \*\* Only those breeds with at least one of the following characteristics are listed: observed number of cases  $\geq 20$ ; expected number of cases  $\geq 20$ ; *R* significantly different ( $P \leq 0.001$ ) from 1.

the reference to calculate *R* for CPD for each known adult weight category. Small dogs had an *R* approximately 12 times that of large dogs. Differences in *R* values between the medium, large, and giant categories were slight.

Relative risk for CPD was calculated for each breed, versus all breeds combined. Pomeranians, Yorkshire Terriers, Chihuahuas, Miniature and Toy Poodles, and Boston Terriers were at significantly increased risk for CPD ( $P \leq 0.001$ ). Of the more popular purebred dogs, the German Shepherd Dog was the breed least likely to have CPD; other purebreds with significantly low *R* were Labrador Retrievers, Dachshunds, and Beagles. The risk of CPD was significantly lower for crossbred dogs than it was for all dogs combined, but not so low as for some purebreds.

## Discussion

The major new finding reported here is the excess risk of CPD in females. If CPD is an autosomal recessive or polygenic trait, as has been suggested,<sup>3,5</sup> an excess risk among females might be related to hormonal influence or to non-hormonal, X-linked factors that might affect expression of CPD. Alternatively, but less likely, excess risk among females might be explained by a single X-linked dominant gene.

Besides confirming previous observations on the size and breed distributions of CPD,<sup>1,2,4</sup> the results of this study indicate the magnitude of risk for individual breed and weight categories and identify some breeds at low risk for CPD. "Low risk" findings can often be of use in eliminating certain hypotheses of disease etiology. Thus, achondroplasia, characteristic of some breeds, does not seem to assume much significance in the etiology of CPD; if this trait were a factor, the Dachshund breed certainly should

not have been at "low risk." The absence of marked differences in risk between the medium, large, and giant categories indicates that CPD is somehow related to "miniaturization" rather than to adult weight category. The risk for Miniature and Toy Poodles is somewhat confounded because of the wide range of size within the combined category. Had it been possible to separate the data for Miniature and Toy Poodles, toys might have been at an even higher risk and miniatures at a lower risk for CPD.

Definitive answers on the hereditary aspects of CPD would seem to lie in controlled breeding trials. Considering the long-recognized importance of the defect in some breeds, it is surprising to find no CPD-oriented breeding trials reported in readily available literature. Appropriate national breed associations should encourage, or even sponsor, breeding trials directed toward answering some of the questions about CPD.

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<sup>c</sup>1% or more of the total clinic-hospital population.