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# Epizootiologic patterns of diabetes mellitus in dogs

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## SUMMARY

A case-control study of spontaneous diabetes mellitus in dogs was undertaken, using 2 veterinary data bases. The Veterinary Medical Data Program (VMDP) contained records of 1,019 cases of canine diabetes from 14 university-affiliated veterinary hospitals. The Animal Medical Center (AMC), a private veterinary hospital which has not participated in the VMDP, contained records of 449 diabetes cases. Each data base was analyzed separately, control groups being chosen from all admissions, excluding diabetic animals.

Summary odds ratios by sex adjusted for age and breed indicated significantly ($P < 0.05$) elevated risks for entire females and neutered females compared with that for entire males. The VMDP data indicated a significantly elevated risk for castrated males, whereas the risk derived from AMC data was not significantly different from 1. Analysis of risks by breed adjusting for age and sex identified Poodles as being at significantly excess risk, and German Shepherd Dogs, Cocker Spaniels, Collies, and Boxers at significantly decreased risk in both data sets. The male:female risk ratio changed with age from 1 at less than 1 year of age to a predominance of females at older ages. In the AMC data base, diabetes was significantly associated with cataracts in dogs of both sexes combined. Diabetes was also significantly associated with benign mammary tumors in female dogs.

Spontaneous diabetes mellitus has been observed and studied in a variety of nonhuman animal species including dogs, cats, primates, mice, rats, and guinea pigs.[1] Spontaneous diabetes mellitus in dogs has been classified into 3 types on the basis of the insulin response to a glucose load. Type I is characterized by a virtual absence of plasma insulin and no response to a glucose load. Type II is characterized by an initial normal-to-high plasma insulin concentration, with no increase following a glucose load. Type III is characterized by a normal-to-high insulin concentration and an initial increase to a glucose load, but with a delayed return to base line (prechallenge concentration). These 3 types have been compared with juvenile or insulin-dependent diabetes mellitus, maturity onset or insulin-independent diabetes mellitus, and chemical diabetes of persons, respectively.[2,3] Most diabetic dogs presenting for medical treatment are type I and daily injections of insulin are usually required to control the disease.[4]

The existence of numerous distinct breeds makes canine epizootiology valuable in studying heritability of disease. Ling et al[5] reported on 75 diabetic dogs, of which 17 were Dachshunds and 16 were Poodles; risk ratios for these breeds were 5.8 and 2.2, respectively, when compared with other hospital admissions. Genetic predispositions to development of diabetes have also been suggested by familial associations,[5,6] and by pedigree analysis of Keeshonden.[7] Wilkinson[8] found 30% of 56 diabetic dogs were Dachshunds and 9%, Poodles, but the breed distribution of the control population was not given.

Chronic relapsing pancreatitis is a common cause of diabetes mellitus in dogs.[1] In persons, seasonality patterns of insulin-dependent diabetes have indicated an infective cause to some authors,[9] but Fleegler et al[10] rejected this interpretation in their study of seasonality of diabetes in cities with different climates. Infective agents have been implicated by human seroepidemiologic data and by induction of diabetes with viruses in genetically susceptible mice.[9] Endocrine autoimmunity and genetically determined disorders in beta cell function or number also have been implicated in the pathogenesis of diabetes mellitus.[9] Other environmental factors have been indicated in maturity onset diabetes in persons, including diet, obesity, and pregnancy.[9]

Epizootiology and "herd health" have long histories in veterinary medicine, but controlled epizootiologic studies of chronic diseases have been uncommon. The Veterinary Medical Data Program (VMDP), formed by the National Cancer Institute in 1964, has provided the material for most of the hospital case-control studies to date (*see* for example references 11 and 12). In a study of feline urologic syndrome, findings from the VMDP have previously compared well with other large data bases.[13]

In the present study, epizootiologic patterns of canine diabetes mellitus were investigated, using information from both the VMDP and the Animal Medical Center (AMC) in

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New York City. The major objectives of the research were to further investigate breed, age, and sex distributions of canine diabetes mellitus and to compare findings between the 2 data sets.

## Materials and Methods

Data on hospital admissions, including date of admission, age, sex, breed, and up to 3 diagnoses per admission, were available in computer-readable form from the VMDP for the years 1964 through 1977. Fourteen veterinary schools in the United States and Canada[a] participated in the VMDP during that time. The AMC, a large private veterinary hospital located in New York City, has not been a participant in the VMDP, but maintained its own computerized data retrieval system from 1969 to 1975. Included in these computerized records were demographic information and up to 3 diagnoses for each admission. The VMDP used the Standard Nomenclature for Veterinary Disease and Operation,[14] whereas AMC used a veterinary adaptation of the International Classification of Disease.[15] Characteristics of the 2 data bases are shown in Table 1.

Records of dogs with a diagnosis of diabetes mellitus were extracted from each data set by searching for the appropriate codes in each of the 3 diagnostic fields for each hospital visit. Age, breed, sex, and neuter status (castration or oophorohysterectomy) at initial diagnosis of diabetes were obtained by finding the earliest entry of diabetes in a dog's computer file. In the VMDP analyses (conducted by PW and WAP), cases and controls were drawn from both inpatient and outpatient records. The VMDP control group was compiled by extracting a random record from each nondiabetic dog's file for each year the dog was seen for any reason. The intent of this method of choosing controls was to approximate patient-years at risk, an approach which has been previously used in analyses of the VMDP data base.[11,12] In the AMC analyses (conducted by MM, LTG, RHC, and AIH), cases and controls were chosen from among inpatient visits only because the majority of diabetes mellitus cases were inpatients. The AMC analyses were conducted, using 2 separate control groups. The 1st control group was compiled by extracting a single random record from each nondiabetic dog's file. The 2nd control group was chosen in the same manner as was used in the VMDP analyses, ie, choosing a random record for each year each dog was seen for any reason.

Summary risk ratios and chi-square values comparing cases with controls by breed, sex, and age at initial diagnosis were calculated according to the Mantel-Haenszel method.[16] Confidence intervals at 95% were calculated, using the test-based method of Miettinen.[17] The monthly pattern of initial AMC admissions for canine diabetes mellitus was compared with that of controls, because of a previously reported seasonal pattern in hospital admissions for juvenile diabetes in persons.[10] Date of initial hospital diagnosis was used as a surrogate for date of onset of diabetes in our analysis.

Medical records of 105 cases seen at the AMC in 1974 and 1975 were obtained and reviewed to ascertain the diagnostic criteria for diabetes mellitus and the relationship between time-of-onset of clinical signs and date of initial hospital diagnosis. A clinical impression of an association between cataracts and diabetes, and mammary tumors and diabetes, in this subset of AMC cases was investigated by comparing the frequencies of these diseases in cases with their frequencies in the control group chosen to be dogs diagnosed with other endocrine diseases. Of the dogs in the endocrine diseases control group, 42% (or 240) had diagnoses of hypoglycemia or insulinoma; 16% (or 88) had Cushing's syndrome; 15% (or 83) had hyperparathyroidism; 11% (or 60) had adrenal hypofunction; and 17% (or 98) had other endocrine diagnoses. This control group was chosen to obtain approximate equivalence in degree of medical attention compared with dogs with diabetes. Failure to obtain such equivalence could result in biased estimates of risk due to a greater probability of detection of secondary diseases in 1 group than in its comparison group.

[a] Auburn University, Colorado State University, University of California at Davis, University of Georgia, University of Guelph, University of Illinois, Iowa State University, Kansas State University, Michigan State University, University of Minnesota, University of Missouri, Ohio State University, Purdue University, and University of Saskatchewan.

## Results

A total of 1,019 cases of canine diabetes mellitus from the VMDP and 449 from the AMC were available for analysis. The VMDP cases, drawn from records of both inpatients and clinic outpatients, constituted 0.19% of all recorded dog visits. The AMC cases constituted 1.02% of recorded inpatient visits. The higher proportional morbidity in the AMC reflected the tendency for most diabetes mellitus cases to involve inpatients and the exclusion of outpatient, clinic visits from the AMC study population. The most common initial signs among the 105 diabetic patients seen at the AMC from 1974 to 1975 are shown in Table 2. A total of 85% of cases had 3 or more of the findings listed in Table 2. Immediate events causing the owner to seek medical help were often vomiting and anorexia, which were rarely allowed to persist longer than 1 week before the dog was brought to the hospital. Polyuria and polydipsia were the signs most often recorded at presentation, but did not cause the owners to act as quickly—these signs being present for 4 or more weeks in 33% of dogs with a chart notation of this sign and its duration.

Diagnostic criteria used in AMC diabetes patients were determined by reading the selection of 105 patients' charts from the period 1974 to 1975. A total of 93% of the charts included laboratory findings of glucosuria and hypergly-

TABLE 1—Characteristics of two veterinary hospital data bases used to analyze epizootiologic patterns of canine diabetes mellitus

| Item | Data base: Veterinary Medical Data Program (VMDP) | Data base: Animal Medical Center (AMC) |
|---|---|---|
| No. of participating institutions | 14 | 1 |
| Location of institutions | United States & Canada | New York City |
| Disease coding system | SNVDO | ICD |
| Period covered | 1964–1977 | 1969–1975 |
| Reference populations | | |
| Dog-yr | 530,170 | 44,172 |
| Dogs | 399,403 | 36,283 |
| No. of diabetes cases | 1,019 | 449 |
| Diabetes mellitus proportional morbidity rate (%) | 0.19* | 1.02† |

* Proportional morbidity as percentage of inpatient plus outpatient clinic visits
† Proportional morbidity as percentage of inpatient visits.
SNVDO = Standard Nomenclature of Veterinary Diseases and Operations. ICD = International Classification of Disease.

TABLE 2—Presence and duration of signs before initial diagnosis of diabetes mellitus was made: 105 dogs, AMC, 1974–1975

| Sign | No. of dogs whose case records referred to given sign | No. of dogs whose case records showed duration of given sign | Percentage distribution of weeks duration of sign before hospital admission: ≤ 1 week | 2 to 3 weeks | ≥ 4 weeks |
|---|---|---|---|---|---|
| Polydipsia | 98 | 74 | 39 | 28 | 33 |
| Polyuria | 96 | 78 | 35 | 28 | 37 |
| Vomiting | 53 | 47 | 83 | 9 | 8 |
| Lethargy | 39 | 28 | 75 | 14 | 11 |
| Anorexia | 37 | 32 | 84 | 13 | 3 |
| Weight loss | 25 | 18 | 39 | 22 | 39 |
| Diarrhea | 13 | 9 | 78 | 22 | 0 |
| Polyphagia | 9 | 4 | 0 | 50 | 50 |

cemia. The average blood glucose concentration for the cases on admission was 421 ± 185 mg/dl; normal for dogs is 50 to 120 mg/dl.[18] Of the 1,019 VMDP cases, clinical chemistry analyses were performed for 87% and urinalysis for 74%. Specific diagnostic tests performed in AMC or VMDP cases were not recorded in the computerized data sets, but a diagnostic code of diabetes mellitus presumably reflected application of clinical standards existing at the time. Although the AMC chart review revealed records of hyperglycemia in ony 93% of the diabetes cases, such laboratory work can be assumed to have been conducted in virtually all cases. The missing 7% was probably due to lost or misfiled laboratory reports or to cases that were referred with prior laboratory work by veterinarians not associated with AMC.

Calculation of risk ratios by sex, adjusting for age and breed (Table 3), indicated that entire and neutered female dogs were at greater risk than males in both data sets. The risk ratio for castrated compared with entire males, adjusted for age and breed, differed between the AMC and VMDP data. The VMDP data base included 44 castrated males and showed a significantly elevated risk ratio (RR) of 2.17 (95% confidence limits (CL)= 1.57, 3.00). The AMC cases included only 10 castrated males and showed an adjusted RR less than 1 (RR = 0.8, 95% CL = 0.35, 1.89), but with 95% CL overlapping those of the corresponding VMDP relative risk. Analysis of the risk ratios by sex within different breeds in the AMC data indicated that castrated male Poodles had a RR, adjusted for age, of 1.35 (95% CL = 0.48, 3.82). Castrated males in all other breeds, except Poodles, were at decreased or indeterminate risk, resulting in a summary risk over all breeds of less than 1.

Because of the similarity evident in Table 3 in results from the 2 different AMC control groups, subsequent tables were constructed, using only the patient-years at risk control group selected in a similar manner to that used in the VMDP analyses. Results for the 2 control groups were in good agreement for all analyses.

The age distribution of cases of canine diabetes mellitus at the time of initial diagnosis is shown in Table 4. The age-specific risks shown in columns (c) and (g) indicated an increasing risk of diabetes with age, compared with the risk for hospital admission for other diagnoses. The risk ap-

TABLE 5—Risk ratios by breed for canine diabetes mellitus, adjusted for age and sex

| | VMDP | | | AMC | | |
|---|---|---|---|---|---|---|
| Breed | No. of cases | RR | 95% CL | No. of cases | RR | 95% CL |
| Keeshond | 12 | 8.0* | (4.8, 13.3) | 0 | --- | --- |
| Alaskan Malamute | 7 | 5.2* | (2.4, 10.8) | 0 | --- | --- |
| Schipperke | 6 | 4.9* | (2.1, 11.1) | 0 | --- | --- |
| Finnish Spitz | 6 | 3.6* | (1.5, 8.4) | 0 | --- | --- |
| Puli | 2 | 3.3 | (0.4, 27.5) | 5 | 4.8* | (1.8, 12.8) |
| Cairn Terrier | 8 | 2.2 | (0.97, 4.5) | 3 | 4.1† | (1.0, 16.7) |
| Miniature Pinscher | 0 | --- | --- | 4 | 3.6† | (1.1, 11.9) |
| Manchester Terrier | 22 | 3.4* | (2.3, 5.2) | 1 | 1.2 | (0.4, 3.4) |
| Miniature Schnauzer | 44 | 2.6* | (1.9, 3.5) | 18 | 1.0 | (0.8, 1.2) |
| Fox Terrier | 33 | 1.9* | (1.3, 2.6) | 13 | 1.2 | (0.6, 2.5) |
| Poodle, unspecified | --- | --- | --- | 180 | 2.0* | (1.6, 2.3) |
| Mini/Toy Poodle | 210 | 1.6* | (1.4, 1.8) | --- | --- | --- |
| Standard Poodle | 18 | 1.2 | (0.7, 2.0) | --- | --- | --- |
| English Springer Spaniel | 11 | 1.4 | (0.7, 2.9) | 5 | 4.7* | (1.7, 13.0) |
| Terrier, unspecified | --- | --- | --- | 10 | 1.4 | (0.6, 3.0) |
| Mixed breed | 263 | 1.1† | (1.0, 1.3) | 106 | 1.0 | (0.7, 1.2) |
| Basset Hound | 10 | 1.1 | ‡ | 2 | 0.7 | (0.0, 27.6) |
| Chihuahua | 29 | 1.1 | (0.7, 1.6) | 5 | 0.5 | (0.2, 1.3) |
| Doberman Pinscher | 11 | 1.0 | ‡ | 2 | 0.3 | (0.0, 1.4) |
| Labrador Retriever | 22 | 0.9 | (0.5, 1.6) | 0 | --- | --- |
| Beagle | 26 | 0.8 | (0.5, 1.3) | 12 | 0.8 | (0.4, 1.6) |
| Dachshund | 61 | 0.8 | (0.7, 1.1) | 23 | 1.2 | (0.7, 2.0) |
| Irish Setter | 10 | 0.7 | (0.3, 1.5) | 0 | --- | --- |
| Cocker Spaniel | 25 | 0.7 | (0.4, 1.0) | 4 | 0.3† | (0.1, 0.9) |
| German Shepherd Dog | 23 | 0.3* | (0.2, 0.5) | 9 | 0.2* | (0.1, 0.4) |
| Collie | 8 | 0.3* | (0.1, 0.6) | 2 | 0.2† | (0.1, 1.0) |
| Pekingese | 2 | 0.1* | (0.04, 0.4) | 2 | 0.5 | (0.08, 2.7) |
| Boxer | 2 | 0.1* | (0.03, 0.3) | 1 | 0.1† | (0.02, 0.9) |
| All breeds combined | 1,019 | 1 | --- | 449 | 1 | --- |

* $P < 0.01$. † $P < 0.05$. ‡ 95% CL indeterminate by Miettien's method.[17]
Data include breeds with either 10 or more cases or continuity corrected chi-square values greater than 6.63 ($P < 0.01$) in either data base.

TABLE 3—Risk ratios for canine diabetes mellitus by sex of dog, adjusted for age and breed

| | VMDP* | | | Control group A* | | | Control group B† | |
|---|---|---|---|---|---|---|---|---|
| Sex | No. of cases‡ | RR | 95% CL | No. of cases | RR | 95% CL | RR | 95% CL |
| Male | 255 | 1 | --- | 155 | 1 | --- | 1 | --- |
| Castrated male | 44 | 2.17§ | (1.57, 3.00) | 10 | 0.79 | (0.35, 1.81) | 0.80 | (0.35, 1.89) |
| Female | 387 | 2.32§ | (1.99, 2.70) | 186 | 1.85 | (1.49, 2.30) | 1.87§ | (1.51, 2.32) |
| Neutered female | 332 | 2.45§ | (2.09, 2.88) | 98 | 1.57 | (1.21, 2.05) | 1.61§ | (1.24, 2.10) |
| Total | 1,018 | | | 449 | | | | |

* Control group based on a single random record per animal. † Control group based on one random record per animal per year. ‡ One case did not have the sex recorded. § $P < 0.01$.

TABLE 4—Risk ratios by age and age-specific RR of males vs females for cases of canine diabetes compared with all other diagnoses

| | VMDP | | | | AMC | | | |
|---|---|---|---|---|---|---|---|---|
| Age (yr) (a) | No. of cases (b) | RR (age vs 7–9 yr) (c) | 95% CL (d) | RR (males vs females) (e) | No. of cases (f) | RR (age vs 7–9 yrs) (g) | 95% CL (h) | RR (males vs females) (i) |
| <1 | 15 | 0.01* | (0.007, 0.014) | 1.12 | 5 | 0.03* | (0.01, 0.06) | 1.19 |
| 1 | 9 | 0.02* | (0.014, 0.029) | 0.52 | 2 | 0.02* | (0.01, 0.07) | 0.16 |
| 2–3 | 52 | 0.08* | (0.065, 0.099) | 0.56 | 9 | 0.05* | (0.04, 0.11) | 0.40 |
| 4–6 | 194 | 0.28* | (0.24, 0.33) | 0.41* | 80 | 0.43* | (0.37, 0.63) | 0.53* |
| 7–9 | 418 | 1 | --- | 0.40* | 158 | 1 | --- | 0.60* |
| 10–14 | 312 | 1.09 | (0.94, 1.26) | 0.49* | 185 | 1.30 | (0.96, 1.51) | 0.53* |
| ≥15 | 14 | 0.56† | (0.32, 0.97) | 1.31 | 10 | 0.72 | (0.33, 1.44) | 0.65 |
| Total | 1,014‡ | | | | 449 | | | |

* $P < 0.01$. † $P < 0.05$. ‡ Five cases were of unknown age.

peared to decline at ages 15 years or older, however, perhaps due to underdiagnosis of diabetes in older animals or to the increasing relative importance of other chronic diseases in old age. Age-specific male-to-female RR, shown in columns (e) and (i), suggested a reversal with age. The male:female RR was approximately equal to 1 at ages less than 1 year, while females predominated at older ages.

Summary relative risks by breed adjusted for age and sex (Table 5) were in agreement between the 2 data sets for most breeds, but differences emerged for some of the less popular breeds. Poodles, a popular breed representing 21% and 42% of the VMDP and AMC cases, respectively, had significantly elevated risks of 1.6 (VMDP) and 2.0 (AMC). In the VMDP, Keeshonden, Alaskan Malamutes, Shipperkes, Finnish Spitzes, Manchester Terriers, and Miniature Schnauzers were at significantly elevated risks, but were not represented or had relative risks approaching 1 in the AMC data set. Conversely, English Springer Spaniels and Miniature Pinschers had elevated risks in the AMC data, but were not at elevated risk in the VMDP data. Agreement between the 2 data sets was better with regard to low-risk breeds. Both data sets indicated that Cocker Spaniels, German Shepherd Dogs, Collies, Pekingese, and Boxers were at significantly lower risk than were all breeds combined.

Seasonal patterns of admission in the AMC cases were investigated by examining the proportion of diabetes admissions to all other hospital admissions by month. The proportion was greatest in February and lowest in July and September (Fig 1), although the overall pattern did not indicate an important seasonal influence. Previous work by Fleegler et al[10] showed maximum "onsets" of human juvenile diabetes in Pittsburgh in January and minimum "onsets" in June and August. Date of onset was estimated by Fleegler et al from the onset of the signs when known or from date of admission.

For the AMC cases, a comparison of the frequency of cataracts in diabetic dogs compared with the frequency in dogs diagnosed with other endocrine diseases (Table 6) revealed a significant association with a crude relative risk of 12.6 (95% CL = 3.8, 42.3) and a summary relative risk adjusted for age of 11.2 (95% CL = 2.6, 41.3). Thirteen of 18 diagnoses of cataracts in diabetic dogs occurred at the time of or after diagnoses of diabetes, whereas 5 diagnoses of cataracts occurred before diagnoses of diabetes. The reduced number of diabetes cases in this table is due to

TABLE 6—Frequency of diagnosis of cataracts in diabetic and control dogs from the AMC

| | Diagnosis of cataract | | |
|---|---|---|---|
| Diabetic status | Yes | No | Subtotal |
| Diabetic | 18 | 406 | 424 |
| Controls* | 2 | 567 | 569 |
| Total | 20 | 973 | 993 |

Crude RR (95% CL) = 12.6 (3.8, 42.3)
Summary† RR (95% CL) = 11.2 (2.6, 41.3)

* Dogs with other endocrine diseases (*see* text). † Adjusted for age by Mantel-Haenszel procedure.[16]

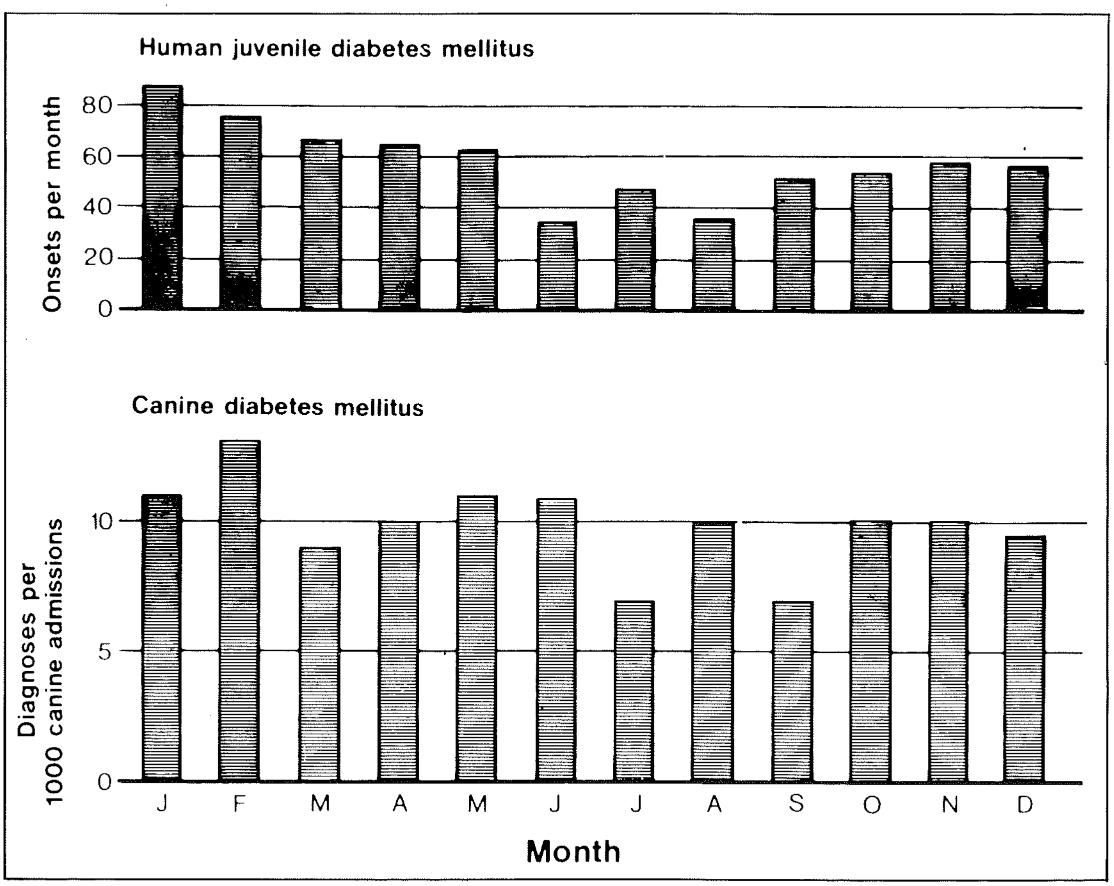


Fig 1—Month of initial diagnosis of AMC canine diabetes cases (n = 449) and estimated month of onset of human juvenile diabetes cases, Pittsburgh Children's Hospital, 1964–1974 (n = 693).

TABLE 7—Frequency of diagnosis of benign mammary tumors in diabetic and control dogs from the AMC

| Diabetic status | Diagnosis of benign mammary tumor | | Subtotal |
|---|---|---|---|
| | Yes | No | |
| Diabetic | 7 | 262 | 269 |
| Controls* | 0 | 282 | 282 |
| Total | 7 | 544 | 551 |

Crude RR (95% CL) = 16.1 (1.4, 191)
Summary† RR (95% CL) = 5.6 (1.7, 18.2)

* Female dogs with other endocrine disease (*see* text). † Adjusted for age by Mantel-Haenszel procedure.[16]

elimination of dogs wherein diagnoses of both cataracts and diabetes were made.

The relationship between mammary tumors and diabetes in female dogs from the AMC data base was also examined, using female dogs with other endocrine diseases as the control group. A significant association was found between benign mammary tumors and diabetes (Table 7), with a summary, age-adjusted relative risk of 5.6 (95% CL = 1.7, 18.2) calculated by incrementing each cell frequency by 0.5 because of the absence of benign mammary tumors in dogs with other endocrine diseases. There was no association found between diabetes and malignant mammary tumors (RR = 1.1, $X^2 = 0.03$).

## Discussion

In both the VMDP and AMC data bases, a number of common canine breeds including Cocker Spaniels, German Shepherd Dogs, Collies, Pekingese, and Boxers appeared to be at relatively low risk for diabetes mellitus, indicating a possible genetic resistance of these breeds to diabetes or precursor diseases. Less common breeds tended to be at high risk in each of the data sets, although the specific rare breeds at high risk differed between the 2 data sets. The high risks thus may have reflected inbreeding among geographically isolated populations contributing to unusual proportional morbidity for diabetes in 1 data set or the other, but not in both data sets. Pedigree analysis of cases in high-risk breeds might help to clarify this possibility.

A suggestion of a difference between the VMDP and AMC data bases was found in the risk for diabetes mellitus among castrated males. In the AMC data base, the summary relative risk was less than 1, whereas the risk in the VMDP data base was significantly greater than 1, although the 2 confidence intervals overlapped. The reason for the possible difference was not apparent. If male hormones are protective for canine diabetes, it might be due to a difference in the average age at castration in the populations served by AMC and VMDP, respectively. Neither data set had sufficient information on age at castration to explore this possibility.

Other sex patterns were more consistent between the 2 data sets. Entire and neutered females were at increased risk in both VMDP and AMC. Also, in both data sets there was a suggestion of a change in sex ratios with age from an equal risk for males and females at younger ages to an excess risk for females at older ages.

The AMC cases of diabetes mellitus had a seasonal pattern with some similarity to that of admissions for juvenile diabetes in persons, peaking in the winter and declining in the summer.[10] To study seasonality, we looked at the ratio of initial admissions for diabetes to all other initial admissions. Fleegler et al[10] studied seasonality of human juvenile diabetes by considering the number of admissions by month. Therefore, their seasonal pattern may have been due, in part, to seasonal variations in all hospital admissions. Similar seasonal patterns for canine diabetes and human juvenile diabetes would suggest possible common etiologic or environmental risk factors.

The relationship between cataracts and diabetes shown in the present study is interesting in light of the association between diabetes and retinal vascular changes in persons. The relationship between diabetes and benign mammary tumors was less pronounced, but may point to some common hormonal pathways in the pathogenesis of breast cancer and diabetes.

The biochemical relationship of canine diabetes mellitus to different forms of human diabetes could not be investigated in the present research, because information on plasma insulin concentrations and glucose tolerance was lacking. Diagnoses were most often based on the presence of clinical signs and laboratory findings, including glucosuria and hyperglycemia. The majority of cases of diabetes in dogs seems to be of the insulin-dependent form, but with clinical onset in middle or older ages. Cases of insulin-dependent canine diabetes with onset at less than 1 year of age have been reported[7,19] and were found in both data bases.

In addition to our descriptive findings on diabetes, the present research demonstrates the value of working with more than 1 data set when searching for etiologic clues. Both consistency and differences between tandem analyses can contribute to better interpretation of results and suggest further areas for study. However, large data sets examined retrospectively are best used for providing clues, rather than testing etiologic hypotheses. Questions raised by this study should be further explored using genetic, biochemical, and epizootiologic techniques in populations of dogs with spontaneous diabetes mellitus.

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