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Prevalence and Clinical Manifestations of Diabetes Mellitus in Canines: A Study from the Jaipur Region of Rajasthan

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ABSTRACT: This study aimed to govern the prevalence and document the clinical signs of diabetes mellitus (DM) in dogs from the Jaipur region of Rajasthan, conducted between August 2024 and January 2025. A total of 200 dogs, representing various age groups, breeds, and genders, were examined based on the presence of symptoms such as polydipsia, obesity, polyuria, significant weight loss, polyphagia, rapidly progressing bilateral cataracts, or a combination of these signs. The canines suspected of suffering from diabetes mellitus were subjected to screening utilizing an on-site glucometer for the assessment of fasting blood glucose concentrations. Individuals demonstrating blood glucose concentrations exceeding 140 mg/dl were classified as diabetic and subsequently integrated into the research investigation. The findings indicated that 13 dogs satisfied the established diagnostic criteria for diabetes mellitus. The aggregate prevalence of diabetes mellitus within the canine demographic was ascertained to be 6.5%. Among the breeds, Labrador Retrievers exhibited the highest rate of diabetes. Dogs over six years of age, particularly females, were more likely to develop the condition. The common clinical manifestations observed in the 13 diabetic dogs included polyphagia, polyuria, polydipsia, weight loss, vomiting, and cataracts.

Keywords: diabetes, polyphagia, incidence, canine, glucometer, incidence.

INTRODUCTION

The term "diabetes" comes from the Greek word diabetes, meaning "to pass through," reflecting the condition's hallmark symptoms of excessive thirst and frequent urination. The Latin derivative mellitus is interpreted as "sweetened with honey," alluding to the elevated glucose levels present in the urine commonly associated with this pathology. The ancient Greeks discerned a malady characterized by symptoms such as excessive urination and notable weight reduction, while Aretaeus of Cappadocia provided a precise account of a disorder marked by polydipsia and polyuria. As the knowledge of diabetes spread westward from the Middle East, it reached Spain, where it was recognized as a condition characterized by both excessive urination and thirst, alongside urine that tasted sweet. The identification of sugar in urine, verified by laboratory tests, brought greater clarity to the condition, particularly by the 18th century (Patel *et al.*, 2012).

Diabetes mellitus (DM) is a widespread condition that severely impacts human health and quality of life. It ranks second in prevalence after cancer, with a global prevalence of 2.8% across all age groups in 2000. According to recent World Health Organization estimates, diabetes contributes to nearly 3 million deaths annually worldwide, and by 2030, the number of affected individuals is projected to double (WHO, 2011). In recent decades, there has been a significant rise in the incidence of both type 1 and type 2 diabetes among humans. While research on diabetes patterns in canines is still limited, studies in the United States have shown an increase from 13.1 cases per 10,000 dogs in 2006 to 23.6 cases per 10,000 in 2015, marking a 79.9% rise. This upward trend in diabetes cases among both humans and dogs likely reflects advancements in medical treatments and higher survival rates. However, this does not fully explain the growing number of newly diagnosed cases of type 1 and type 2 diabetes in humans. It's suggested that environmental factors,

particularly those influencing individuals during key developmental stages, may play a significant role in this increase. While the complex interactions between genetic factors and environmental influences on diabetes risk are not fully understood, current theories propose that environmental factors may affect the immune system in type 1 diabetes and stress pancreatic beta cells in type 2 diabetes (Heeley *et al.*, 2023).

In canine populations, diabetes mellitus is one of the most commonly diagnosed endocrine disorders, particularly among middle-aged to senior dogs. This condition is characterized by hyperglycemia, glycosuria, and weight loss, which arise as a consequence of either an absolute or relative insufficiency of insulin (Audrey, 2012). The development of DM in dogs is multifaceted, typically classified into two main types: insulin-deficient DM, stemming from disorders in beta cells, and insulin-resistant DM, which involves target organ dysfunction. The exact mechanisms underlying these conditions in dogs are likely complex, with interactions between genetic predispositions and environmental factors contributing to the progressive loss of beta cells and subsequent insulin dependence in most canine cases (Heeley *et al*., 2023). Pathologically, diabetes in dogs affects multiple organs, leading to chronic failure in the metabolism of proteins, carbohydrates, and fats, especially in insulin-sensitive organs. The pathogenesis of diabetes mellitus in canines and felines exhibits parallels to that observed in Homo sapiens (Nelson & Reusch 2014). Although diabetes can manifest in any canine, empirical studies suggest that female dogs, senior canines, and certain breeds possess an elevated susceptibility to this metabolic disorder (Franco-Martinez *et al*., 2024). Interestingly, a study by Singh (2022) found that the prevalence of diabetes in male dogs was higher (80%) than in females (20%).

MATERIALS AND METHODS

A total of 200 canines, encompassing a diverse array of ages, genders, and breeds, manifested clinical manifestations including excessive thirst (polydipsia), heightened appetite (polyphagia), frequent urination (polyuria), obesity, swiftly advancing bilateral cataracts, or unaccounted weight loss, either singularly or in various combinations. These canines were subjected to an evaluation of their blood glucose concentrations employing a portable glucometer apparatus. Animals exhibiting arbitrary blood glucose levels surpassing 140 mg/dl were subjected to a fasting protocol extending for a duration of 12 hours, after which they were reevaluated the subsequent day for the purpose of measuring fasting blood glucose concentrations (Chaudhary, 2021). The dogs that manifested a fasting blood glucose concentration that exceeded 140 mg/dl were consequently incorporated into the research study. The design of the investigation facilitated the exploration of the incidence of diabetes mellitus, encompassing variations attributable to breed, age, and sex.

RESULTS AND DISCUSSION

Out of the 200 dogs initially suspected of having diabetes, 13 were diagnosed as diabetic, yielding an incidence rate of 6.5%. This is lower than the 10.88% and 10.00% incidence rates reported by Kumar *et al.* (2014); Shruthi (2016), respectively. In contrast, studies by Nelson and Reusch (2014); Kapoor (2019); Chaudhary (2021); Meena *et al*. (2023) recorded significantly lower incidence rates, ranging from 0.4% to 5.5%. Several factors may contribute to the observed increase in the prevalence of diabetes mellitus, including urbanization, lifestyle changes among pet owners, increased reliance on commercial pet food, unregulated feeding practices, and a lack of exercise. Additionally, certain breeds, such as those with a genetic predisposition to obesity, may be more vulnerable to developing the disease (Klinkenberg *et al.*, 2006).

Among the canine breeds exhibiting a significant prevalence of diabetes mellitus, Labrador Retrievers demonstrate the highest incidence rate of 38.46%, succeeded by Pugs and German Shepherds, each reporting an incidence of 23.07%, followed by Pomeranians at 7.69% and Beagles at 9.09%. The aforementioned observations are congruent with the findings reported by Deepa *et al.* (2014); Shruthi (2016), who likewise determined that Labradors represent the breed most commonly afflicted. Labradors demonstrate a specific vulnerability to obesity, which constitutes a significant risk factor for the onset of diabetes, attributed to both genetic predispositions (notably the deletion of the POMC gene) and behavioral traits (particularly a marked appetite). The phenomenon of obesity culminates in insulin resistance, a defining characteristic of type 2-like diabetes in canines, as articulated by Raffan *et al.* (2016).

Genetic factors significantly contribute to the pathogenesis of diabetes mellitus in canine populations. Empirical research has elucidated correlations between specific genetic markers and an increased predisposition to this disorder, particularly those associated with the major histocompatibility complex (MHC) class II genes, which prominently includes the dog leukocyte antigen. Unique haplotypes and genotypes have been delineated among breeds that exhibit an elevated vulnerability to diabetes. Additionally, polymorphisms in the canine insulin gene, particularly in regions containing variable numbers of tandem repeats (VNTRs), have been linked to breed-specific susceptibility to the disease. Variations in immune response genes, such as those in the CTLA4 promoter, further contribute to the increased risk of diabetes in certain pedigreed breeds.

Table 1: Distribution of Diabetes Mellitus Cases by Breed in Canines.

Sr. No.	Breed	Positive cases (13)	Percentage (%)
1.	Labrador	5	**38.46**
2.	Pug	3	**23.07**
3.	German Shepherd	3	**23.07**
4.	Pomeranian	1	**7.69**
5.	Beagle	1	**7.69**

In the analysis of the age-related prevalence of diabetes mellitus in canine populations, the most significant incidence was documented in individuals exceeding six years of age, accounting for 53.84% of the total cases. The next most affected group were dogs aged between one and six years, making up 38.46% of the diagnosed cases, while the youngest group, under one year of age, accounted for only 7.69%. These findings align with studies by Shruthi (2016); Guptill *et al.* (2003); Fall *et al.* (2007); Kawasumi *et al.* (2014); Kumar *et al.* (2014); Kwong *et al.* (2023), all of which reported a greater prevalence of diabetes in older dogs. One proposed explanation for this trend is the development of insulin resistance in aging canines. Diabetes in older dogs is also frequently associated with treatments involving corticosteroids, progestagens, or underlying endocrine disorders like hypothyroidism and hyperadrenocorticism (Hess *et al.*, 2000). Juvenile-onset diabetes is notably rare in dogs, with Catchpole *et al.* (2005) finding only 9 cases under the age of 12 months in a sample of 500 diabetic dogs. Cases in animals younger than six months are considered to have a congenital origin (Davison *et al.*, 2015). The phenomenon of delayed disease onset in dogs, when compared to the typical early diagnosis of type 1 diabetes in children, is a striking aspect of canine diabetes. This delayed onset may be partly due to delayed diagnosis, leading to the disease often being recognized in middle-aged or older dogs.

Further analysis of the data revealed that female dogs were disproportionately affected by diabetes, with 76.03% of the cases occurring in females, compared to 23.07% in males. These empirical observations align with the research conducted by Fall *et al.* (2007); Catchpole *et al.* (2005); Das and Lodh (2015), who documented female representation varying between 53% and 73.3%. In a similar vein, investigations carried out by Kwong *et al.* (2023); Meena (2023); Franco-Martinez *et al.* (2024) also indicated an increased prevalence of diabetes among female canines. This disparity in gender-related equity is predominantly ascribed to hormonal factors, specifically the secretion of growth hormone stimulated by progesterone and several progestogens (Herrtage, 2009). During the dioestrus phase, heightened concentrations of progesterone and growth hormone may negatively affect insulin efficacy, resulting in glucose intolerance (Feldman & Nelson 2014a).

Clinical Signs of Diabetes Mellitus in Canines. In this study, the clinical signs observed in canines diagnosed with diabetes mellitus included polyphagia (84.61%), polyuria (76.92%), polydipsia (76.92%), weight loss (61.53%), vomiting (30.76%), and cataract formation (15.38%). These findings align with those reported in studies by Hume *et al.* (2006); Caryn and Gelatt (2007); Durocher *et al.* (2008); Herrtage (2009); Kumar *et al.* (2014); Rucinsky *et al.* (2010); Huang (2012); Chaudhary (2021); Singh (2022); Meena (2023). Elevated serum glucose levels are a hallmark of diabetes mellitus, resulting from the body's inability to properly utilize glucose due to inadequate insulin secretion. This leads to reduced glucose, amino acid, and fatty acid utilization, increased hepatic glucose production, and the breakdown of lipids and proteins—all contributing to hyperglycemia and weight loss. As glucose levels consistently exceed the renal threshold of 180-220 mg/dL, the kidneys can no longer reabsorb glucose effectively, resulting in glycosuria. The presence of glucose in the urine induces osmotic diuresis, causing frequent urination, which is further compensated by excessive thirst. Under normal circumstances, hunger is regulated by the feeding center in the brain, which is temporarily suppressed after food intake. This suppression is facilitated by glucose uptake in the satiety center of the brain higher glucose uptake results in a stronger feeling of satiety and reduced hunger. However, in diabetic dogs, a lack of insulin impedes the uptake of glucose into cells, including the satiety center. As a result, the feeding center is not inhibited by the satiety center, leading to polyphagia or continuous hunger (Ettinger & Feldman 2010).

Additionally, diabetic dogs are prone to developing cataracts, a condition triggered by excess glucose in the lens of the eye. This glucose is converted into sorbitol, which has osmotic properties that draw water into the lens, leading to swelling and damage, ultimately resulting in cataract formation. Sorbitol exhibits a tendency to accumulate within the ocular lens attributable to its biosynthetic process occurring at a rate that surpasses its conversion into fructose, a reaction mediated by the enzyme known as sorbitol dehydrogenase. Given the polar characteristics of sorbitol, it possesses a limited capacity for diffusion out of the lens cells, thereby resulting in the formation of a hyperosmotic milieu. The resultant accumulation of sorbitol within the lens fibers precipitates cellular swelling, degeneration, and eventually the development of diabetic cataracts (Pollreisz & Schmidt-Erfurth 2010). In cases of diabetic ketoacidosis, vomiting is frequently observed, driven by metabolic acidosis and the irritating effects of ketone bodies on the gastrointestinal tract.

Table 2: Prevalence of Diabetes Mellitus in Canines.

Sr. No.	Age (Years)	Diabetic dog (13)	Percentage (%)
1.	**< 1year**	**1**	**7.69**
2.	**1-6 year**	**5**	**38.46**
3.	**> 6 years**	**7**	**53.84**

Table 3: Relationship Between Breed and Diabetes Mellitus Incidence.

Sr. No.	Sex	Diabetic dog (13)	Percentage (%)
1.	Male	3	23.07
2.	Female	10	76.93

Table 4: Age-wise Incidence of Diabetes Mellitus.

Sr. No.	Breed	Positive cases (13)	Percentage (%)
1.	Labrador	5	**38.46**
2.	Pug	3	**23.07**
3.	German Shepherd	3	**23.07**
4.	Pomeranian	1	**7.69**
5.	Beagle	1	**7.69**

Table 5: Clinical Signs Observed in Diabetic Canines.

Sr. No.	Clinical manifestations	Diabetic dog (13)	Percentage (%)
1.	Polydipsia	10	76.92
2.	Polyphagia	11	84.61
3.	Polyuria	10	76.92
4.	Weight loss	8	61.53
5.	Vomiting	4	30.76
6.	Cataract formation	2	15.38

Diabetic dog showing weight loss

Cataract formation in diabetic dog

Fig. 1. Clinical Manifestations of Diabetes Mellitus in Dogs - Weight Loss and Cataract Formation.

CONCLUSIONS

The current work indicated the incidence rate of 6.5% in which breed susceptibility pattern was seen in breed Labrador. Further, the findings derived from the aforementioned research indicated that diabetes mellitus predominantly affects middle-aged and senior canines, with females constituting the majority of the canine population afflicted by this metabolic disorder. Further, the most prominent clinical sign encountered among all the signs was polyphagia.

FUTURE SCOPE

Future investigative pursuits may focus on clarifying the hereditary and ecological factors that play a role in the development of diabetes mellitus within canine populations. Furthermore, the investigation of more sophisticated diagnostic methodologies, including genetic screening and biomarker identification, could facilitate early identification and the formulation of individualized therapeutic strategies. Prolonged investigations into the effectiveness of various treatment modalities would also prove to be of significant importance.

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