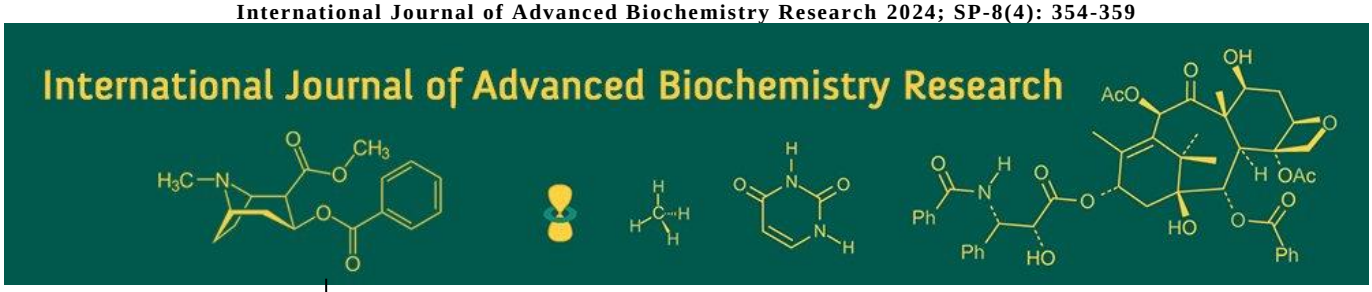

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Chand
Division of Medicine, ICAR-Indian Veterinary Research Institute, Bareilly, Uttar Pradesh, India

Akash B Mote
Division of Veterinary Public Health, ICAR-Indian Veterinary Research Institute, Bareilly, Uttar Pradesh, India

Sahadeb Dey
Division of Medicine, ICAR-Indian Veterinary Research Institute, Bareilly, Uttar Pradesh, India

Ujjwal Kumar DE
Division of Medicine, ICAR-Indian Veterinary Research Institute, Bareilly, Uttar Pradesh, India

AC Saxena
Division of Surgery, ICAR-Indian Veterinary Research Institute, Bareilly, Uttar Pradesh, India

Raguvaran R
Division of Medicine, ICAR-Indian Veterinary Research Institute, Bareilly, Uttar Pradesh, India

Arjun Shanavas
Division of Medicine, ICAR-Indian Veterinary Research Institute, Bareilly, Uttar Pradesh, India

Anandu S
Division of Parasitology, ICAR-Indian Veterinary Research Institute, Bareilly, Uttar Pradesh, India

Navjot Singh Thakur
Division of Medicine, ICAR-Indian Veterinary Research Institute, Bareilly, Uttar Pradesh, India

Indu Yadav
Division of Parasitology, ICAR-Indian Veterinary Research Institute, Bareilly, Uttar Pradesh, India

Ankit Dahiya
Division of Medicine, ICAR-Indian Veterinary Research Institute, Bareilly, Uttar Pradesh, India

K Mahendran
Division of Medicine, ICAR-Indian Veterinary Research Institute, Bareilly, Uttar Pradesh, India

Corresponding Author:
K Mahendran
Division of Medicine, ICAR-Indian Veterinary Research Institute, Bareilly, Uttar Pradesh, India

Occurrence of renal disorders and associated clinico-epidemiological factors in dogs of Bareilly region of Uttar Pradesh, India

Chand, Akash B Mote, Sahadeb Dey, Ujjwal Kumar De, AC Saxena, Raguvaran R, Arjun Shanavas, Anandu S, Navjot Singh Thakur, Indu Yadav, Ankit Dahiya and K Mahendran

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Abstract
Urinary system plays an important role in the excretion of the metabolic waste from the body. Kidney is the vital organ of the body having variety of functions, important for the survivability of the animal. Any of alteration in kidney function disbalance the normal homeostasis of the body and if not noticed earlier, the alteration in kidney in chronic case may leads to the death of animals. Overall incidence of kidney failure cases from March, 2021 to August,2021 was found 1.16%. Dogs were screened for renal failure on basis of history (Toxin, nephrotoxic drug), clinical signs (vomiting, anorexia, weight loss, oral ulcer, halitosis, dullness, pale mucus membrane etc.), haemato-biochemical analysis (Haemoglobin, Packed cell volume, Total erythrocyte count, total antioxidant capacity, creatinine, blood urea nitrogen) urinalysis (proteinuria, glucosuria, ketonuria, leucocytes and Casts and specific gravity) and ultrasonography. According to different age groups it was found that highest incidence were in 4-8 yrs. of age group, followed by >8 yrs. of age group and lowest in 0-4 yrs. of age group. Highest cases of renal failure were recorded in Labrador followed by Pomeranian and German shepherd etc. In terms of males and females, males (1.24%) were more affected than Female (0.57%) out of total diseased cases of canine population from March, 2021 to August, 2021.

Keywords: Kidney failure, age, sex, breed, haemato-biochemical, urinalysis

Introduction
Renal disorders are one of the most serious problems in canine in the form of renal failure *viz.* acute and chronic renal failure (Pathak *et al*., 2023). [29] About two to fiveper cent of dogs suffers from renal diseases making it common life-threatening illness in dogs. It is the third leading cause of death in dogs (Bronson, 1982 and Lund *et al*., 1999) [7, 21]. Advances in diagnostics and therapy, International Renal Interest Society (IRIS) staging of renal failure, and dietary modification has all been shown to increase life expectancy in dogs (Bartges, 2012) [2]. However, it is becoming a serious threat to canines in the recent pastdue to inability to detectit in time and it gets detected many a times once irreversible damage to kidney occurs which leads to considerable morbidity as well as mortality. Therapeutic intervention at this stage becomes certainly challenging. Despite scientific expansion in biomedical research and understanding in renal pathogenesis, the kidney disease management remains a critical challenge (Bellomo *et al*., 2008) [3]. Moreover, incidence of kidney diseases is influenced by climate and geographical conditions so it becomes more important to study it considering various predisposing factors like age, sex, breed susceptibility, etc. (Singh *et al*., 2020) [24].

Though chronic kidney disease is a progressive disorder, early detection and management helps to minimise disease progression rate and improve patient life expectancy (O'Neill *et al*., 2013) [27]. Considering the paucity of studies on occurrence and factors of disease distribution on renal diseases in dogs from India, the present study elucidates the clinico-epidemiological disease attributes with regard to occurrence of kidney diseases in dogs in the Bareilly region of northern India.

Materials and Methods

The proposed study was conducted on clinical cases of dogs reported during half a year (March to August, 2021) at the Referral Veterinary Polyclinic, Indian Veterinary Research Institute, Bareilly, India located at an altitude of 172 m above the mean sea level and at a latitude of 28.20° North and at a longitude of 79.24 °East experiencing humid subtropical with dry winter climate.

Plan of Work

The study was conducted based on animal ethical consideration. The clinical cases are included in the study with pet owner consent. A total number of 2394 cases of dogs suffering from different ailments were screened during the study period, out of which 28 dogs were diagnosed as cases of renal failure. The diagnosis was based on initial clinical examination followed by serum renal function markers, urine analysis and nephrosonographic examination. The cases found suffering from renal disorders were subjected to further analysis to find out epidemiological factors for predisposition such as age, breed, and gender as well as association with hemato-biochemical parameters. The occurrence rate was calculated using statistical analysis.

Clinical examination

The dogs were subjected to extensive clinical examination, various clinical signs like vomiting, anuria, oliguria, polyuria, anorexia, limb oedema, diarrhoea, ulceration of oral mucous membrane, dullness, weight loss, and neurological signs like epileptic seizures were recorded.

Sample collection: Blood samples were collected in clean vials from six healthy dogs (control) and suspected cases by venipuncture from cephalic/or radial vein with owner consent. Blood was stored in EDTA (Ethylene diamine tetra acetate) vial for haematology and to vial without an anticoagulant for serum biochemical analysis. The serum was harvested by centrifuging at 3000 rpm for 15 min and stored at –20°C till analysed. The urine samples from healthy and disease suspected dogs were collected aseptically using urinary catheter.

Renal function markers: Serum creatinine, urea nitrogen, total antioxidants, total protein, albumin, sodium, potassium, chloride, calcium and phosphorus concentrations were estimated using available commercial kits.

Urinalysis: The collected urine was examined for the presence of casts, leucocytes, RBCs, protein, ketone, and glucose with the help of dipstick strips whereas specific gravity of freshly collected urine was examined using refractometer.

Nephrosonography: Ultrasonographic examination of cases as well as healthy dogs was carried out using Sonosite 600M sonography machine as per the procedure described by Nyland and Mattoon (2002), using 2.5–5 MHz transducer on both side kidneys.

Statistical analysis

The data were analysed statistically using SPSS software, statistical analysis (SPSS version 20, 2011). Different groups were analysed using t-test. Recorded statistic and significance noted at 1% and 5% level.

Results

Clinical examination

The dogs were examined for symptoms of anorexia, oral ulcer, vomition, diarrhoea, dullness, weight loss, polyuria, anuria, oliguria, edema of leg, pale mucus membrane of eye, prepuce (male), vagina (female) and epileptic seizures. Animal showing these signs were considered as suspected case of kidney diseases for further investigation. Table1 depicts distribution of various symptoms observed in the suspected animals for kidney diseases.

Table 1: Clinical signs in renal failure dogs

Sr. No.	Clinical signs	No. of cases	Percentages (%)
1	Anorexia	21	75
2	Oral Ulcer	7	25
3	Vomiting	25	89.28
4	Diarrhoea	11	39.28
5	Dullness	17	60.71
6	Weight loss	13	46.42
7	Polyurea	8	28.57
8	Oligourea	11	39.28
9	Anurea	4	14.28
10	Leg oedema	7	25
11	Halitosis	4	14.28
12	Epilepsy/Seizure	3	10.71

Haematology

The mean values of haematological parameters of dogs with kidney diseases are presented in (Table 2). As compared to the healthy dogs, significantly (p<0.01) reduced levels of haemoglobin, total erythrocyte count, and packed cell volume and significantly (p<0.01) increased levels of total leucocyte count was found. However, changes inthe differential leucocyte count were statistically non-significant in comparison to healthy dogs.

Table 2: Haematological parameters of renal failure dogs

Parameters	Control	Renal Failure	t-value	P-value
Haemoglobin(g/dl)	14.48±0.44	9.20±0.56	6.096	0.00
PCV (%)	37.83±0.89	26.67±1.97	5.150	0.00
TEC (x106/µl)	7.11±0.37	4.55±0.29	5.133	0.00
TLC (/mm3)	8016.67±657.32	16398±1757.37	4.467	0.00
Neutrophil (%)	70.33±1.94	76.08±3.03	1.262	0.22
Lymphocytes (%)	22.50±1.56	19.92±2.77	0.811	0.43
Monocytes (%)	5.17±0.74	2.67±1.28	1.679	0.113
Eosinophils (%)	0.00±0.00	0.50±0.35	1.393	0.191

Renal function markers

The biochemical changes in dogs with kidney failure are presented in Table 3. The serum concentration of creatinine, and BUN were increased significantly (p<0.01) whereas albumin, albumin-globulin ratio and total antioxidant capacity values were decreased significantly as compared to healthy dogs. However, changes in serum globulin, sodium, potassium, chloride, calcium, phosphorus, BUN-creatine ratio and total protein values were non-significant.

Urinalysis

Specific gravity of urine was decreased in dogs with kidney failure as compared with healthy dogs. Out of 28 cases, proteinuria was recorded in 22 dogs (78.57%), glucosuria in 07 (25%), casts in 08 (28.57%), WBCs in 11 (39.28%), and ketonuria in 23 (82.14%) cases (Figure 1).

Table 3: Biochemical parameters of renal failure dogs

Parameters	Control	Renal Failure	t-value	p-value
Creatinine (mg/dl)	1.00±0.05	10.14±1.05	6.016	0.00
BUN (mg/dl)	19.2±2.03	176.27±18.98	8.227	0.00
BUN/Creatine	19.09±1.68	20.66±4.48	0.240	0.813
Total Protein (g/dl)	7.13±0.35	6.48±0.24	1.517	0.149
Albumin (g/dl)	3.40±0.17	2.60±0.12	3.627	0.002
Globulin (g/dl)	3.7±0.28	3.8±0.16	0.477	0.640
Albumin/Globulin	1.00±0.10	0.67±0.03	3.629	0.002
TAC(microMoles/dl)	671.67±84.85	218.11±16.79	5.244	0.003
Sodium (mEq/l)	139.56±2.97	141.39±3.26	0.357	0.726
Chloride (mEq/l)	103.87±1.31	110.54±2.29	1.950	0.069
Potassium (mEq/l)	6.34±0.52	6.27±0.26	0.140	0.891
Calcium (mg/dl)	8.84±0.33	8.00±0.26	1.873	0.838
Phosphorus (mg/dl)	3.99±0.21	4.84±0.44	1.286	0.217

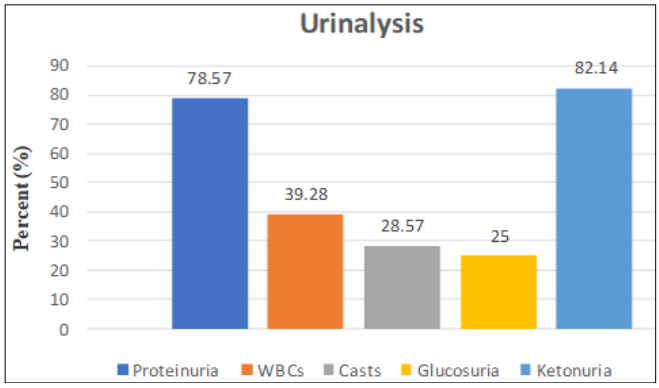

Fig 1: Graphical presentation of urinalysis of renal failure dogs

Nephrosonography: A total of 28 cases were diagnosed for renal disorders *viz*. renomegaly, nephritis, and shrunken kidneys. Severity varied from mild, moderate and very severe type. Out of 28 cases, 12 (42.85%) were having small to large concretion in one or both kidneys with clear cortico-medullary differentiation whereas 09 (32.14%) cases with small to large concretions were without cortico-medullary differentiation and poor visualization of internal renal architecture. Nephritis was seen in 07 cases (25%) and small size (One or both kidneys) was noticed in 03 cases (10.71%) Figure 2.

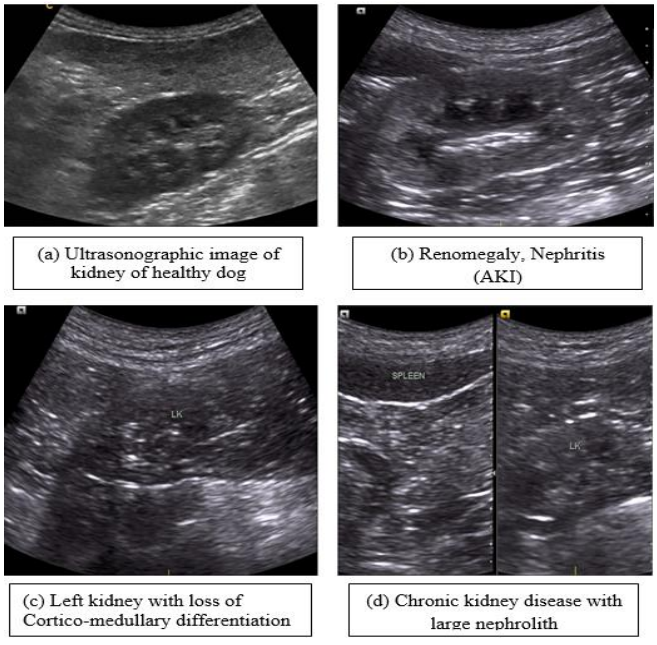

Fig 2: Ultrasonographic findings of healthy and renal failure dogs

Occurrence rate

A total of 2394 dogs were screened for renal disorders, out of which 28 dogs were affected with renal disorders. Therefore, the overall occurrence of renal disorders in the dog population was 1.16 percent.

Age wise distribution

Distribution of renal disorders according to age is summarized in figure 3. The highest occurrence rate of kidney diseases was recorded in 4 to 8 years of age group (1.42%) and lowest in 0 to 4 years of age group (0.98%).

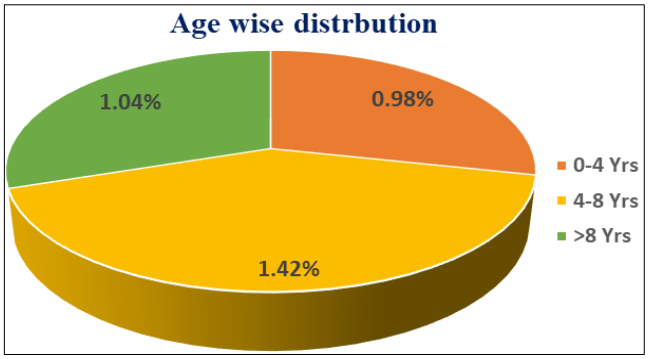

Fig 3: Age wise distribution of renal failure dogs

Breed wise distribution

The breed wise distribution of renal disorders in dogs is shown in Figure 4. The highest occurrence of kidney diseases in different breeds of dogs was recorded in Labrador (0.5%), followed by Pomeranian (0.2%).

Sex wise distribution

Out of 28 dogs, 1.43% male and 0.69% female dogs were confirmed for kidney diseases indicating higher incidence rate of kidney disease in males than females (Figure 5).

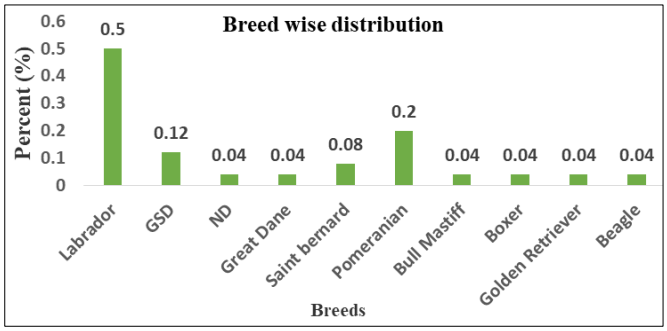

Fig 4: Breed wise distribution of renal failure dogs

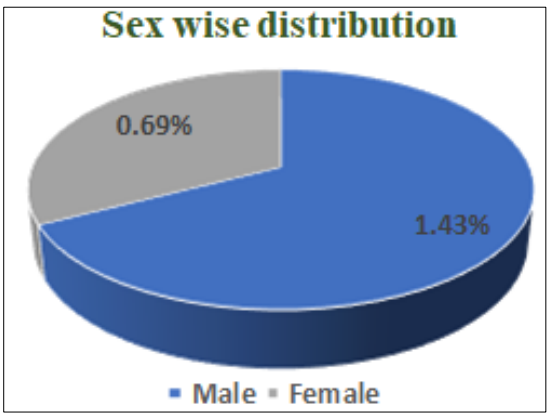

Fig 5: Sex wise distribution of renal failure dogs

Discussion

We recorded 1.16% of overall occurrence of renal failure in dogs of Bareilly region in the polyclinic-based study (n=2394) for the period of March to August, 2021. The results of the study corroborate well with the findings of earlier studies in India who observed the occurrence ranging from 0.93 to 3.48% (Tufani *et al*., 2015; Karunanithy *et al*., 2021; Chaitanya *et al*., 2020; Singh *et al*., 2020; Pathak *et al*., 2023) [37, 16, 8, 24, 29]. However, a comparatively higher occurrence of renal disorderswasalso reported from India ranging from 12.03 to 22.81% (Srikanth and Karlapudi, 2015; Mshelbwala *et al*., 2016; Nabi *et al*., 2018) [35, 24, 26]. Variations in the occurrence rates in different regions of India might be due to variations in the toxin exposure due to modern agricultural practices, comorbid haemoprotozoan diseases, malnutrition and indiscriminate use of medicines, etc. (Katoch *et al*., 2018) [17]. Differences in study design may also account for the differences in occurrence rates.

Majority of the studies have reported higher occurrence of this disorder in senile age dogs of more than 8 years (Kavitha *et al*., 2013; Tufani *et al*., 2015; Devipriya *et al*., 2018; Chaitanya *et al*., 2020; Pathak *et al*., 2023) [18, 37, 11, 8, 29]. However, in the present study, the highest number of cases suffering from kidney disease were noticed in 4-8 years of dogs which corroborates with findings of previous studies showing high occurrence of CKD in 4 to 7 years (O Neill *et al.,* 2013) [27] and high chances of renal failure in 6 to 8 years of age (Mallela *et al.,* 2006) [22]. The possible reason of less occurrence observed in more than 8 years age group in the present study can be attributed to survival incapability of dogs before reaching to this age. The pattern of the breed wise occurrence is lined well with the previous studies showing higher breed wise occurrence of renal disorders in Labrador breed (Ahmed *et al*., 2011; Kandula and Karlapudi, 2014; Nabi *et al*., 2018) [1, 15, 26] followed by Pomeranian breed (Oburai *et al*., 2015; Karunanithy *et al*., 2021; Chaitanya *et al*., 2020) [28, 16, 8]. According to Author, more susceptibility of Labrador breed to pyometra, leptospirosis, systemic causes and other mixed infections predispose it to renal failure (Tufani *et al*., 2015) [37]. The breed wise relative differences in renal disorders might be due to geographical location, genetic makeup, breed abundance and preference and managemental practices.

The result of the present study commensurate with the findings of Tufani *et al*. (2015) [37], Oburi *et al*. (2015) [28], and Karunanithy *et al*. (2019) [16] who observed higher occurrence of renal disorders in male dogs. Certain studies have reported no gender wise difference (Sahu *et al*., 2021; Meena *et al*., 2022; Pathak *et al*., 2023) [32, 23, 29]. However, Kandula and Karalapudi (2014) [15], Mukherjee *et al*. (2014) [25] and Nabi *et al*. (2018) [26] reported higher occurrence in female dogs. In present study, males were found more in number as compared to the females. Male dogs are at high risk of kidney stones, which is a common etiological factor for renal failure (Tufani *et al*., 2015; Bjorling, 2003) [37, 4]. Moreover, higher values of creatinine in males were observed as compared to female dogs (Jergens *et al*., 1987) [14]. Tufani *et al*. (2015) [37] reported that the factors like idiopathic factor, leptospirosis, urolithiasis leading to renal failure, were more in male dogs as compared to female dogs.

Anorexia, vomiting, diarrhoea, are the common symptoms we recorded in cases of renal failure which could be resulted from gastrointestinal ulceration led by uraemia (Kralova *et al*., 2010) [19]. Vomiting is frequent sign of uraemic animals with acute renal injury. Increased gastric acidity and associated inflammation due to hypergastrinaemia takes place in animals with decreased renal function (Grauer 2022) [13]. In addition, vomiting occurs from direct stimulation of chemoreceptor trigger zone by uremic toxins. Dehydration or hypokalaemia linked to polyuric renal failure, metabolic acidosis, or adverse drug reactions from renal failure treatments can all lead to anorexia. Dogs were reported to have diarrhea, which could be caused by bacterial urease breaking down urea into ammonia and producing symptoms similar to hemorrhagic gastroenteritis (Schulman and Krawiec 2000) [33]. It has been documented that despite an intravascular volume deficit, limb oedema can result from hypoalbuminemia or vasculitis that causes interstitial fluid buildup. (Vaden 2004) [38]. Uraemia can be diagnosed with history of vomition, presence of ulcer in mouth and increased serum level of BUN and creatinine. The signs of oliguria, anuria, polyurea and polydipsia were also noticed in dogs with renal failure (Foster *et al*., 2013) [12]. Our findings of epileptic seizuresin renal failure dogs supports the earlier findings of uremic encephalopathy in relation to kidney falure. The epileptic seizures are result of uremic toxins crossing blood brain barrier along with guanidine compounds which leads to neurological disturbances (Vanholder *et al*., 2008) [39]. in Renal failure dogs with anaemia leads to less level of oxygen supply to remaining tissues of the kidney which relates with lethargy, weakness and anorexia (Chakrabarti, 2012) [9].

In the present study, the decreased specific gravity in renal failure dogs is similar to the findings of earlier studies. Reduced urine specific gravity can be explained by the fact that when nephrons are completely unable to alter glomerular filtrate, the resulting urine typically has a specific gravity (ranging from 1.008 to 1.012) resembling that of the glomerular filtrate. The current study has noted the presence of varying proportions of proteinuria, glucosuria, and ketonuria. The presence of persistent moderate to heavy proteinuria without abnormalities in urine sediment strongly indicates the possibility of glomerular disease (Vaden *et al*. 1997) [38]. Glucosuria can be seen in dogs suffering from chronic renal disease, tubular injury due to nephrotoxins, and certain familial renal conditions. The localization of the lesion is not aided by the presence of white blood cells unless white cell casts are found, which suggest a renal origin. Presence of WBCs in urine of kidney disease dogs has also been reported by Börkü *et al*. (2000) [6]. According to this study, renal size and parenchymal structural changes are crucial for detecting various illnesses, and ultrasonography is a rapid, useful, and sensitive way to spot these changes. The ultrasonographic variationsseen in dogs with chronic renal failure supports the findings of Perondi *et al*. (2020) [30], who found that, increased cortical echogenicity, abnormal corticomedullary junction and dilated pelvis were the most common abnormalities in CRF. Similarly, Kumar *et al*. (2011) [20] also reported the significant nephrosonographic alterations in the dogs with renal failure.

Conclusion

The overall occurrence of renal disorders in dogs was 1.16%. Male dogs and dogs of 4 to 8 years of age had more occurrence with Labrador breed being most affected with renal disorders followed by Pomeranian. This study

warrants the need for precautions to be taken by dog owners to avoid renal failure in male Labrador dogs in Bareilly region. Blood Urea Nitrogen and Creatinine were found as reliable renal function markers to diagnose renal failure coupled with supported hematology and urinanalysis. Nephrosonography revealed multiple echotextural alterations in some affected dogs suggestive of Chronic renal failure. As a result, the initial diagnostic workup in renal failure in dogs is aimed at identifying the underlying cause, so that the latter can be eliminated and further kidney injury can be minimized to become a chronic condition.The current research provides insights into the epidemiology of renal failure and explores diagnostic methods that could potentially lower the incidence of renal failure by facilitating early detection and monitoring in dogs.

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Conflict of interest
The authors affirm that there are no conflicts of interest to disclose.

References
1. Ahmed SB, Ronksley PE, Hemmelgarn BR, Tsai WH, Manns BJ, Tonelli M, Hanly PJ. Nocturnal hypoxia and loss of kidney function. PLoS One. 2011;6(4):e19029.
2. Bartges JW. Chronic kidney disease in dogs and cats. Vet Clin Small Anim Pract. 2012;42(4):669-692.
3. Bellomo R, Wan L, May C. Vasoactive drugs and acute kidney injury. Crit Care Med. 2008;36(4):S179-S186.
4. Bjorling DE. The urethra. In: Slatter D, ed. Textbook of Small Animal Surgery; c2003.
5. Bogari MH, Munshi A, Almuntashiri S, Bogari A, Abdullah AS, Albadri M, Hashim A, AlZahrani MS. Acute gastroenteritis-related acute kidney injury in a tertiary care center. Ann Saudi Med. 2023 Mar-Apr;43(2):82-89. DOI: 10.5144/0256-4947.2023.82. Epub 2023 Apr 6. PMID: 37031372; PMCID: PMC10082947.
6. BÖRKÜ M, Guzel M, Karakurum M, Ural K, AKTAŞ S. Nimesulide-induced acute biliary tract injury and renal failure in a kitten: a case report. Veterinárnímedicína. 2008;53(3).
7. Bronson RT. Variation in age at death of dogs of different sexes and breeds. Am J Vet Res. 1982;43:2057-2059.
8. Chaitanya Y, Rani NL, Rao VV, Kumar PR, Srinu M. Epidemiological studies of renal diseases in dogs. Pharma Innovation. 2020;9(12):06-07.
9. Chakrabarti S, Syme HM, Elliott J. Clinic pathological variables predicting progression of azotemia in cats with chronic kidney disease. J Vet Intern Med. 2012;26(2):275–281.
10. Den Abeele V. Steps on the human Arcobacter trail [dissertation]. Ghent University; 2018.
11. Devipriya K, Lavanya C, Selvaraj P, Napolean RE. Early diagnosis of renal insufficiency in dogs with haemato: Biochemical findings. J Entomol. Zool. Stud. 2018;6(5):703-705.
12. Foster JD. Update on mineral and bone disorders in chronic kidney disease. Vet. 2016.
13. Grauer G. Reassessment of "normal" values in dogs and cats with chronic kidney disease; c2022.
14. Jergens AE, McCaw DL, Hewett JE. Effects of collection time and food consumption on the urine protein/creatinine ratio in the dog. Am J Vet Res. 1987;48:1106-1109.
15. Kandula S, Karlapudi SK. Prevalence of renal disorders in dogs-A Clinical Study. Int J Agric Sci Vet Med. 2014;2(3):146-148.
16. Karunanithy M, Thakur N, Dey S. Prevalence of renal disorders in dogs of Bareilly area of Uttar Pradesh, India. Biol Rhythm Res. 2021;52(1):116-126.
17. Katoch A, Wadhwa DR, Sharma A. Epidemiological observations on canine renal disorders. Himachal J Agric Res. 2018;43(2):135-138.
18. Kavitha S, Nambi AP, Srinivasan SR, Balachandran C, Muralimanohar B. Ultrasonographic and histopathological changes in dogs with chronic renal disease. Tamilnadu J Vet Anim Sci. 2013;9(2):153-155.
19. Kralova S, Leva K, Toman M. Changes in lymphocyte function and subsets in dogs with naturally occurring chronic renal failure. Can J Vet Res. 2010;74(2):124-129.
20. Kumar M, Sarma K, Saravanan M, Mondal DB. Dietary management of chronic renal failure cases in dogs. Amelioration of chicken infectious anaemia virus induced immunosuppression by protein and immunoglobulin supplementation in chicks. 2011;40.
21. Lund EM, Armstrong PJ, Kirk CA. Health status and population characteristics of dog and cats examined at private veterinary practice in United States. J Am Vet Res Assoc. 1999;214:1336-1341.
22. Mallela MK, Bhutia YD, Suryanarayan C, Rajni B, Reddy MCS. Efficacy of conservative therapy in managing chronic renal failure in dogs. Indian Vet J. 2006;26:82-89.
23. Meena P, Bargujar J, Nagar JK, Meena A, Bhardwaj SK, Choudhary S, Jangid SK. Occurrence of renal failure in Labrador dogs at PGIVER Jaipur and its relation with age, sex and body weight. Pharma Innov. 2022;11(5):1412-1414.
24. Mshelbwala FM, Ajayi OL, Adebiyi AA, Olaniyi MO, Omotainse SO, Omotainse OS, Kadiri AKF. Retrospective studies on the prevalence, morphological pathology and aetiology of renal failure of dog in Lagos and Abeokuta, Nigeria. Niger Vet J. 2016;37(4):206-216.
25. Mukherjee P, Chakrabarti A, Har T, Batabyal K, Das B. Study of haematological profiles of dogs infected with pathogenic aerobes. 2014.
26. Nabi S, Dey S, Shah O, Hussain T, Amin U, Vala J, Beigh SA. Incidence of renal disorders in canines and its relation with age breed and sex. Pharma Innov J. 2018;7:87-89.
27. O'Neill DG, Elliott J, Church DB, McGreevy PD, Thomson PC, Brodbelt DC. Chronic kidney disease in dogs in UK veterinary practices: prevalence, risk factors, and survival. J Vet Intern Med. 2013;27(4):814-821.
28. Oburai NL, Rao VV, Bonath RBN. Comparative clinical evaluation of Boerhavia diffusa root extract

with standard Enalapril treatment in Canine chronic renal failure. J Ayurveda Integr Med. 2015;6(3):150.
29. Pathak SK, Tiwari A, Gupta D, Dubey A, Shahi A, Singh B, Rakesh S. Occurrence study of renal disorders in canines using renal function markers and nephrosonographic modalities; c2023.
30. Perondi F, Lippi I, Marchetti V, Bruno B, Borrelli A, Citi S. How Ultrasound Can Be Useful for Staging Chronic Kidney Disease in Dogs: Ultrasound Findings in 855 Cases. Anim Biosci. 2020;7(4):147.
31. Peters RM, Goldstein RE, Erb HN, Njaa BL. Histopathologic features of canine uremic gastropathy: a retrospective study. J Vet Intern Med. 2005;19(3):315-320.
32. Sahu G, Mehta HK, Singh N, Bagherwal RK, Gautam K. Prevalence study of renal diseases in dogs in and around Mhow region. 2021.
33. Schulman RL, Krawiec DR. Gastrointestinal complications of uremia. In: Kirks Current Veterinary Therapy. 2000:864-865.
34. Singh SP, Shekhar P, Singh GD, Kumar V, Singh AK, Prasad JK. An epidemiological and ultrasonographic study of renal failure in canine. Pharma Innov. 2020;9(6):121-127.
35. Srikanth Kandula SK, Karlapudi SK. Haemato-biochemical changes in dogs with renal insufficiency and its diagnostic significance; c2015.
36. Tilley LP, Smith FWK. Renal failure. In: Blackwell's Five Minute Veterinary Consult. Philadelphia: Saunders; c2007. p. 1638-1651.
37. Tufani NA, Singh JL, Kumar M, Gupta D, Shekhar P, Rajora VS. Renal failure in Indian dogs: An epidemiological study. Indian J Vet Pathol. 2015;35(1):7-11.
38. Vaden SL, Levine JF, Lees GE, Groman RP, Grauer GF, Forrester SD. Renal biopsy: a retrospective study of methods and complications in 283 dogs and 65 cats. J Vet Intern Med. 2005;19(6):794-801.
39. Vanholder R, De Deyn PP, Van Biesen W, Lameire N. Marconi revisited: from kidney to brain-two organ systems communicating at long distance. J Am Soc. Nephrol. 2008;19(7):1253-1255.