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The prevalence and classification of chronic kidney disease in cats randomly selected within four age groups and in cats recruited for degenerative joint disease studies

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Abstract

Chronic kidney disease (CKD) and degenerative joint disease are both considered common in older cats. Information on the co-prevalence of these two diseases is lacking. This retrospective study was designed to determine the prevalence of CKD in two cohorts of cats: cats randomly selected from four evenly distributed age groups (RS group) and cats recruited for degenerative joint disease studies (DJD group), and to evaluate the concurrence of CKD and DJD in these cohorts. The RS group was randomly selected from four age groups from 6 months to 20 years, and the DJD group comprised cats recruited to four previous DJD studies, with the DJD group excluding cats with a blood urea nitrogen and/or serum creatinine concentration >20% (the upper end of normal) for two studies and cats with CKD stages 3 and 4 for the other two studies. The prevalence of CKD in the RS and DJD groups was higher than expected at 50% and 68.8%, respectively. CKD was common in cats between 1 and 15 years of age, with a similar prevalence of CKD stages 1 and 2 across age groups in both the RS and DJD cats, respectively. We found significant concurrence between CKD and DJD in cats of all ages, indicating the need for increased screening for CKD when selecting DJD treatments. Additionally, this study offers the idea of a relationship and causal commonality between CKD and DJD owing to the striking concurrence across age groups and life stages.

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Supplementary data Algorithm to determine cats with chronic kidney disease (CKDpos), small kidney and CKDneg groups.

Conflict of interest BDXL has received honoraria for sponsored CE from all of the sponsors of the work described in this study, and has acted as a consultant for Novartis Animal Health, Nutramax and Boehringer Ingelheim. None of the other authors have conflicts of interest to declare.

Introduction

Chronic kidney disease (CKD) in cats is a prolonged process marked by irreversible loss of kidney function, usually without an identifiable cause, and has been increasingly diagnosed over the past three decades, particularly in older cats.[1–4] Because glomerular filtration rate (GFR) is not commonly measured in the clinical setting, serum creatinine concentration is most often used as a marker of GFR.[5] The International Renal Interest Society (IRIS) has developed a staging system in which the stages are based on the serum creatinine concentration in animals with stable CKD. The staging system is used as a guide for therapeutic intervention, as well as prognostication.[5,6] The first stage is often overlooked because the serum creatinine concentrations fall within the normal reference interval for most laboratories; therefore, CKD stage 1 can be identified by finding proteinuria, normoglycemic glucosuria, isosthenuria (1.008–1.012), poorly concentrated urine (1.013–1.035) or evidence of CKD via renal imaging.[1,5,6] CKD stages 2, 3 and 4 represent progressive increases in serum creatinine concentrations and clinical signs.

Degenerative joint disease (DJD) is the progressive destruction of one or more components of synovial or cartilaginous joints.[7,8] Radiographic DJD is very common in cats; however, these findings do not correlate well with results of orthopedic examination,[8–10] making the diagnosis of DJD-associated pain and impairment challenging. There are many proposed treatments for feline DJD.[11,12] Although nonsteroidal anti-inflammatory drugs (NSAIDs) have been shown to be efficacious in controlling pain associated with DJD in cats, there is concern regarding the use of NSAIDs in cats with DJD and concurrent CKD[13] owing to the recognized role prostanoids play in renal function.[14]

Previously published reports on the prevalence of CKD in cats that predate the IRIS staging system used a serum creatinine concentration >1.8 or 2 mg/dl (159 or 177 μmol/l) as the indicator for CKD.[2–4,15] The objectives of this study were to use multiple indicators of renal disease to describe the prevalence of CKD in a cohort of cats randomly selected from four age groups and a group of cats recruited for multiple DJD studies, the concurrence of CKD with DJD in the latter group and assign IRIS stage classification to both cohorts of cats if CKD was present.

Materials and methods

This is a retrospective study combining data from five studies at our institution. The Institutional Animal Care and Use Committee at North Carolina State University approved all studies used to collect the data reported herein. The studies were explained to all pet owners, who then signed an informed consent.

Part 1: Randomly selected group

The randomly selected (RS) group consisted of a population of randomly selected cats from a single practice, as described previously.[9,16] This database of cats was divided into four age groups (6 months to 5 years; 5–10 years; 10–15 years; and 15–20 years) and each cat was assigned a number within the given age group. The numbers were randomly ranked using a computer program and the first 25 cats in each age group were selected to come in for a health screen. This yielded a cohort of 100 cats with 25 cats that had been randomly selected in each age group.[9] Although selected at random, no cat was acutely ill at the time of data collection. Age, gender, body weight and body condition score (BCS) using a five-grade body index system[17] were recorded for all cats. All cats underwent physical, orthopedic and neurological examinations. Orthogonal radiographs were made of all appendicular joints and spinal segments while cats were under sedation. Samples were subsequently collected for complete blood count (CBC), serum chemistry and urine analysis (by cystocentesis).[9]

Part 2: DJD group

The DJD group consisted of 128 cats recruited to one of four different studies of reduced activity or impaired mobility conducted at our institution: a trial of a feline therapeutic diet[18,19] (study A); a study evaluating a nutritional supplement (study B; unpublished data, subjects described previously[19]); a study assessing the reliability of a novel feline musculoskeletal pain index[20] (study C), and an ongoing study investigating a treatment for DJD-associated chronic pain (study D; unpublished data). As described previously, patient history, physical examination, CBC, serum chemistry and urine analysis were used to screen cats for other systemic disorders and a detailed client questionnaire was used to determine whether there was mobility impairment.[9,18,19] Age, gender, body weight and BCS using a nine-grade body index system[21] were recorded for all cats.

For all studies, cats were included if (i) they lived only indoors, (ii) no anti-inflammatory medications had been given 4 weeks prior to the study, (iii) no clinically significant changes in CBC or serum chemistry results had occurred within the previous 4 weeks, and (iv) a client-specific outcome measures form indicated impairment for activities, as described previously.[11] Cats were enrolled in studies A, B and C if pain was elicited in at least one joint during orthopedic examination and there was radiographic evidence of DJD.[9,16] Cats with at least two painful joints and overlapping radiographic evidence of DJD in these joints were enrolled into study D. Cats in studies A and B only had radiographs made when joint pain was elicited, whereas those in studies C and D had radiographs made of all appendicular joints and spinal segments.

Cats were excluded from studies A and B if the blood urea nitrogen and/or serum creatinine was >20% above the upper limit of the reference interval.[18] Cats were excluded from studies C and D if the serum creatinine was >2.8 mg/dl (249 μmol/l).[20] In summary, cats recruited to studies A, B, C and D were all cats that exhibited mobility impairment due to DJD-associated pain, excluding cats with the most severe CKD.

CKD evaluation

As part of the present study, cats in the RS and DJD groups were placed in one of three categories based on the results of CBC, serum chemistry, urine analysis, and radiographic determination of degenerative kidney changes and kidney size [evidence of CKD (CKDpos), small kidney, or no evidence of CKD (CKDneg)] (Supplementary data). Because urine specific gravity (USG) is not a reliable indicator of feline kidney function in isolation, and other factors, such as water intake and other diseases, can affect this, cats with a USG of

1.013–1.034 without other indicators of kidney disease were categorized as CKDneg. Two authors (CLM and SLV) went over the above results for each cat to determine category placement. If the features of parenchymal mineralization, irregular margins and/or misshapen kidneys were seen radiographically, then cats were considered to have degenerative kidney changes. A board-certified radiologist reviewed all radiographs for kidney abnormalities. The left and right kidneys were visualized on the ventrodorsal view of spinal radiographs and the lengths were measured to the nearest millimeter (Efilm Workstation 3.3.0; Soundelkin). The kidney lengths were compared to the length of a single lumbar vertebra (L2) measured from endplate to endplate by a single investigator (CLM).[22–24] A ratio was calculated for each kidney; a range of 2–3 times the length of L2 was considered normal.[3,22,23,25–27] Cats with CKD were staged according to the IRIS guidelines[5]; without urine protein to creatinine ratios and blood pressure measurements, IRIS substaging was not possible in this study.

Data analysis

Descriptive statistics were used to characterize demographic data, including gender, body weight, BCS and breed. The prevalence of CKD was determined as the ratio of CKDpos cats to the total number of cats and the total in each age group. For the CKDpos cats, CKD stage was determined and the prevalence of each stage was reported as a ratio to the total number of CKDpos cats and the total number of cats in both the RS and DJD groups (population totals). For the purpose of this study, DJD group cats were placed in one of four life stages (immature, mature, senior or geriatric), with the immature life stage including kitten, junior and prime, according to the American Association of Feline Practitioners guidelines.[28,29] Henceforth, the RS cohort divisions are referred to as age groups and the DJD cohort divisions are referred to as life stages.

Results

Part 1: RS group

Fourteen cats were excluded from the study because either a urine sample was not collected for urine analysis or the kidneys were not visible on radiographs, precluding full evaluation of CKD. Of the 86 remaining, 24 cats were aged 0–4.9 years, 22 cats were aged 5.0–9.9 years, 19 cats were aged 10.0–14.9 years and 21 cats were aged 15–20 years (Table 1). Demographic data for these 86 cats are presented in Table 2. Sixty cats were domestic shorthair, five domestic longhair, two mixed and 19 purebred (seven Siamese, six Maine Coon Cats, three Abyssinians, one each of Persian, Tonkinese and British Shorthair). Of the RS cats, 50% (43/86) were CKDpos, 11.6 % (10/86) were in the small kidney group and 38.4 % (33/86) were CKDneg (Figure 1). Of the 33 CKDneg cats, six had a USG <1.035 with no other evidence of CKD. For the 43 CKDpos cats, 27.9% (12/43) were CKD stage 1, 65.1% (28/43) stage 2 and 7.0% (3/43) stage 3; none of the cats was CKD stage 4 (Table 3). All small kidney cats were CKD stage 1 and were not included in the CKDpos cat group. The total prevalence (CKDpos/RS population total) for CKD stages 1, 2 and 3 were 13.9% (12/86), 32.6% (28/86) and 3.5% (3/86), respectively (Table 3). Five Siamese (71.4%) and three Maine Coon Cats (50%) were CKDpos, and another Maine Coon Cat was in the small kidney group. All Abyssinians in the RS group were CKDneg.

Part 2: DJD group

One hundred and twenty-eight cats were included from studies A (24 cats), B (37 cats), C (24 cats) and D (43 cats). Eight were immature, 32 mature, 59 senior and 29 geriatric. Demographic data for this cohort are presented in Table 4. One hundred cats were domestic shorthair, nine were domestic longhair, one was mixed and 18 were purebred (seven Maine Coon, five Siamese, two Scottish Folds, and one each of Abyssinian, British Shorthair, Manx and Himalayan). Of the 128 cats, 68.8% (88/128) were CKDpos, 1.6% (2/128) were in the small kidney group and 29.7% (38/128) were CKDneg (Figure 1). Of the 38 CKDneg cats, 13 had a USG <1.035 with no other evidence of CKD. For the 88 CKDpos cats, 33.0% (29/88) were CKD stage 1, 65.9% (58/88) stage 2, 1.1% (1/88) stage 3 and none were stage 4 (Table 3). The total prevalence (CKDpos/DJD population total) for CKD stages 1, 2 and 3 were 22.7% (29/128), 45.3% (58/128) and 0.8% (1/128) respectively (Table 3). Four Siamese (80%), six Maine Coon Cats (85.6%) and the Abyssinian were CKDpos.

Discussion

The objectives of this study were to determine the prevalence of CKD in two different cohorts of cats (the RS group and the DJD group), report the concurrence of CKD and DJD in the DJD group, and assign CKD stage using IRIS guidelines. The 50% prevalence of CKD in the RS cats was much higher than previously reported, with increase in prevalence in cats aged 15 years and older. However, direct comparisons of the data from the two groups must be made very cautiously as the inclusion criteria were very different for the two groups.

Demographic data for cats with CKD was similar to previous reports.[2–4] More females than males were CKDpos in the RS and DJD groups. Previously reported gender ratios are variable.[2,3,16,30,31] The variability in this study is likely a result of the small sample size. Consistent with previous studies both groups comprised mainly domestic short- and longhair cats.[3,4,16] Siamese, Maine Coon cats, Abyssinian, Russian Blue and Burmese cats have been previously reported to have twice the likelihood of being affected with CKD than domestic shorthair cats.[3] Findings presented here support the previously reported increased risk for CKD in purebred cats; however, the small number of purebred cats in this study precluded the ability to identify breed predispositions or to determine if the breed distribution in CKDpos cats differed between the RS and DJD cats.

The prevalence of CKD in the RS cats is strikingly higher than previously reported. The prevalence of kidney disease in cats seen at academic institutions is reported to be 1.18–3.05%, but only 1.9% in cats evaluated in a private practice setting.[3,4] However, these studies used azotemia to make the diagnosis of kidney disease and likely missed nonazotemic cats with CKD, particularly those with CKD stages 1 or 2. Nonetheless, the prevalence of azotemic cats in the present study (CKD stage 2 and 3) was higher than previously reported (36.2%). Kidney size does not always correlate with kidney disease;[23] however, small kidneys may be a risk factor for subsequent kidney disease.[3] In the current study, cats in the small kidney group had a lower BCS and weight than CKDpos and CKDneg cats. This may account for the smaller kidney size without the other appreciated changes (Tables 2 and 4). The increase in CKD found in this study is likely multi-factorial.

Veterinarians and pet owners have a heightened awareness of feline CKD.[28] Fewer pet owners take their cat to the veterinarian for preventive care, even though 75% of owners admit that routine care is important for their cat.[32] Thus, the early stages of CKD are probably missed in many cats. Additionally, other factors may represent important biases. The RS group of cats was recruited from a single feline-only practice in the USA. Feeding and maintenance of these cats may differ from other geographical locations, and may affect the prevalence of CKD.

Unexpectedly in the RS cats, the prevalence of CKD in the three age groups <15 years was very similar (37.5%, 40.9%, 42.1%) (Figure 2). One study found the prevalence of CKD to be 13% in cats <4 years, 24% in cats aged 4–10 years, 31% in cats aged 10–15 years and 32% in cats ≥15 years.[3] The CKD stages in the RS group of cats did indicate more advanced CKD (stage 3) in cats >10 years of age; however, this only encompassed 3.5% of the RS cats. Of interest was the similar prevalence of CKD stages 1 and 2 in the three age groups <15 years of age. The reason for this even distribution of CKD stage among the younger cats is not known; however, there are no historical data to compare our data with. Previous studies have not evaluated the severity of azotemia, nor have they included cats with a creatinine concentration <1.6 mg/dl (140 μmol/l). Though difficult to diagnose, recognizing CKD stage 1 and 2 cats is likely critical to finding an inciting cause and implementing appropriate therapy.[6] Histopathology and long-term follow up may elucidate why so many younger cats have CKD. Our data indicate that cats of all ages should be screened for CKD to identify at-risk cats and adjust treatment accordingly.

An even higher prevalence of CKD was found in the DJD cats than RS cats (68.8%); however, because of the difference in the way cats were selected for the RS and DJD groups, a direct comparison cannot be made between the two groups nor between age groups and life stages. Increasing age is highly correlated with the presence and severity of radiographic DJD, as well as an increased chance of finding crepitus, effusion or joint thickening on orthopedic examination;[10,17,33] age-related progression of this DJD is likely to be the cause of mobility impairment, and explains why the majority of cats in the DJD group were older. Despite the low number of cats in the immature life stage (n = 8), 50% of these cats with DJD were CKDpos, 75% of which were CKD stage 2 (3/4) (Figure 3). Similarly, the majority of CKDpos cats in other life stages were CKD stage 2. A single CKD stage 3 cat was enrolled in the DJD group erroneously owing to differing laboratory ranges. Although this cat was included in our descriptive statistics, and its data presented in this report, inclusion does not affect the data presented on CKD stages 1 and 2 cats. It is known that pathological kidney changes may already be present even when the serum creatinine concentration is <2 mg/dl (177 μmol/l), which would allow cats at the lower end of CKD stage 2 to be missed if simply evaluating serum creatinine concentration.[34] Together, our findings indicate a strong concurrence between these two disease processes and the need to screen for CKD, particularly when considering NSAID treatment for DJD, in any aged cat.

The high prevalence of CKD in cats with DJD has not been documented previously. This has important implications for treatment.[35] Avoiding NSAIDs in cats with both DJD and CKD would mean few cats with DJD would be treated with what is currently assumed to be the most effective class of analgesics for the treatment of chronic musculoskeletal pain in the cat. Two recent studies have suggested that cats with CKD can be safely treated with low doses of NSAIDs; however, in these studies the authors report the decision to treat cats with CKD with NSAIDs was biased, with the veterinarian choosing cats that 'looked' able to tolerate NSAIDs.[36,37] Additionally, the doses used in these studies (0.02 mg/kg/day, on average) are not known to be effective in alleviating DJD-associated pain. Further understanding of the effect of NSAIDs on the compromised feline kidney is needed, and an understanding of what alternative therapies are efficacious for managing feline DJD-associated pain is required.

The high co-prevalence of CKD and DJD is interesting, and could be explained in several ways. One explanation for the concurrency could be behavioral. In the DJD studies, owners presented cats for inclusion because of perceived changes in activity level and interaction with their cats. It is possible that CKD may have been a reason for these behavioral changes in the cats (in any life stage); when screened for the study, these cats were found to have DJD. Another possible explanation for the concurrency could be shared etiology of CKD and DJD. The cause of primary DJD in cats is not currently known, although inflammatory and immune-mediated etiologies have been suggested,[38] and immune dysfunction has been seen in association with DJD in a genomic/proteomic study.[39] A previous study of DJD in cats revealed an increase in the prevalence of azotemia, but this significant association was no longer statistically significant when controlled for age.[10] Histologically, end-stage CKD is associated with tubulointerstitial fibrosis.[30] Chronic inflammation is often implicated in the development of fibrosis; however, the inciting cause is rarely identified because of the chronicity of the disease.[30,40] It would be interesting to know whether this inflammation results from targeting of a specific antigen within the kidney or if the inflammation is due to immune system dysfunction. It is possible that inflammation or immune dysfunction may be a common mechanism behind both DJD and CKD, and this requires further study.

Limitations of this study included lack of ultrasonographic evaluation of the kidneys to document chronic degenerative changes. Radiographs are often the best tool for measuring kidney size, but subtle changes to the renal parenchyma that can be missed with radiographs might be detected via ultrasonic evaluation. Ultrasonography might have provided additional information about the small kidney cats and whether they should have been included in the CKDpos group. Cats with a USG of 1.013–1.035 were not included in the CKDpos group because additional diagnostics (eg abdominal ultrasound) were needed to confidently diagnose CKD in the absence of other indicators; therefore, the true prevalence may actually have been underestimated by the exclusion of these cats. Some cats had albuminuria. Urine protein to creatinine ratios and blood pressure measurements were not routinely measured in the original studies. Future studies should include these two variables to allow for IRIS CKD substaging, which may potentially discern subtle differences between age groups and life stages. The RS cats were selected at random, 25 within each of four age groups, and thus the prevalence may not represent the prevalence in the general population. Additionally, the RS cats were selected from a single feline-only practice, and the DJD cats were required to be predominantly indoor cats, and this may have biased the results.

Conclusions

The 50% prevalence of CKD in a randomly selected population of cats from a single feline-only practice was significantly higher than previously reported, including cats with CKD stage 1, 2 and 3. The prevalence of CKD was similar in cats up to 15 years of age, but there was an increased prevalence among cats older than 15 years. The prevalence of CKD in cats recruited to DJD studies was 68.8%, with the majority of these cats being CKD stage 2. Future studies are needed to determine if CKD and DJD are related, and additional studies should aim to define treatment options for cats with DJD that are safe in cats with concurrent CKD.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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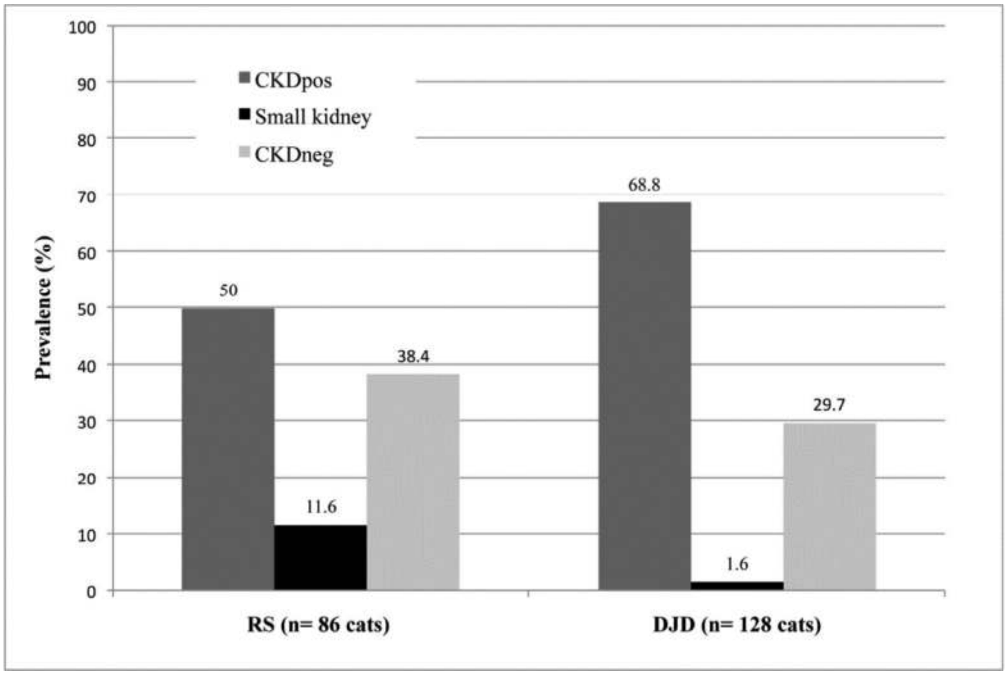

Figure 1.

The prevalence of CKD_{pos}, small kidney and CKD_{neg} cats in the RS and DJD groups. Total prevalence (percentage) is shown above each bar. The prevalence was calculated as the number of cats in each category out of the total number of cats in the RS and DJD groups. CKD = chronic kidney disease; DJD = degenerative joint disease; RS group = cats randomly selected within 4 age groups; DJD group = cats recruited for multiple DJD studies; CKD_{pos} = cats with CKD; small kidney = the small kidney group; CKD_{neg} = cats without CKD.

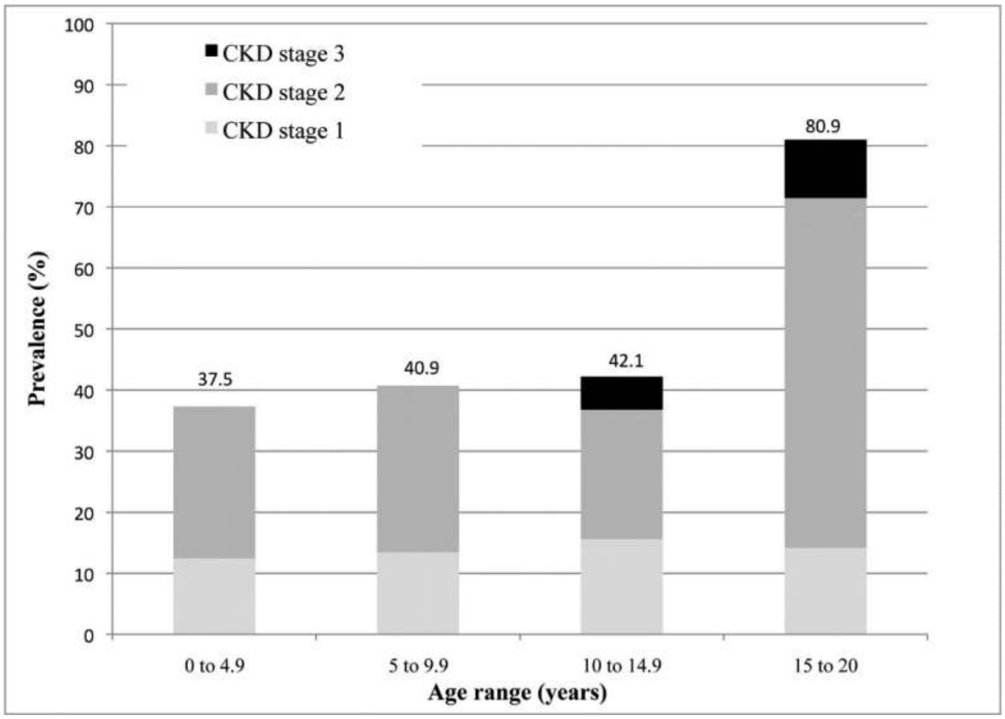

Figure 2.

The prevalence of CKD_{pos} cats in each age group of the RS group cats with IRIS CKD stage contribution designated by different shades within each bar. The total prevalence (percentage) of $CKD_{\text{pos cats out of the total number of cats}}$ in the respective age group is shown above each bar. The number of CKD_{pos} cats in each age group is presented in Table 2. CKD = chronic kidney disease; IRIS = International Renal Interest Society; RS group = cats randomly selected within 4 age groups; CKD_{pos} = cats with CKD

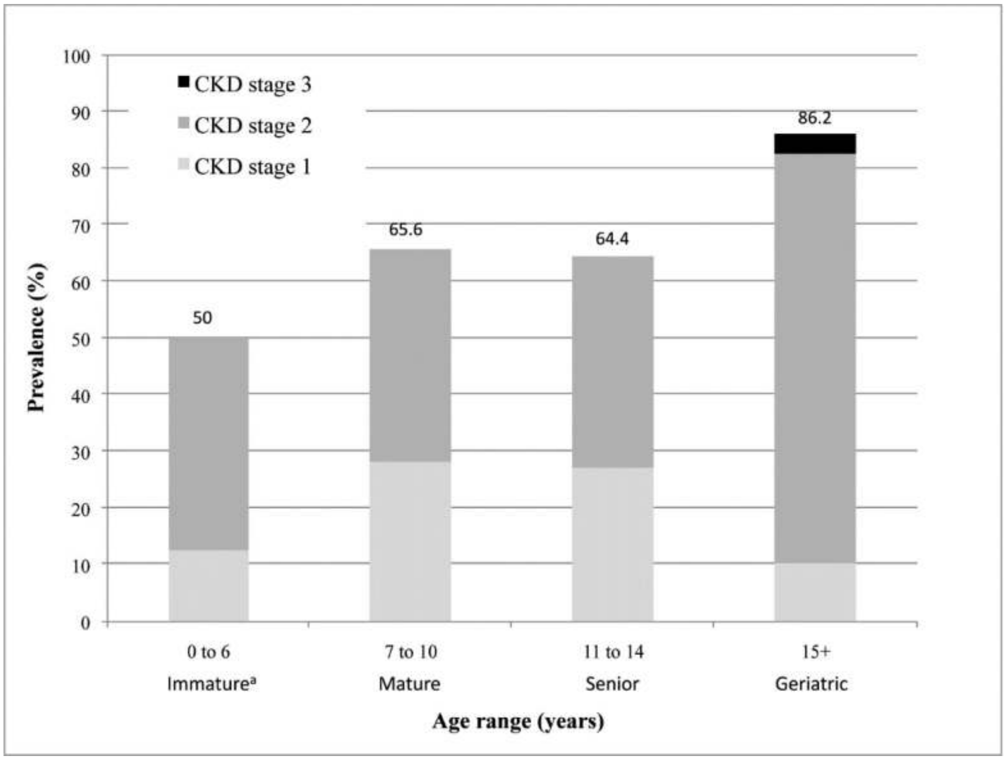

Figure 3.

The prevalence of CKD_{pos} cats in each life stage of the DJD group with the IRIS CKD stage contribution designated by different shades within each bar. The total prevalence (percentage) of CKD_{pos} cats out of the total number of cats in the respective life stage is shown above each bar. CKD stage contribution within each life stage is represented by different shading. The number of CKD_{pos} cats in each life stage is presented in Table 2.

[a] Combines kitten, junior and prime AAFP life stages

CKD = chronic kidney disease; IRIS = International Renal Interest Society; DJD = degenerative joint disease; DJD group = cats recruited for multiple DJD studies; CKD_{pos} = cats with CKD

Table 1

The prevalence of CKD_{pos} cats and IRIS CKD stage in each age group and life stage for the RS and DJD groups. For CKD stage, the denominator is the total number of CKD_{pos} cats in each age group and life stage. Percentages presented in parentheses.

	RS group				**DJD group**			
Age (y) Life stage	0 – 4.9	5 – 9.9	10 – 14.9	15 – 20	0 – 6 Immature[c]	7 – 10 Mature	11 – 14 Senior	15+ Geriatric
	n = 24	n = 22	n = 19	n = 21	n = 8	n = 32	n = 59	n = 29
CKD_{pos}[a]	9/24 (37.5)	9/22 (40.9)	8/19 (42.1)	17/21 (80.9)	4/8 (50.0)	21/32 (65.6)	38/59 (64.4)	25/29 (86.2)
CKD stage 1[b]	3/9 (33.3)	3/9 (33.3)	3/8 (37.5)	3/17 (17.6)	1/4 (25)	9/21 (42.9)	16/38 (42.1)	3/25 (12)
CKD stage 2[b]	6/9 (66.7)	6/9 (66.7)	4/8 (50)	12/17 (70.6)	3/4 (75)	12/21 (57.1)	22/38 (57.9)	21/25 (84)
CKD stage 3[b]			1/8 (12.5)	2/17 (11.8)				1/25 (4)

CKD = chronic kidney disease; IRIS = International Renal Interest Society; DJD = degenerative joint disease; RS group = cats randomly selected within the 4 age groups; DJD group = cats that were recruited for multiple DJD studies; CKD_{pos} = cats with CKD; CKD_{neg} = cats without CKD; AAFP = American Association of Feline Practitioners

[a]Percentage represents the number of CKD_{pos} cats out of the total number of cats in each age group and life stage.

[b]Percentage represents the number of cats in each IRIS CKD stage out of the total number of CKD_{pos} cats in each age group and life stage.

[c]Combines kitten, junior and prime AAFP life stages

Table 2

Demographic data from the 86 cats in the RS group summarized for the whole group as well as CKD_{pos} (including IRIS CKD stages), the small kidney group, and CKD_{neg} cats.

			CKD_{pos}				
		All cats	**CKD stage 1**	**CKD stage 2**	**CKD stage 3**	**Small kidney**	$\mathbf{CKD_{neg}}$
		n = 86	**n = 12**	**n = 28**	**n = 3**	**n = 10**	**n = 33**
Age (y)	mean ± SD	9.1 ± 5.1	9.4 ± 5.2	10.9 ± 5.4	15.7 ± 2.5	7.4 ± 4.1	7.3 ± 4.4
	range	1.0 – 20.0	1.6 – 11.0	1.0 – 20.0	12.8 – 17.3	1.4 – 15.0	1.0 – 16.2
Weight (kg)	mean ± SD	5.0 ± 1.6	5.1 ± 1.0	4.8 ± 1.9	4.7 ± 0.4	3.9 ± 1.1	5.4 ± 4.4
	range	2.1- 10.2	3.0 – 6.3	2.1 – 9.8	4.4 – 5.2	2.4 – 6.1	3.4 – 10.2
Sex	MC	30	1	10	1	1	17
	FS	56	11	18	2	9	16
BCS (1-5)	median (min, max)	3 (1,5)	4 (2,5)	3 (1,5)	3 (1,4)	2 (1,4)	3 (2,5)

CKD = chronic kidney disease; IRIS = International Renal Interest Society; RS group = cats randomly selected within 4 age groups; CKD_{pos} = cats with CKD; small kidney = the small kidney group; CKD_{neg} = cats without CKD; MC = male castrated; FS = female spayed; BCS = body condition score on a 1 to 5 scale; SD = one standard deviation of the mean

Table 3

The prevalence of each IRIS CKD stage in the RS and DJD CKD_{pos} cats. 'CKD_{pos}/ CKD_{pos} total' represents the number of cats in each CKD stage per the total number of CKD_{pos} cats in the RS and DJD groups. 'CKD_{pos}/pop total' is the number of cats in each CKD stage over the total number of cats in the RS and DJD groups. Percentages presented in parentheses.

		CKD stage 1	CKD stage 2	CKD stage 3
RS group	CKD_{pos}/CKD_{pos} total	12/43 (27.9)	28/43 (65.1)	3/43 (7.0)
	CKD_{pos}/RS pop total	12/86 (13.9)	28/86 (32.6)	3/86 (3.5)
DJD group	CKD_{pos}/CKD_{pos} total	29/88 (33.0)	58/88 (65.9)	1/88 (1.1)
	CKD_{pos}/DJD pop total	29/128 (22.7)	58/128 (45.3)	1/128 (0.8)

CKD = chronic kidney disease; IRIS = International Renal Interest Society; DJD = degenerative joint disease; RS group = cats randomly selected within 4 a

Table 4

Demographic data from the 128 cats in the DJD group summarized for the whole group as well as CKD_{pos} (including IRIS CKD stages), the small kidney group, and CKD_{neg} cats.

			CKD_{pos}				
		All cats	**CKD stage 1**	**CKD stage 2**	**CKD stage 3**	**Small kidney**	**CKD_{neg}**
		n = 128	**n = 29**	**n = 58**	**n = 1**	**n = 2**	**n = 38**
Age (y)	mean ± SD	12.5 ± 3.6	11.7 ± 2.6	13.4 ± 3.8	18.3	11.8 ± 0.8	11.7 ± 3.5
	range	2.5 – 21.2	6.0 – 16.9	3.8 – 21.1		10.9 – 12.8	2.6 – 21.2
Weight (kg)	mean ± SD	5.3 ± 2.8	5.0 ± 1.0	5.3 ± 1.4	5.8	4.6 ± 0.8	5.8 ± 1.7
	range	2.8 – 11.0	2.9 – 7.3	2.8 – 8.7		4.0 – 5.1	3.3 – 11
Sex	MC	52	10	26		1	15
	FS	76	19	32	1	1	23
BCS (1-9)	median (min, max)		5 (3,8)	6 (3,9)	5	4.5 (4,5)	7 (2,9)

CKD = chronic kidney disease; IRIS = International Renal Interest Society; DJD = degenerative joint disease; DJD group = the cohort of cats recruited for DJD studies; CKD_{pos} = cats with CKD; small kidney = the small kidney group; CKD_{neg} = cats without CKD; MC = male castrated; FS = female spayed; BCS = body condition score on a 1 to 9 scale; SD = one standard deviation of the mean