

## Psychometric Validation of a General Health Quality of Life Tool for Cats Used to Compare Healthy Cats and Cats with Chronic Kidney Disease

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**Background:** Numerous validated psychometric tools are available to assess impact of disease on a human's quality of life (QoL). To date, no psychometrically validated general health-related QoL tool exists for cats.

**Hypothesis/Objectives:** To develop and validate a tool for assessment of owner-perceived QoL in cats (CatQoL) and to use this tool to compare QoL between healthy cats and those with chronic kidney disease (CKD).

**Animals/Subjects:** Total of 204 owners of young healthy cats (YH,  $n = 99$ ;  $<9$  years), older healthy cats (OH,  $n = 35$ ), and cats diagnosed with CKD (CKD,  $n = 70$ ) completed the CatQoL.

**Methods:** Discussions with a focus group and 2 pilot surveys informed design of 16 QoL questions grouped into 4 domains. Each item scored according to frequency and importance, and item-weighted-impact-scores were calculated. The validity of the tool was assessed using principal components analysis and Cronbach's  $\alpha$ . The average item-weighted-impact-score (AWIS) was compared among groups and domains.

**Results:** Sixteen-item CatQoL showed good internal consistency reliability (Cronbach's  $\alpha$ , 0.77) and unidimensionality with significant loadings (0.2–0.7) and communalities ( $>0.3$ ). Young healthy cats had significantly higher AWIS (median [IQR], 1.25 [0.63, 1.88]) than OH (0.56 [−0.06, 1.00]) and CKD cats (−0.06 [−0.81, 0.88]),  $P < .001$ . CKD cats had significantly lower AWIS for eating domain (YH: 2.00 [1.00, 3.00]; OH: 2.00 [0.67, 3.00]; CKD : 1.00 [0.00, 2.67]) when compared with the YH group and OH group, and all groups differed significantly in their management domain (YH: −0.50 [−1.00, 0.00]; OH: −1.00 [−1.88, −0.50]; CKD : −1.50 [−2.50, −1.00],  $P < .001$ ).

**Conclusions and Clinical Importance:** The CatQoL was validated for use in cats, and can be used as additional assessment parameter in clinical and research settings.

**Key words:** Feline; Owner; Renal disease.

The assessment of quality of life (QoL) as a treatment outcome, in addition to biological parameters, is fully integrated in most of human medical practice and research. Multiple general and disease-specific questionnaires have been validated for this purpose.<sup>1–3</sup> In recent years, there also has been increasing interest in assessing health-related QoL in animals leading to attempts to quantify this subjective phenomenon in veterinary medicine.<sup>4,5</sup> Veterinary QoL assessments published to date vary from linear analog scales asking owners to rate their pets' QoL on a scale of 1–10, to a handful of psychometrically validated multi-question general health QoL tools.<sup>6–8</sup> In addition, various disease-specific tools are available, such

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### Abbreviations:

AWIS	average-weighted-impact-score
B	behavior (-domain)
CatQoL	general-health quality of life tool for cats
CKD	chronic kidney disease
E	eating (-domain)
GH	general health (-domain)
IRIS	International Renal Interest Society
IWIS	item-weighted-impact-score
M	management (-domain)
OH	old healthy
PCA	principal components analysis
QoL	quality of life
UK	United Kingdom
USG	urine specific gravity
YH	young healthy

as questionnaires for use in cats with heart disease, and a tool for both dogs and cats with cancer and diabetes.<sup>9–12</sup> To date, no psychometrically validated general tool is available to assess health-related QoL in cats.

In animals, QoL assessment can only be performed by a third party reporting on behalf of the patient, the proxy respondent. This approach is comparable to the assessment of QoL in babies and young children by their parents or caregivers. Several studies have evaluated the correlation between proxy reports and self reports from older children and suggest some tools perform better than others.<sup>13</sup> Some therefore believe assessment should be performed by several informants (eg, parents, children, caregivers) whenever possible.<sup>13</sup>

Studies that focus on the impact of chronic kidney disease (CKD) on QoL in humans have used both general and disease-specific tools, and patients with CKD have been shown to have a significantly lower QoL when compared to a healthy population.<sup>3,14</sup> In cross-sectional analyses, QoL scores deteriorate with more advanced stages of CKD and evolve over time, with a significant decline in patients' scores over several years.<sup>15</sup>

Chronic kidney disease is a common and often progressive condition in older cats and its severity mainly has been assessed based on clinical signs and biochemistry results.<sup>16–18</sup> CKD is recognized to at least have the potential to negatively impact the QoL of cats by various mechanisms, including effects on activity level and appetite, as well as the effects of a change in diet or administration of medication. Quantification of QoL therefore could provide a much needed additional dimension to assess the severity of the disease, the impact of the disease on specific aspects of the cat's life, and the efficacy of any treatment or intervention on ameliorating such impact.

The aim of our study was to (i) design and validate a health-related QoL tool for cats and (ii) to use this tool in a preliminary investigation of the potential impact of CKD on QoL in cats by comparing cats with CKD with healthy older and younger cats.

## Materials and Methods

### Design of the CatQoL

Items included in the health-related quality of life tool for cats (CatQoL) were identified based on detailed discussions with a focus group consisting of veterinarians (n = 5; 4 of whom also are authors of this report), veterinary nurses (n = 2) and cat owners (n = 31). Studies from human literature using self assessments and proxy assessments were used as a basis for the tool's design.<sup>3,19–21</sup> These initial surveys led to identification of 18 items reported to be of relevance by the focus group, and corresponding multiple-choice questions were designed to adhere to general survey question design recommendations and ensure neutrality of the questions.<sup>22</sup> The resulting draft questionnaire was assessed by 4 veterinarians and 1 veterinary nurse, and feedback was used to implement additional modifications. The subsequent version was used in a pilot trial (4 veterinarians and 18 owners of young [ $<9$  years] healthy cats, 14 owners of old [ $\geq 9$  years] healthy cats and 15 owners of cats with CKD) intended to identify potential missing or superfluous questions, as well as areas of confusion. Once again, feedback was used to finalize the CatQoL. The CatQoL then was digitized using an online software package (www.surveymonkey.com).

### Description of the CatQoL Survey

The questionnaire was divided into 4 domains: general health (GH), eating (E), behavior (B) and management (M). An overview of the different items included in the questionnaire can be found in Table 1. Each item was scored according to the frequency or severity with which it impacted the cat's life, and an importance rating was included for all questions to capture individual differences (Fig 1; the full questionnaire can be viewed on www.surveymonkey.com/s/catquality). The frequency or severity ratings ranged from -3 to +3, and the importance ratings ranged from 0 to +3.

**Table 1.** Descriptive statistics, principal components analysis, and reliability of the 16-item CatQoL for all cats (n = 204).

Domain	Item Code	Item Name	IWIS (Mean ± SD)	Frequency Rating (Mean ± SD)	Importance Rating (Mean ± SD)	IWIS (Median [IQR])	Communalities (Extraction)	Factor Matrix (Loading)	Corrected Item-Total Correlation	Cronbach's $\alpha$ if Item Deleted
General health	GHQ1	Feeling ill	-0.23 ± 0.82	-0.17 ± 0.46	0.20 ± 0.55	0 [0, 0]	0.776	0.703	0.332	0.768
General health	GHQ2	Pain	-0.16 ± 0.62	-0.14 ± 0.41	0.14 ± 0.45	0 [0, 0]	0.643	0.673	0.328	0.77
General health	GHQ5	Mobility	-1.22 ± 1.51	-0.63 ± 0.68	2.27 ± 0.77	-0.5 [-2, 0]	0.649	0.684	0.586	0.751
General health	GHQ6	Stools	-0.25 ± 0.92	-0.22 ± 0.57	0.19 ± 0.52	0 [0, 0]	0.335	0.526	0.307	0.768
Eating	EQ4	Liking food	5.45 ± 3.69	2.02 ± 1.26	2.50 ± 0.76	6 [2, 9]	0.536	0.234	0.291	0.775
Eating	EQ5	Appetite	-0.38 ± 1.09	-0.40 ± 0.69	0.37 ± 0.67	0 [0, 0]	0.715	0.735	0.39	0.764
Eating	EQ6	Difficulties eating	-0.16 ± 0.58	-0.16 ± 0.49	0.22 ± 0.52	0 [0, 0]	0.678	0.382	0.313	0.77
Behavior	BQ1	Happiness	-0.38 ± 1.14	-0.29 ± 0.54	0.41 ± 0.70	0 [0, 0]	0.680	0.643	0.254	0.769
Behavior	BQ2	Stress	-0.55 ± 1.06	-0.38 ± 0.68	0.60 ± 0.74	0 [-1, 0]	0.718	0.659	0.286	0.768
Behavior	BQ3	Interactivity	4.39 ± 3.68	1.71 ± 1.35	2.30 ± 0.80	4 [2, 9]	0.534	0.234	0.36	0.766
Behavior	BQ4	Playing	2.26 ± 3.82	0.72 ± 1.75	2.01 ± 0.75	2 [0, 4]	0.731	0.556	0.685	0.723
Behavior	BQ5	Hunting	0.84 ± 3.88	-0.35 ± 2.12	1.58 ± 0.96	0 [-2, 2]	0.600	0.529	0.59	0.736
Behavior	BQ6	Grooming	2.46 ± 3.34	0.99 ± 1.39	2.11 ± 0.71	2 [0, 4]	0.566	0.449	0.529	0.744
Behavior	BQ7	Scratching	1.62 ± 3.58	0.47 ± 1.62	1.99 ± 0.81	1 [0, 4]	0.53	0.498	0.525	0.745
Management	MQ1	Going to the vets	-1.64 ± 1.69	-1.07 ± 0.72	1.38 ± 0.96	-1 [-2, 0]	0.521	0.625	0.439	0.758
Management	MQ3	Medications	-0.65 ± 1.42	-0.87 ± 1.06	0.91 ± 1.10	0 [-1, 0]	0.467	0.201	0.183	0.772

4a. How much does your cat like his/her food?

(Hates his/her food) 1 2 3 4 5 6 7 (Loves his/her food)

b. For my cat, enjoying his/her food has always been...

Very important

Important

Not that important

Not important at all

**Fig 1.** Example CatQoL question with corresponding multiple choice answers. The frequency or severity rating (a) ranges from  $-3$  (“hates his/her food”) to  $+3$  (“loves his/her food”). The importance rating (b) ranges from 3 (“very important”) to 0 (“not important at all”). The item-weighted-impact-score (IWIS) is calculated by multiplying the score of (a) and (b).

Multiplying frequency and importance ratings generated an item-weighted-impact-score (IWIS) for all questions.<sup>9</sup> If an item negatively impacted a cat's life, and it occurred very frequently, IWIS could be as low as  $-9$ . Similarly, if an item positively influenced the cat's life, and occurred very frequently, a positive IWIS of  $+9$  could be reached. A frequency/severity rating or an importance rating of 0 led to an IWIS of 0. The average-weighted impact score (AWIS) was calculated by dividing the sum of all IWISs by the number of items. This AWIS provided an overall quantitative measure of the cat's QoL. In addition, the questionnaire contained 1 overview question in which the owner graded his or her cat's overall QoL on a scale from 1 to 10 (“On a scale from 1 to 10, 1 being a very poor quality of life and 10 being an excellent quality of life, I feel that my cat's quality of life during the past week was...”), and a number of demographic questions. A free comments section at the end of the questionnaire provided cat owners with the opportunity to give feedback about the questions, as well as add anything about their cat's QoL. The study was approved by the Royal Veterinary College ethics committee. All participating cat owners were assigned case numbers to ensure anonymity.

### Recruitment of Respondents

The survey was made available online through the web address <http://www.surveymonkey.com/s/catquality>. The questionnaire is accessible online or in the online supplement. The web link was not advertised openly to prevent malicious participation that could influence the results. In addition, the Internet protocol address of each respondent was recorded. This aided in the subsequent identification and deletion of duplicate entries. Questionnaires were collected between February 2013 and April 2014. Owners of cats that were  $<9$  years of age and considered healthy by their owners were recruited by means of the university's internal-facing website for staff and students (young healthy [YH] group). Inclusion criteria for the YH group consisted of having accurate information available about the cat's age ( $<9$  years) and selecting “none” at the question “does your cat suffer from any diseases.” To be included in the old healthy (OH) group and CKD group, the cats must have been  $\geq 9$  years. Owners of cats in these 2 groups were recruited from 2 London-based first opinion practices (the Beaumont Sainsbury Animal Hospital in Camden and the Peoples Dispensary for Sick Animals in Bow). The OH cats and CKD cats all had results available from comprehensive plasma biochemistry profiles performed  $< 3$  months before completing the questionnaire. To be included in the OH-cat group, the following criteria had to be met: 1. No health concerns reported by the owner when questioned during his or her visit at the above practices; 2. No clinically relevant abnormal physical examination findings (eg, mild tachycardia, mild tartar and gingivitis were allowed) by the attending clinician; 3. Normal serum biochemistry results and normal total T4

( $<40$  nmol/L; reference interval, 10–55 nmol/L; or T4  $\geq 40$  nmol/L and TSH  $\geq 0.03$  ng/mL; reference interval TSH, 0.03–0.15 ng/mL).<sup>23</sup> All cats in the CKD group had been diagnosed previously with azotemic CKD (defined as having 2 consecutive blood samples with serum creatinine concentration  $\geq 2.0$  mg/dL ( $\geq 177.1$   $\mu\text{mol/L}$ ; reference interval, 0.23–1.99 mg/dL) or 1 blood sample with azotemia in conjunction with dilute urine (USG  $< 1.035$ ). On the basis of these findings, owners previously had been instructed to return their cats to the clinic every 8 weeks for blood pressure re-evaluation and blood and urine sample collection.

### Statistical Analysis

All statistical analyses were performed using the statistical software package SPSS Statistics for Windows 21.0.<sup>8</sup> Principal components analysis (PCA) was used to validate the CatQoL. This analysis assessed the uni-dimensionality of the QoL tool (ie, whether the set of questions are measuring the same entity)<sup>24</sup> and identified critical and noncritical items within the scale, providing a structure in which the number of items could possibly be decreased.<sup>25</sup> As part of this process, extraction communalities (indicators of the amount of variance in each variable that can be explained by the other variables) were calculated. A value  $<0.20$  was interpreted to indicate that an item did not correspond well with the other included items and that it must be excluded from the analysis, provided no further arguments existed to retain the item.<sup>26</sup> Acceptable arguments that would allow retention of an item despite low communality included a high mean importance rating for that item.<sup>9</sup> The factor loadings were recorded for each variable by performing a factor analysis with an oblimin rotation.<sup>26</sup> This analysis evaluates the structure of the items and groups them into factors or domains. Consistent with currently accepted conduct in the field of psychometrics, items with factor loadings of  $<0.30$  were considered for exclusion given their unreliable correlation with the domains within the scale, again provided no other arguments existed for their retention in the tool.<sup>26</sup>

Cronbach's  $\alpha$  was calculated to measure internal consistency and was deemed acceptable if  $>0.70$ .<sup>27</sup> Cronbach's  $\alpha$  measures the reliability of the score that is obtained from combining all of the different items, and  $\alpha$  is higher if items, although independent from one another, are highly correlated.<sup>24</sup> This value was calculated for the overall 18-item CatQoL as well as when each item was left out of the scale, in order to identify specific items that negatively impacted internal consistency reliability. Corrected item total correlations, a representation of how much each individual item correlates with the scale, also were calculated, and a value  $>0.30$  was considered ideal.<sup>26</sup> Inclusion and exclusion of items was based on assessment of the combination of the extraction communalities, factor loadings, corrected item total correlation, the value for Cronbach's  $\alpha$  if the item was deleted, and assessment of the

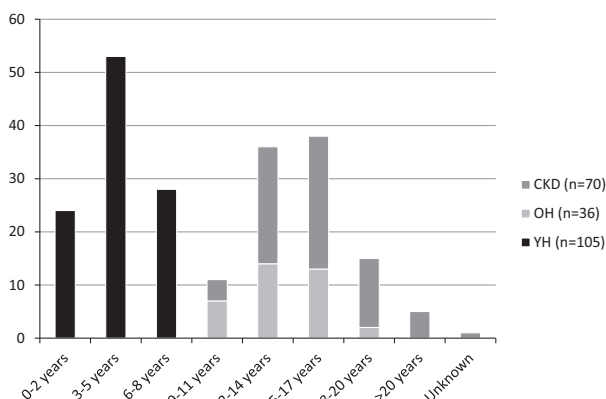
frequency and importance values of items, consistent with good psychometric practice.<sup>9,12,26</sup> After exclusion of items that negatively affected the validity of the QoL tool, PCA and reliability analysis were repeated and all values re-assessed to investigate whether additional exclusions and analyses were needed. Frequency and importance ratings and IWIS were reported as mean  $\pm$  SD; AWIS was reported as median [IQR].

The correlation between the overview question and the AWIS was assessed by performing a 2-tailed Spearman's correlation ( $\rho$ ), and significance for this correlation was set at a  $P$  value of  $<.05$ . Comparisons between the individual IWISs, the AWIS of the individual domains and the overall AWIS of the YH group, OH group and CKD group were made using a non-parametric Kruskal–Wallis test, and this same test was used to compare the AWIS of the OH group and the various stages of CKD (azotemic International Renal Interest Society (IRIS) stage 2 defined as the most recent serum creatinine concentration between 1.6 and 2.8 mg/dL, IRIS stage 3 as 2.9–5.0 mg/dL, and IRIS stage 4 as  $\geq 5.0$  mg/dL) (www.IRIS-kidney.com). A posthoc comparison using Bonferroni correction was performed where appropriate. No cats in IRIS stage 1 were included in this study. Significance was set as  $P < .05$ .

## Results

### Demographical Data

A total of 204 cat owners completed the questionnaire. All owners of OH cats ( $n = 35$ ) and cats with CKD ( $n = 70$ ) originated from the United Kingdom. The majority of YH cat owners resided in the United Kingdom ( $n = 94$ ), 3 owners were from the United States, 1 owner originated from Canada, and 1 from the Netherlands. Domestic shorthaired cats were the most commonly represented breed ( $n = 132$ ), followed by domestic long hairs ( $n = 30$ ). Ninety-four cats (46%) were female, of which 3 were not neutered. The questionnaire was completed for 110 male cats (54%), of which 2 were intact. Fifty of the 70 cats with CKD were IRIS stage 2. Nineteen cats had been diagnosed as IRIS stage 3 and 1 cat was IRIS stage 4 at the time the owner completed the questionnaire. An overview of the age range of the cats included in the study can be found in Fig 2.



**Fig 2.** Age range of cats included in this study. Y-axis represents number of cats.

### Validation of the CatQoL

**Selection of Included Items.** Inclusion of all 18 items that were identified in the surveys led to a Cronbach's  $\alpha$  of 0.76 ( $n = 204$ ). A combination of the descriptive statistics, PCA and internal consistency reliability justified inclusion of all but 2 items. GHQ3 "sleeping" and GHQ4 "being active" had reasonable extraction communalities (0.73 and 0.66, respectively), but factor loadings were below the suggested cut-off of 0.30 for both (GHQ3, 0.15; GHQ4, 0.24) and exclusion of the GHQ3 led to an increase in Cronbach's  $\alpha$  to 0.77. The IWIS for GHQ3 was  $5.92 \pm 3.16$  and item GHQ4 had an IWIS of  $-1.07 \pm 2.01$ . Subjective assessment of the frequency and importance rating (found in Table 1) led to the conclusion that both items were perceived as very important by cat owners, but frequency ratings did not show great variability among cats, from which it can be determined that these 2 items may contribute to QoL but have little power to cause a consistently reliable difference in QoL. In combination with the poor factor loadings and the higher value for Cronbach's  $\alpha$  in their absence, we decided to delete items GHQ3 and GHQ4. The resulting 16-item CatQoL then was re-analyzed. Improved scale reliability and greater internal consistency were found and a numeric overview of the performance of this final version of the tool can be found in Table 1. Cronbach's  $\alpha$  of the 16-item CatQoL was 0.77.

**Descriptive Statistics.** Item-weighted-impact-scores, frequency, and importance ratings for all cats are shown in Table 1, and a comparison of the individual IWISs among the 3 groups can be found in Table 2. EQ4 "liking food" and BQ3 "interactivity" had the most positive impact on AWIS, with IWIS scores of  $5.45 \pm 3.71$  and  $4.39 \pm 3.68$  respectively. GHQ5 "mobility" (IWIS of  $-1.22 \pm 1.51$ ) and MQ1 "going to the vets" (IWIS  $-1.64 \pm 1.69$ ) had the most negative impact. A total of 6 items ("liking food," "interactivity," "playing," "hunting," "grooming" and "scratching") consistently had a positive impact on QoL. A total of 8 items ("feeling ill," "pain," "stools," "appetite," "difficulties eating," "happiness," "stress," and "medications") consistently had negative impact on QoL (Fig 3).

**Principal Components Analysis.** None of the items had extraction communalities  $<0.30$  and 14 of the 16 included items had extraction communalities  $>0.50$  indicating all items were reasonably related to another. Factor matrix analysis indicated an internal structure of 4 domains in the questionnaire. Three items (EQ4 "liking food," BQ3 "interactivity" and MQ3 "medications") had loadings below the suggested cut-off of 0.30.<sup>26</sup>

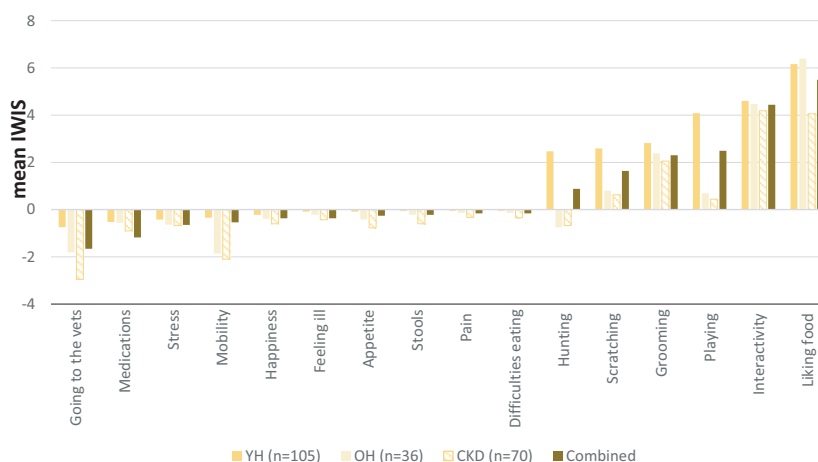
**Internal Consistency Reliability.** A Cronbach's  $\alpha$  score of 0.77 ( $n = 204$ ) indicated good internal consistency.<sup>27</sup> All items had a corrected item total correlation of  $>0.20$  with the exception of item MQ3. However, deletion of this item would not have resulted in an increased value for Cronbach's  $\alpha$  and it therefore was retained.

**Correlation of CatQoL and AWIS.** AWIS for all cats combined ( $n = 204$ ) was  $0.70 \pm 1.16$ , consistent with an overall positive QoL for all cats. The overview question

**Table 2.** Item-weighted-impact-scores (IWIS) for the 16 items in the CatQoL.

		YH (n = 99) (Mean ± SD)	OH (n = 35) (Mean ± SD)	CKD (n = 70) (Mean ± SD)
GHQ1	Feeling ill <sup>C</sup>	-0.08 ± 0.40	-0.22 ± 0.77	-0.42 ± 1.19
GHQ2	Pain <sup>C</sup>	-0.05 ± 0.22	-0.14 ± 0.43	-0.33 ± 0.96
GHQ5	Mobility <sup>B</sup>	-0.36 ± 0.87	-1.86 ± 1.31	-2.10 ± 1.65
GHQ6	Stools <sup>B</sup>	-0.01 ± 0.10	-0.23 ± 1.03	-0.60 ± 1.32
EQ4	Liking food <sup>D</sup>	6.09 ± 3.35	6.40 ± 2.94	4.06 ± 4.16
EQ5	Appetite <sup>D</sup>	-0.08 ± 0.31	-0.43 ± 1.24	-0.77 ± 1.50
EQ6	Difficulties eating <sup>C</sup>	-0.03 ± 0.22	-0.14 ± 0.43	-0.34 ± 0.88
BQ1	Happiness <sup>C</sup>	-0.23 ± 0.98	-0.40 ± 1.09	-0.60 ± 1.30
BQ2	Stress	-0.43 ± 0.81	-0.66 ± 1.14	-0.67 ± 1.31
BQ3	Interactivity	4.54 ± 3.66	4.34 ± 3.53	4.19 ± 3.82
BQ4	Playing <sup>B</sup>	4.07 ± 3.49	0.77 ± 2.51	0.44 ± 3.65
BQ5	Hunting <sup>B</sup>	2.46 ± 3.61	-0.69 ± 3.08	-0.67 ± 3.72
BQ6	Grooming	2.79 ± 2.91	2.34 ± 3.67	2.06 ± 3.71
BQ7	Scratching <sup>C</sup>	2.58 ± 3.02	0.89 ± 2.90	0.63 ± 4.23
MQ1	Going to the vets <sup>A</sup>	-0.66 ± 0.89	-1.80 ± 1.35	-2.96 ± 1.79
MQ3	Medications	-0.52 ± 0.87	-0.51 ± 1.10	-0.90 ± 2.04

YH, young healthy cats (<9 years); OH, old healthy cats (≥9 years); CKD, cats diagnosed with chronic kidney disease (plasma creatinine concentration ≥2.0 mg/dL and USG < 1.035). Superscript letters identify groups, which differed significantly: A – YH, OH and CKD all differ from one another; B – YH differs from OH and CKD; C – YH differs from CKD; D – CKD differs from OH and YH. Scatter plots of each item can be found in the Appendix S1.

**Fig 3.** Mean item-weighted-impact-score (IWIS) of the items in the 16-item CatQoL.

yielded a score of  $8.63 \pm 1.35$  (mean  $\pm$  SD,  $n = 203$ ). The overview question and the AWIS score were moderately correlated ( $\rho = 0.521$ ,  $P < .001$ ).

**Free Comments Section.** Seventy respondents provided an entry in the free comments section. Twenty-one of the respondents felt that the questionnaire covered all aspects of their cat's life and that the questionnaire was not difficult to understand. Ten owners commented on questions that were difficult for them to answer, 5 of which could be solved by including an option for "I don't know" in the questionnaire. Sixteen owners suggested additional questions be included in the questionnaire with the demographic question of whether the cat is indoor or outdoor being mentioned most often ( $n = 6$ ). Three owners found it difficult to answer the importance rating if the frequency rating was zero. Two owners reported that they found it very difficult to score their cat's QoL on a scale of 1–10.

### Application of the CatQoL in Healthy Cats and Cats with CKD

**Comparison Among Groups.** A significant difference ( $P < .001$ ) was found between the AWIS of the YH group (median 1.25; IQR, 0.63, 1.88;  $n = 99$ ), the OH group (median 0.56; IQR, -0.06, 1.00;  $n = 35$ ) and CKD group (median, -0.06; IQR, -0.81, 0.88;  $n = 70$ ). Posthoc comparisons indicated that the YH group had significantly higher AWIS than the OH and CKD groups ( $P < .001$ ) but that there was no significant difference between the OH and CKD groups.

Comparison among the different domains within the CatQoL indicated that the CKD group and the OH group had significantly lower AWIS for the GH-domain than the YH group (YH: median, 0.00; IQR, 0.00, 0.00; OH: median, -0.50; IQR, -0.75, -0.25; CKD: median, -0.50; IQR, -1.25, -0.44;  $P < .001$ ). The CKD group

scored significantly lower in the eating (E) domain when compared to the YH group and OH group (YH: median, 2.00; IQR, 1.00, 3.00; OH: median, 2.00; IQR, 0.67, 3.00; CKD: median, 1.00; IQR, 0.00, 2.67;  $P < .001$ ). The YH group scored significantly higher than both other groups in the behavior (B) domain (YH: median, 2.43; IQR, 1.00, 3.42; OH: median, 1.14; IQR, -0.14, 1.86; CKD: median, 0.43; IQR, -0.71, 2.21;  $P < .001$ ). All groups significantly differed from one another in the management (M) domain (YH: median, -0.50; IQR, -1.00, 0.00; OH: median, -1.00; IQR, -1.88, -0.50; CKD: median, -1.50; IQR, -2.50, -1.00;  $P < .001$ ). An overview of IWISs per group can be found in Table 2.

Comparison of AWIS among the OH group and cats in IRIS stage 2 ( $n = 50$ ) and cats in IRIS stages 3 and 4 ( $n = 20$ ) showed no significant difference among groups ( $P = .108$ ), with a median AWIS of 0.56; IQR, -0.06, 1.00 for OH cats, a median, 0.09; IQR, -1.02, 1.09 for cats in IRIS stage 2, and a median, -0.25; IQR, -0.56, 0.63 for cats in IRIS stages 3 and 4.

## Discussion

To our knowledge, the CatQoL is the first published attempt to develop a psychometrically validated, quantitative and individualized general health-related QoL assessment-tool for companion animal cats. The initial questions were formulated by a team of cat owners, veterinary nurses and veterinarians. Veterinary nurses often form the bridge between owner and veterinarian, and having more nurses in the focus group might have improved the questionnaire. The questionnaire was validated by taking all aspects of the psychometric analysis into account and assessing each question individually. Based on the change in Cronbach's  $\alpha$  with deletion of the item, the correlation of the item with the total questionnaire, the factor loadings (how much the individual item affects the outcome), the extraction communalities (the percentage of variance in a given variable explained by all of the variables combined), the perceived importance of items by the owners, and the variability in the answers, the original 18-item tool was decreased to a 16-item instrument. The psychometric analysis was repeated and the 16-item CatQoL showed good validity, uni-dimensionality and reliability during large-scale testing, PCA and Cronbach's  $\alpha$  assessment.

A study evaluating types of items that are considered important by cat owners to a cat's QoL found that 60% of mentioned items were "inactive" items, such as sleeping or being petted.<sup>28</sup> It is therefore expected that cat owners want to answer questions about "sleeping" and "being active" in the online questionnaire. These 2 questions therefore were initially retained but subsequently excluded from further analyses because of their poor discriminating value. Three items in the final 16-item CatQoL had factor loadings below the suggested cut-off of 0.3: EQ4 ("liking food"), BQ3 ("interactivity") and MQ3 ("medications"). Only deletion of EQ4 would have increased Cronbach's  $\alpha$  (to 0.78). This item did, however, show good extraction communalities and

variability in frequency rating, and owners rated this item as very important to their cats. A survey asking 26 owners what influences a cat's QoL the most found that "appetite" and "interaction" were among the most mentioned parameters.<sup>8</sup> Indeed, EQ4 had the greatest positive influence on the AWIS in the current study. Deletion of BQ3 and MQ3 would have decreased the value of Cronbach's  $\alpha$ , and these items also showed good extraction communalities. In addition, BQ3 had the second greatest impact on AWIS. MQ3 had a low item-to-total correlation of 0.18, which most likely is because of the fact that the majority of cats (169 of 204) included in the validation of the questionnaire were not receiving any medications. This item also was rated relatively important by owners. For all of these reasons, we retained EQ4, BQ3, and MQ3 in the final QoL tool.

Once the survey was finalized, 6 owners commented in the free comments section that a question about the cat being able to go outside of the house would have been useful. This question had not been included in the original questionnaire, but could indeed influence the cat's QoL. "Being active", "being happy", and "hunting" are the 3 items most likely influenced by not being able to go outside, and therefore this item is partially covered in the questionnaire, although inclusion of the actual question might be considered for future adaptations of the QoL tool.

The CatQoL indicated that YH cats had superior health-related QoL than did OH and CKD cats. A shortcoming of this study is the fact that YH cats were reported to be healthy by their owners, but this was not necessarily confirmed by a veterinarian. The questionnaire contained several questions about the health of the cat that allowed for exclusion of cats with reported health problems. Nevertheless, the possibility remains that cats with more subtle health problems not recognized by the owner (such as CKD) might have been included. The prevalence of CKD increases with age,<sup>16</sup> but reports on the age distribution of cats with CKD are lacking; it has been reported that the median age of cats in England that die of renal disease is 15 years.<sup>29</sup> This significantly decreases the likelihood that many cats with CKD were included in the YH group. In addition, the YH group had a significantly higher AWIS than OH and CKD cats, and inclusion of ill cats in the YH group would have made a significant difference in numbers less likely. Significant differences were not found between OH cats and cats with CKD, despite lower AWIS and IWISs in cats with CKD. Equally, QoL scores seemed to decrease with more advanced IRIS stages, but, again, this tendency was not statistically significant. A significant difference was found between OH cats and cats diagnosed with CKD within the E and M domains of the CatQoL, signaling that these QoL aspects are more vulnerable to the negative effects of CKD. Furthermore, an increase in the size of the CKD group and especially the various IRIS stages potentially could have led to more significant differences. The cats included in our study were not age-matched, which is a confounding factor of this

study, and difficult to control for, because CKD prevalence increases with age.<sup>16</sup>

One inevitable weakness of the CatQoL is that it is a proxy assessment and therefore can never completely reflect the individual cat's experiences. QoL assessments are subjective in nature and thus susceptible to being affected by expectations, prior experiences, cultural aspects, environment, the QoL of the owner and the person's gender. The exact nature of the relationship between the owner and pet also will influence the outcome. In addition, awareness of a diagnosis may influence health perception.<sup>30</sup> The cat's QoL may be more influenced by the owner's characteristics than the cat's, which implies the owner's QoL could be of great importance when assessing the animal's QoL.<sup>31</sup> The CatQoL captures both the cat's and the owner's QoL by assessing the importance of each item, and realizing that every cat-human bond is different is important in interpreting the results of the questionnaire. From the human literature, parents seem to be more able to judge their child's externalizing problems (eg, aggressiveness) than their internalizing problems (eg, anxiety).<sup>13</sup> Studies focusing on children with renal disease found a moderate correlation between parent and children reports.<sup>20,21</sup> Getting insight into an animal's mental state is even more challenging, and objective approaches are complicated by uncritical anthropomorphism.<sup>32</sup> Nevertheless, these limitations should not be reasons to give up on the quantitative assessment of QoL in ill cats, especially when a psychometrically validated tool is available. When this tool is being used for serial measurement of QoL in the same pet-owner combination, unique information will be added to the current physical and physiological variables used. The advice from the human literature remains to obtain reports from both parents and children, and other assessors, such as teachers and nurses, when assessing QoL.<sup>13</sup> Translation of this advice into veterinary medicine can lead to the conclusion that the CatQoL would be of most value if several members of the household and other people close to the animal complete the questionnaire.

In veterinary practice, a single broad question (eg, "How is your cat getting on?") is the most common method used to assess QoL.<sup>33</sup> It is not uncommon in veterinary science to rate QoL using a ranking and to interpret the effect of treatment on QoL based on this score.<sup>8,34</sup> However, only moderate correlation was found ( $p = 0.521$ ) between the general overview question asked as part of this study ("On a scale from 1 to 10, 1 being a very poor quality of life and 10 being an excellent quality of life, I feel that my cat's quality of life during the past week was...") and the AWIS, suggesting that asking this 1 question is an incomplete assessment of the patient's QoL. Additional and more specific questions are necessary to fully evaluate all factors contributing to a cat's QoL, especially because the changes that are observed in the cat's behavior often are often considered to be "slowing-down related to age," whereas it is likely that a physical condition contributes to these problems.<sup>35</sup> The current tool therefore could be used for this purpose and also will enable

a homogenization of QoL assessment within a practice as well as enable continuity even if several different members of the veterinary care team are involved.

The AWIS of OH cats and cats with CKD did not differ significantly in our study. The behavior of a general QoL tool is difficult to predict in different groups of patients, because they often develop coping mechanisms to adapt to their disease state.<sup>36</sup> This makes a comparison between healthy cats and cats with CKD more challenging, and using the CatQoL longitudinally to assess the QoL for 1 patient over time instead may be the most useful application of the tool. In addition, awareness of a disease may influence the proxy's (cat owner's) answers, both negatively and positively. A questionnaire assessing the QoL of cats and dogs with diabetes and their owner's QoL showed a markedly positive impact of the disease on the bond between the owner and the diabetic pet.<sup>9,12</sup> This positive effect also could have increased IWISs of cats with CKD. Additionally, the results of our study should be interpreted in light of the cat-owner population tested. All older cats included in our study belonged to diligent and motivated owners who were prepared to attend the 2 first opinion practices on a regular basis.

Cats with CKD scored significantly lower than OH cats on the E domain and M domains. The E domain contained questions about appetite and liking food. The studies described earlier also observed poor appetite in 43–92% of cats.<sup>16,37</sup> All CKD cats included in the current study were eating a commercially available renal diet, which has restricted, high quality protein content. Restricted protein diets may not be as palatable as general maintenance diets. Indeed, a study of 50 cats with CKD that were started on renal diet indicated that in 21 cats acceptable compliance was not achieved. Although the reason for non-compliance was not described, it likely is affected by both owner and cat characteristics.<sup>38</sup> Concurrent dehydration and azotemia also could result in decreased appetite. The IWIS for "liking food" indeed was significantly lower in CKD cats when compared to YH and OH cats (Table 2). OH cats and CKD cats scored significantly lower than YH cats in the B domain. Studies in humans indicate that increased age leads to a decrease in physical domains of QoL tools, and the same therefore could have been expected for cats.<sup>15</sup> One explanation for this observation could be decreased mobility caused by an increased prevalence of arthritis. Prevalence of arthritis increases with age and therefore can negatively impact items included in the B domain, such as playing and hunting.<sup>35</sup> A study including 58 client-owned cats with degenerative joint disease identified significant improvement in the pain score of cats on meloxicam, and the pain score was determined by assessing behaviors such as playing and sharpening nails.<sup>39</sup> These items indeed had a significantly lower IWIS in OH cats, CKD cats, or both when compared to YH cats (Table 2).

Comparison between OH cats, and cats with CKD in IRIS stage 2 and IRIS stages 3 and 4 did not identify a significant difference among groups, although a tendency for lower scores in cats with more advanced

kidney disease was encountered. The cross-sectional design of the current study makes it difficult to assess for causal interference. Studies assessing QoL over time in cats with CKD therefore are indicated to fully understand the effect of CKD on QoL. Two large-scale studies demonstrated that children with CKD have significantly lower QoL scores than their healthy counterparts,<sup>20</sup> and children with more severe symptoms have a significantly more impaired health-related QoL.<sup>21</sup> Inclusion of more cats with CKD in the current study possibly could have led to the identification of a significant difference in AWIS between OH cats and cats with CKD. When using the CatQoL in a clinical setting, however, AWIS over time in individual cats could be the most informative use of the CatQoL.

In conclusion, the CatQoL was validated and proven to be a reliable tool to measure QoL in cats. Using this tool, OH cats and CKD cats were shown to have a significantly lower QoL than YH cats. CKD cats specifically scored lower on “management” and “eating” than OH cats. Likely a higher number of cats as well as age-matched groups are needed to determine whether there are significant differences in overall QoL (as measured by AWIS) between CKD cats and OH cats as well as between cats in the different IRIS stages of CKD. On the basis of our study, we recommend considering longitudinal use of the CatQoL when investigating the influence of management and treatment interventions in an individual patient, along with more classical variables such as body weight, plasma creatinine concentration, urine specific gravity and blood pressure.

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## Footnote

<sup>a</sup> SPSS Inc., Chicago, IL

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*Conflict of Interest Declaration:* Authors disclose no conflict of interest.

*Off-Label Antimicrobial Declaration:* Authors declare no off-label use of antimicrobials.

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### Supporting Information

Additional Supporting Information may be found online in Supporting Information:

**Appendix S1.** Scatter plots of the item-weighted-impact-scores (IWIS) for the 16 items in the CatQoL.