Original article

A systematic review of the quality of life assessment tools for cats in the published literature.

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Abstract

Quality of life (QoL) is an important parameter to assess in cats, as it can be pivotal to important decision-making. Research reports that owners of cats with heart disease would trade longevity for QoL, and treatment associated improvement in QoL is very important for cats with chronic kidney disease. This systematic review aimed to explore the published literature to identify the number and range of QoL assessment tools available to researchers and veterinary professionals, by discovering tools which have already been used in published studies. Medline and CAB Abstracts were searched in March 2018, using terms relevant to cats and QoL or well-being. Inclusion and exclusion criteria were applied and information on uniqueness, validation and a short description of each tool extracted.

A total of 1138 manuscripts were found, of which 96 met all criteria. Forty out of 96 manuscripts contained an assessment of QoL, using one of 32 unique tools found. Sixteen of the tools found were structured, making detailed patient assessments. Only eight of the structured tools were validated, and of these, three could be applied to healthy cats; the remainder being specific to a disease or being hospitalised. Some validated tools appeared in more than one manuscript. Overall, 12 manuscripts used a validated tool. In the 16 unstructured tools, five tools assessed QoL by assigning a single word (e.g. 'poor'). Eight tools assessed QoL on a single Likert scale (e.g. a number between one and 5=five). This work identifies the tools that are currently available for the assessment of QoL by researchers and veterinary professionals. Additionally, it demonstrates that many are not validated or lack detailed animal assessment, highlighting that further work in this important area is needed.

Keywords: Assessment tools; Cat; Quality of life; Validated; Well-being

Introduction

Quality of life (QoL) considerations are central to virtually every aspect of the welfare and humane care of animals, particularly health care (McMillan, 2000). Quality of life or the well-being of animals is a parameter regularly discussed and assessed in a range of environments (e.g. shelters, laboratory animal facilities, zoo and wildlife premises, veterinary practices, homes of owners etc.) by a number of different individuals (e.g. veterinary surgeons, pet owners, and other caregivers in these environments) including researchers developing novel treatments (Lambeth et al., 2014; Lascelles and Main, 2002; Lambeth et al., 2014; Arena et al., 2019). There is currently debate over the most suitable definition for QoL in animals and no widely accepted definition for QoL in animals exists (Gaynor and Muir, 2014). Belshaw et al. (2015) state that the "lack of a suitable definition of QoL in animals makes objective measuring of quality of life challenging". Belshaw et al. (2015) operationally define QoL as "an individual's satisfaction with its physical and psychological health, its physical and social environment and its ability to interact with that environment". In Gaynor and Muir (2014) a definition is proposed around the individual's response to their circumstances, with the following: "the subjective and dynamic evaluation by the individual of its circumstances and the extent to which these meet its expectations, which results in, or includes, an affective response to those circumstances".

Regardless of a current lack of consensus relating to the definition of QoL, assessment of QoL is an important component of veterinary surgeon and owner decision-making for many conditions. Veterinary surgeons are likely guided in their formulation and monitoring of treatment regimens by the owner's perception of their cat's QoL (Reynolds et al., 2010). In fact, QoL assessment forms a part of the decisions made at many stages of veterinary treatment, including; whether to seek veterinary advice (Hoyumpa et al., 2010), how to

compare efficacy of treatments, and euthanasia decisions (McMillan, 2000). Euthanasia is commonly elected when treatment fails to maintain adequate patient QoL. If medications incur negative effects; for example, difficulty in administering medication, then treatment itself can decrease perceived QoL (Reynolds et al., 2010). Veterinary surgeons treating dogs with osteoarthritis describe the balance between quantity and QoL when decision-making on treatments (Belshaw et al., 2016).

Work carried out by Dean (2014) looking at current treatment uncertainties for cats with chronic kidney disease (CKD) identified the top ten uncertainties for this condition. Over half of this top ten were concerned with whether treatments would "improve the life of" cats with CKD, where "improve" referred to both QoL and length of life (Dean, 2014). It is likely that these two outcomes are also important to those caring for cats with other diseases and conditions.

A structured review of the literature relating to QoL assessment is required to understand how QoL is assessed in published research, as this could be an important resource for individuals searching for established methods of QoL assessment. To the authors' knowledge there have been no previous studies identifying the number or type of QoL assessment tools for cats. Giuffrida and Kerrigan (2014) advise that reliable, validated instruments are needed to facilitate the measurement and comparison of pet QoL. Belshaw et al.. 2015 advised that the assessment of canine QoL should be done with appropriate, validated instruments and it is likely the same is true for domestic cats. Therefore, the aim of this study was to explore the published literature to identify how QoL is assessed, by determining the number and range of different assessment tools available in the literature to assess QoL or well-being in domestic cats.

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95 **Materials and methods:**

96 For the purposes of this work, a QoL assessment tool was defined as 'any form of
97 assessment or categorisation of a cat's QoL or well-being'. As no widely accepted definition
98 for QoL in animals exists (Gaynor and Muir, 2014), each manuscript was not searched for a
99 definition of quality of life. If a manuscript described that an assessment of QoL had been
100 carried out, it was deemed eligible for analysis for the purposes of this review.

101

102 *Search methods*

103 The OVID interface was used to search two databases: Medline (R) In-Process and
104 Other Non-Indexed Citations (1946 to present) and CAB Abstracts (1910 to present). The
105 search was carried out in March 2018, so results are restricted to publications appearing in the
106 databases up until then. Search terms were adapted for cats from the review conducted by
107 Belshaw et al. (2015). The search terms were the same for both databases and were linked
108 with Boolean terms and the abstract, title, original title, broad terms and heading terms within
109 publications were searched. The keywords used were: cat, cats, feline, felines, felis, quality of
110 life, QOL, well being, wellbeing, well-being and quality-of-life. The subject headings used
111 were: cats and quality of life.

112

113 *Inclusion and exclusion criteria*

114 The output from both databases were then exported into EndNoteX6 software
115 (Thomson Reuters) to remove duplicates and apply inclusion and exclusion criteria, as listed
116 in Table 1. The criteria for inclusion were as follows: (1) Written in English; (2) Full study
117 available and published in peer reviewed literature; (3) Able to obtain through University of
118 Nottingham library or inter-library loan request to the British Library Document Supply

Centre; (4) About domestic cats either privately owned, or managed within other environments (e.g. shelters, teaching organisations) or used for research purposes; (5) Make reference to QoL or well-being within the title or abstract of the manuscript; (6) Make reference to QoL or well-being within the Materials and Methods section; (7) Study type is either randomised controlled trial, or controlled trial without randomisation, or cohort study, or case-control study, or cross sectional study or case series or case study; (8) QoL or well-being of cats is assessed within the manuscript; this may be done with a specified tool. For criteria 1-5, only the titles and abstracts of each manuscript were assessed, although whether the full manuscript was available was also checked at this stage.

Language was assessed by examining the citation information within the EndNote software. Publication type was also assessed by examining the citation information, and by searching for the journal on Ulrichsweb (https://ulrichsweb.serialssolutions.com) to see if the title was listed as “refereed”. These criteria were also assessed at the whole manuscript level if it was unclear from the above sources. The population of interest and subject criteria were assessed by reading the title and abstract. It was decided that only domestic cats would be included as it was thought that there may be variation in what constitutes good QoL between domestic and wild cats.

The criteria numbers six, seven and eight (Table 1) were then assessed at the full-text stage, including study type. The manuscripts were examined for the inclusion and exclusion criteria by assessment of the Materials and Methods section of the manuscripts. The terms “quality of life” or “well-being” and an indication of some form of assessment had to be mentioned within this section for the manuscript to meet the inclusion criteria. Reporting of the method of assessment within the manuscript was also required. For those manuscripts

where the tool or form of assessment was not reported within the Materials and Methods section but was mentioned elsewhere in the manuscript, the Results section was also investigated.

All publications were assessed by HD for all inclusion and exclusion criteria. A random sample of 15% of the papers meeting the initial inclusion criteria (language, publication type, availability, population of interest and subject) were assessed independently by MB for the remaining inclusion and exclusion criteria (study type and assessment). The results of the two independent assessments were compared and any disagreements were discussed between HD and MB until agreement was reached.

Information extracted

From each manuscript remaining after application of the inclusion and exclusion criteria at the full-text stage, the following information was extracted: full reference details for the manuscript, the name of the QoL tool (if applicable), a brief description of the tool, whether the tool was unique and used for the first time or referenced elsewhere, and whether it had been validated within the study (i.e. an assessment was made as to whether the tool was truly measuring what it was designed to measure) (Belshaw et al., 2015). The tool could be applied by researchers, veterinary surgeons or cat owners or carers.

Tools were then classified by type as to the level of detail of their QoL assessment. Tools classed as "structured" were those in which more than one question or assessment was carried out and these tools attempted to go into detail regarding the cat's life or behaviour. The remaining tools either consisted of only "one word" (where QoL assessment was defined by description with one word, e.g. poor), or "single scale" (where QoL was defined by a

number on a scale e.g. from 1-5), or "other" (where the QoL tool did not fit any of the previous descriptions). The validated tools were then examined in greater detail.

Results

The search results returned 1138 unique manuscripts. Figure 1 gives a summary of the number of manuscripts which were included and excluded from this review, and the number of QoL assessment tools extracted from the included manuscripts.

Of the 1138 manuscripts, 96 met the inclusion criteria 1-5 when screened at the title and abstract level, and all 96 additionally met criterion 6 when screened at whole manuscript level (Figure 1). Double assessment was carried out on 36 citations by MB and HD and resulted in initial disagreement about the inclusion of 1/36 manuscripts (97% agreement). After discussion, it was agreed that the manuscript should be excluded by both reviewers.

Manuscripts identified containing quality of life assessments

Of the 96 manuscripts included, 40 (42%) were found to contain some form of QoL tool or assessment (Figure 1). Within the 40 manuscripts containing an assessment of QoL, we found 32 unique tools or assessment methods which could be clearly identified. Twenty-nine of these appeared within a manuscript detailing their first use. An additional three unique tools appeared within the remaining 11/40 manuscripts. However, for these three, the manuscript describing their origin or first use did not appear within our search results. This made a total of 32 unique tools found. Within the remaining 8/40 manuscripts, seven referenced tools were already found within the 32 unique tools, and the final manuscript described a paper which was insufficiently described and referenced for the tool or its origin to be clearly identified. Supplemental Table 1 provides more detail on all the tools found in

194 the 40 manuscripts where a QoL assessment was carried out, including author, title,
195 administration of tool, how information was gathered for the tool, a brief description of the
196 tool used, whether the tool was unique, and whether the tool was validated. The majority of
197 tools were owner completed questionnaires, of varying complexity. Three tools clearly
198 explained that they included a veterinary surgeon's involvement or a physical examination.
199 Two of these tools were validated (Adamelli et al., 2004/2005; Taffin et al., 2016) and one
200 was not validated (Fox et al., 2000). Change in QoL was assessed in 12 tools, for example,
201 before and after treatment, or time to return to "best" QoL. Of these 12, eight tools used
202 numbered scales e.g. rate QoL 1-10 before and after treatment, three used one word
203 assessments e.g. QoL worse or QoL improved, one recorded the number of days e.g. to return
204 to normal QoL.
205
206 *Unique tools found across the 40 manuscripts*
207 Out of 32 unique tools found, 16 were classed as structured and 16 were considered
208 not structured. Structured tools were identified as those in which more than one question or
209 assessment was carried out, and the tool went into detail regarding clinical signs and/ or life
210 and/or behaviour. These were converted to scores, which were then summed to give overall
211 totals. The 16 unstructured tools carried out a simple assessment of QoL as a single word,
212 number or one or two short questions (see Figure 2). Of the 16/32 unique unstructured tools,
213 eight tools (Brown et al., 2009; Bowles et al., 2010; Ruda and Heine, 2012; Boland et al.,
214 2014; Hung et al., 2014; Kooij et al., 2014; Fritsch and Jewel, 2015; Matei et al., 2017)
215 scored QoL on a Likert scale (e.g. rating of 1-3 or 5-1). In five tools (Bass et al., 2005;
216 Lascelles et al., 2007; Pakozdy et al., 2013; Theobald et al., 2017; Guedes et al., 2018) a
217 single word was used to describe a QoL assessment, such as "poor" or "good". In the
218 remaining three tools, one used an owner subjective overall assessment of tumour size, eating

and grooming as a proxy for QoL assessment (Sabhlok and Ayl, 2014), one looked for clinical signs and chronic diseases potentially associated with a decreased QoL from the veterinary clinical notes (Gates et al., 2017) and one asked two questions about time taken to return to best or normal QoL (Forster et al., 2010).

All 16 structured tools carried out a detailed assessment on a variety of aspects of the life and behaviour of the cats assessed and included a scoring system (titled disease or condition specific tools). Explored parameters included: physiological parameters such as breathing pattern, appetite and mobility and other more behavioural parameters including: hunting, grooming, sleeping, sunbathing, visiting favourite places, interacting with people, interacting with other cats, play behaviour and mood. There were parameters that fitted into both physiological and behavioural indicators, e.g. litter tray parameters which included different assessments depending on the tool. Litter tray parameters noted included: stool volume, diarrhoea, appropriate use of litter box and toileting habits.

Of the 16/32 tools defined as structured, 6/16 were named and of the tools considered unstructured (16/32), 2/16 were named. Some of the named tools appeared more than once in the overall search results: Karnofsky's score modified for cats appeared in 4 manuscripts: Hartmann and Kuffer, 1998; Ritz et al., 2007; Fischer et al., 2011; Taffin et al., 2016. DIAQoL-pet appeared in 2 manuscripts: Niessen et al., 2010 and Gostelow et al., 2018, and the Cats' Assessment Tool for Cardiac Health CATCH appeared in two manuscripts: Freeman et al., 2012 and Rush et al., 2015.

Validated tools

243 Of the 32 unique tools found, 50% were structured (16/32) and 26% were validated
244 (8/32). Validated tools were more likely to be structured (8/8; 100%) and named (6/8; 75%).
245 The eight validated tools which were found consisted of three tools designed to assess the
246 QoL of healthy cats (one represented in Adamelli et al., 2004 and 2005; one in Freeman et
247 al., 2016 and one in Tatlock et al. 2017), one tool for assessing hospitalised cats (Taffin et al.,
248 2016), one to assess cats with chronic kidney disease (Bijsmans et al., 2016), one to assess
249 cats with cardiac disease (Freeman et al., 2012), one tool to assess cats with diabetes (Niessen
250 et al., 2010), and one tool to assess cats with skin disease (Noli et al., 2016) (Figure 2). All of
251 these tools were detailed questionnaires, and 6/8 were only completed by the cat's owner. Of
252 the remaining two tools, one included a veterinary physical examination which was coded
253 and scored (Adamelli et al., 2004 and 2005) and the other (Karnofsky's score modified for
254 cats, validated in Taffin et al., 2016) included a score from 0-5 given by the examining
255 veterinary surgeon. Three of the validated tools appeared in more than one manuscript within
256 this review. The same unnamed tool appears in Adamelli et al, (2004) and Adamelli et al,
257 (2005), the CATCH tool (Freeman et al., 2012) appeared in two manuscripts, and the
258 DIAQoL-pet tool (Niessen et al., 2010) appeared in three manuscripts. This made a total of
259 12 manuscripts where one of the eight validated tools was used. This was 30% (12/40) of all
260 manuscripts included in this review. Supplemental Table 1 contains full details of all 40
261 manuscripts. Those using a validated tool are identified by an [a] after the author names.

262

263 The number of items examined in each validated tool ranged from 17 items (CATCH
264 tool, Freeman et al., 2012)) to 100 items (CHEW, Freeman et al., 2016) (Supplementary
265 Table 1). In some tools these items were divided into domains, for example play, mood,
266 energy, appetite, physique, coat (Freeman et al., 2016), and in all tools the items were scored
267 numerically to give an overall QoL result. The number of items assessed in the tool used in

both Adamelli et al, (2004) and Adamelli et al, (2005) was not stated. Nor was the number of items assessed in the tool used in Taffin et al, (2016). Most of the tools found contained an additional question to assess the assessor's impression of the QoL of the cat overall. The only stated recall periods were seven days (CHEW, Freeman et al., 2016) and the preceding 4-week period (Tatlock et al., 2017). For the other assessment tools the recall period was described as one of the following: during the study, or since the intervention, or since the previous visit, or was not stated.

Unvalidated tools

Unvalidated tools designed to assess the QoL of cats with a particular disease condition were found for degenerative joint disease (Benito et al., 2012), osteoarthritis "FMPI" (Benito et al., 2013) and cancer "HRQoL" (Lynch et al., 2011). An additional three unvalidated tools were found to assess QoL associated with chemotherapy or the presence of tumours: Tzannes et al., 2008; Sabhlok and Ayl, 2014; Williams et al., 2017. One unvalidated tool was found to assess the QoL of healthy cats: Karnofskys' score modified for cats (Hartman and Kuffer, 1998) although this was later validated (Taffin et al., 2016).

Discussion

This is the first structured literature review focused on assessment tools for QoL of cats in all circumstances, whether healthy or unwell. The only other review of QoL tools for cats that the authors are aware of is the systematic review by Giuffrida and Kerrigan (2014) looking at tools for QoL of cats (and dogs) with cancer. In this review, we aimed to understand what tools are currently available for decision makers and researchers for assessing cat QoL. Defining QoL is very complex and no universally accepted definition yet exists (Gaynor and

Muir 2014). We aimed to find out whether any assessment of QoL was carried out in manuscripts which discussed QoL, whether a simple or structured tool was used, and whether that tool was validated. In human medicine, Carr and Higginson (2001) discussed how evaluation of QoL can be very specific to an individual patient. Therefore, it is possible that without an agreed definition of QoL or any validated tools, QoL may not be well assessed. Independent assessments using different tools may come to different conclusions about QoL.

We found that although QoL or well-being was mentioned in manuscripts, actual assessment of QoL with some form of tool was carried out in less than half of the manuscripts. Some papers mentioned the importance of QoL or discussed how a new treatment has the potential to improve QoL, without any actual assessment of QoL alongside this. Assessment with a validated tool was carried out in just over a quarter of manuscripts. Many tools used a Likert scale or one word to assess QoL and these very simple, unstructured tools were not validated. QoL is a very complex construct (Scott et al., 2007) so it is likely that it would not be possible to validate these over-simplified tools for QoL assessment. Assessing this important concept so simply in research studies, particularly clinical trials, may risk missing subtle differences between patients. This would reduce the useful contribution that these trials could make to the evidence-base for treatment decision-making. Quality of life assessment in cats may be more than a single construct. It may incorporate specific characteristics within different contexts, likely to have a common set of characteristics that may apply to all contexts. Scott et al. (2007) explain that QoL is a complex and subjective construct which should not be over-simplified in order to measure it. Many papers found by the current study have over-simplified the construct by their chosen measurement methods. Even within the validated tools found, there is wide variability in the number of items assessed by each tool, and so each tool may produce a different quality of

life assessment. Defining quality of life is very complex and existing publications propose several definitions, none of which has been universally accepted. The purpose of this review was not to create a new definition for quality of life, or to solve the existing problem of a lack of universally accepted definition. The authors agree that this is an important problem that needs addressing. However, the purpose of this review was to explore whether papers that discuss cat quality of life use a tool to assess it, what sort of tool they use, and whether they use a validated tool.

The validation of tools to measure QoL is important, as without validation we cannot be certain that a tool is truly measuring what it has been designed to measure (Scott et al., 2007; Belshaw et al., 2015). Assessment of the validation process used for these tools should now be carried out and if validation is found to have been conducted rigorously, users can be more reassured as to how well the validated tools measure QoL and how comparable the results gained from assessments with each tool may be. Assessment of validation should be carried out according to the Consensus-based Standards for the selection of health Measurement Instruments (COSMIN) (Prinsen et al., 2016), and the authors aim to address this in future work as it falls outside the scope of this current review. In assessing the credibility of the QoL tools the authors will also need to assess their reliability (Spofford et al., 2013). Giuffrida and Kerrigan (2014) define reliability as whether the test measures something in a reproducible manner. Spofford et al., 2013 state that using reliable tools helps to gather accurate results. The next step in this work is to look at both the validity and reliability of the QoL assessment tools, because both are important for determining how well a tool assesses what it is supposed to in a consistent way. However, we anticipate this process may be complicated by the lack of definition of QoL for animals as described by Gaynor and

Muir (2014) and Belshaw et al. (2015) which will make it difficult to fully assess the validation process, and test reliability.

As many QoL tools have not been validated, this limits what individuals involved in QoL assessments on a daily basis (e.g. veterinary surgeons, animal owners/ managers etc.) can utilise for decision-making in relation to the animals under their care, be they assessments of positive or negative QoL in healthy animals, or those suffering from a disease. For decision making in the veterinary clinic, the FMPI tool (Benito et al., 2012) is now accessible on a website for vets to use for assessing musculoskeletal pain. This may increase awareness and use of this tool, however as this tool is unvalidated for QoL assessment, the quality of assessments made using it is not known. It is hoped that this review will highlight the validated tools which do exist, to encourage future researchers and clinical practitioners to use them. It is hoped that these validated tools will provide a more thorough and appropriate QoL assessment than unvalidated tools. However, the assessment of the validation process and reliability of the tools has not yet been carried out. Therefore, users should note that further recommendations may be made after this process, and that they may not be able to rely fully on the assessments of all validated tools at this stage of the process.

There are some potential limitations to the work carried out in this review. The search strategy used only covered the databases Medline and CAB Abstracts. These databases should have good coverage of the literature relating to animals, as research has identified that CAB Abstracts covers 90% of journals relevant for veterinary medicine (Grindlay et al., 2016). However, it is possible that further searching with additional databases and hand searching the grey literature may have found more results. Since this review was carried out the authors have been made aware of an additional manuscript (Noble et al., 2018), which

was likely not indexed at the time of the original search. In addition, the search terms used were very specific to QoL. The term "well-being" was included and was also helpful as many authors seemed to use this interchangeably with QoL. The search terms used in this review were the same as used by Belshaw et al. (2015) in a review of QoL assessment tools for dogs. It is possible that using additional search terms, for example "welfare" could have returned more results, as some consider the terms "welfare" and "QoL" to be synonymous (Mullan, 2015). However, welfare can also include practical welfare measurement, which is most usually concerned with ensuring minimum standards of care are provided (Scott et al., 2007). Therefore, including this term may have made the results much broader, covering more general practical aspects of a cat's life, and less applicable to the specific assessment of QoL, in which Scott et al. (2007) emphasise the importance of the individual's perspective, and how the subject feels about their circumstances. In addition, the manuscripts in this review only met the inclusion criteria if they were in English. If more languages had been included in the scope of this review, it is possible that additional QoL tools may have been found.

Conclusions

Researchers appear to assess QoL in cats using a wide range of tool types, and few appear to use the small number of tools that have been validated. Researchers assessing QoL at present should aim to use the existing validated tools where appropriate, whilst being aware that future work will aim to assess the quality of the process used to validate the tools, and tool reliability. In addition, a universally agreed definition of QoL should be sought.

Conflict of interest statement

None of the authors has any financial or personal relationships that could inappropriately influence or bias the content of the paper.

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642 **Table 1**

643 Inclusion and exclusion criteria for this scoping review

Criteria No.	Criteria	Inclusion	Exclusion
Title and abstract screening			
1	Language	English	Any language other than English
2	Publication type	Full study reported Published literature	Non-peer reviewed literature (defined as Journal not stated on Ulrichsweb: https://ulrichsweb.serialssolutions.com as "refereed/ peer reviewed"). Grey literature Abstracts only available (methods and results not available on request) Book/book section/generic
3	Availability	Able to obtain through University of Nottingham library or inter-library loan request to the British Library Document Supply Centre	Cannot obtain manuscript in full
4	Population of interest	About domestic cats either privately owned, or managed within other environments (e.g. shelters, teaching organisations) or used for research purposes	Wild or big cats In vitro studies Any other species
5	Subject	Make reference to QoL or well-being within the title or abstract of the manuscript.	No reference to QoL or well-being within title and abstract
Whole manuscript screening			
6	Subject	Make reference to QoL or well-being within the materials and methods section	Does not make reference to QoL or well-being within the materials and methods section
7	Study type	Randomised Controlled trials	Narrative reviews Conference proceedings

			Controlled trials without randomisation Cohort studies Case-control studies Cross sectional studies Case series Case study	
8		Assessment	Assessment of QoL or well-being of cats within the manuscript was made, may use a specified tool to do so.	Discuss QoL without actually providing an assessment of QoL or using any tool. Manuscripts which mention QoL or well-being but do not assess it in any way.

644 QoL, quality of life

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Supplemental Table 1

Overview of the information extracted from the 40 papers found during a scoping review of quality of life assessment tools for cats.

Author	Title	Administration of tool	How information gathered for tool	Brief description of the quality of life tool used, as it is described within the manuscript	Unique tool used for the first time? Or reference from elsewhere?	Is validation of the tool described?
Adamelli et al., 2005 [a]	Owner and cat features influence the quality of life of the cat	Owner and veterinary surgeon	Questionnaires and physical examination	Questionnaires covered "care", for example: veterinary care and frequency of brushing and "cat behaviour", for example: urinating outside the litter tray and time spent with owner. Each answer was coded into a number and then the sum of these numbers was translated into the category low or medium or high. Each aspect of the physical examination of the cat was also coded onto a numeric scale of 1-3, these aspects were then summed to give a total score. This score was then categorised as low, medium or high.	Referenced from Marinelli et al., 2001	States was previously validated by Marinelli et al., 2001

				QoL was calculated by adding the numeric values (from questionnaire together to give a total numeric value of QoL. Also, to assess the level of QoL, the combination of the three low, medium or high ratings was considered: an overall low QoL= three low scores or two low scores and one medium. An overall high QoL= three high scores or two high and one medium. All other score combinations= medium QoL.		
Adamelli et al., 2004 [a]	Factors influencing the quality of life of the cat in its relationship with owners	Owner and veterinary surgeon	Questionnaires and physical examination	Four questionnaires examined the relationship between the cat and the owners, and the influence of factors on the cat's QoL. These covered owner features (age, gender, education, marital status, job family features, place and size of swelling, social relations), cat features (age, gender, breed, neuter status, age of adoption, source, whether lives with other animals), care given to the cat and the cat's behaviour (attachment to the owner, house, soiling, behaviour towards owner and other animals). A score scale was used to codify responses and the sum used to represent: care given to cat, cat behaviour and physical condition.	Referenced from Marinelli et al., 2001	States was previously validated by Marinelli et al., 2001

				The manuscript states that some owner and some cat features were found to influence the cat's QoL. However, it is not clear from reading this manuscript in isolation how that conclusion was drawn.		
Bass et al., 2005	Retrospective study of indications for and outcome of perineal urethrostomy in cats	Owner	Questionnaire	Asked whether they considered their cat's QoL to be good, acceptable or poor, following surgery.	Unique tool, not a named tool, not referenced.	No
Benito et al., 2013	Reliability and discriminatory testing of a client-based metrology instrument, feline musculoskeletal pain index (FMPI) for the evaluation of degenerative joint disease-associated pain in cats	Owner	Questionnaire	"Feline Musculoskeletal Pain Index": a 21-question tool with one question on overall QoL. The question was a descriptive rating scale with four descriptors: excellent, good, fair, poor.	Unique named tool used for the first time	No

Benito et al., 2012	Owner-assessed indices of quality of life in cats and the relationship to the presence of degenerative joint disease	Owner	Questionnaire	The questionnaire was modelled from Budke et al., 2008 in which owners they wrote down five activities they believe were important for the cat's QoL. They were then asked to rate the importance of each activity, with the sum total of all the ratings being 100.	Referenced from Budke et al., 2008	No, in Budke et al., 2008 the tool was originally designed for dogs
Bijsmans et al., 2016 [a]	Psychometric validation of a general health quality of life tool for cats used to compare healthy cats and cats with chronic kidney disease	Owner	Questionnaire	"CatQoL survey" divided into four domains: general health, eating, behaviour and management, which covered 18 items in total. Each item scored according to the frequency or severity with which it impacted the cat's life (-3 to +3), along with an importance rating for each question (0 to +3). The frequency and importance ratings multiplied to give an item-weighted-impact-score (IWIS). Lowest possible IWIS was -9 and highest possible +9. An average of all the IWIS scores then taken to give an overall quantitative measure of the cat's QoL. An additional question allowed the owner to separately grade their cat's QoL from 0-10 (very poor- excellent). A free comments section allowed owners to add anything they wished about their cat's QoL.	Unique tool, first use	Psychometric validation is carried out and described within the paper, where two of the items are removed as a result, leading to a final 16 item tool.
Boland et al., 2014	A survey of owners'	Owner	Questionnaire	QoL assessed on a linear analogue scale of 1-10 before and after	Unique tool, first use	No

	perceptions and experiences of radioiodine treatment of feline hyperthyroidism in the UK			radioiodine treatment, where 1= very poor and 10 = excellent.		
Bowles et al., 2010	Owner's perception of carboplatin in conjunction with other palliative treatments for cancer therapy	Owner	Questionnaire	QoL rated on a 10 point numerical system where 1= could not be worse and 10= could not be better. This was done for the following times: a) before cancer, b) after diagnosis of cancer but before treatment, c) during treatment with carboplatin.	Unique tool, first use	No
Brown et al., 2009	Gene therapy by electroporation for the treatment of chronic renal failure in companion animals	Owner	Questionnaire	Control patients not individually assessed for QoL but the veterinarians felt it was getting worse. In the treated animals the owners were asked to rate their pet's QoL as significantly increased (5); increased (4); no change (3); decreased (2) or significantly decreased (1). This was done four times over the 60-day study period.	Unique tool, first use	No
Christmann et al., 2016	Effectiveness of a new dietetic weight management food to achieve weight loss in	Owner	Questionnaire	QoL described at each visit by scoring the following criteria on a Likert scale: energy level, happiness, appetite, begging behaviour, flatulence, stool volume. Scores ranged from 0-10, so for example, for	Unique tool used for the first time	No

	client-owned obese cats			happiness, a score of 0 meant sad and a score of 10, meant very happy.		
Fischer et al., 2011	Randomized, placebo-controlled study of the effect of propentofylline on survival time and quality of life of cats with feline infectious peritonitis	See Hartmann and Kuffer (1998)	See Hartmann and Kuffer (1998)	Karnofsky's score modified for cats- see Hartman and Kuffer (1998)	Referenced from Hartmann and Kuffer (1998)	No
Forster et al., 2010	Owners' observations of domestic cats after limb amputation	Owner	Questionnaire	Information was collected on the owner's perception of cat's QoL. Also, the owner was asked how long the cat took to reach "best" QoL after the procedure and whether the cat returned to a "normal" QoL after the procedure. In addition, how long it took for the QoL to stop improving.	Unique tool, first use	No
Fox et al., 2000	Use of cis-bis-neodecanoato-trans-R,R-1,2-diaminocyclohexane platinum (II), a liposomal cisplatin analogue, in cats with oral squamous cell carcinoma	Owner and veterinary surgeon	Questionnaire and additional evaluation, method not described	On day 10 after each treatment a "performance status questionnaire" was done, assessing attitude and activity, appetite and weight loss. For each category it appears that owners would select the most appropriate response, e.g. for appetite: eats well without assistance/ eats well with assistance/ force-fed/ will not eat/ requires enteral nutrients.	Unique tool, first use.	No

				In addition, owners and clinicians evaluated the QoL and if poor, the cats were subjected to euthanasia. Method of evaluation not described.		
Freeman et al., 2012 [a]	Development and evaluation of a questionnaire for assessment of health-related quality of life in cats with cardiac disease	Owner	Questionnaire	Cat's Assessment Tool for Cardiac Health (CATCH) A 17-item questionnaire designed to assess the degree to which the clinical signs of cardiac disease affected the cat's comfort or sociability, graded on a scale of 0-5 where 0= not at all and 5= very much. Responses for each of the items were summed to obtain an overall score where higher scores indicated a poorer health related QoL. Additionally, owners asked to assess overall QoL on a scale of 1-5 where 1 = excellent and 5 = very poor.	Unique named tool used for the first time	Yes
Freeman et al., 2016 [a]	Development and initial validation of the Cat HEalth and Wellbeing (CHEW) Questionnaire: a generic health-related quality of life	Owner	Questionnaire	Cat HEalth and Wellbeing (CHEW) questionnaire. Tool contained 11 domains with 100 items, over a seven day recall period, alongside two general questions determining overall HRQoL and overall health status on a five point Likert scale (to be used for validation and classification). Domains included	Unique tool, first use.	Validity and reliability evaluated within this manuscript.

	instrument for cats			play, mood, energy, appetite, physique and coat.		
Fritsch and Jewell, 2015	Acceptance and effects of a therapeutic renal food in pet cats with chronic kidney disease	Owner	Questionnaire	Asked at each visit to rate change in QOL since previous visit, on sevenpoint scale from extreme deterioration (7) to extreme improvement (1)	Unique tool, first use	No
Gates et al., 2017	Preliminary description of aging cats and dogs presented to a New Zealand first opinion veterinary clinic at end-of-life	Researcher	Information gathered from clinical notes written by the veterinary surgeon	The presence of clinical signs potentially associated with a decreased QoL (e.g. respiratory impairment, lethargy, recumbency, poor body condition) were noted and whether the patient had chronic disease (e.g. renal failure, blindness, cardiovascular disease) potentially associated with decreased QoL was also noted.	Unique assessment, first use.	No
Giuffrida and Kerrigan, 2014	Quality of life measurement in prospective studies of cancer treatments in dogs and cats	N/A	N/A	This is a review of QoL measurement tools in prospective studies of cancer treatment in cats and dogs. The "Karnofsky's score modified for cats" tool (Hartmann and Kuffer, 1998) found elsewhere in this search was identified in this manuscript. The identity of other tools found in this 2014 search was unclear from the information provided.	Not applicable	Not applicable

Gostelow et al., 2018 [a]	Prospective evaluation of a protocol for transitioning porcine lente insulin treated diabetic cats to human recombinant protamine zinc insulin	See Niessen et al., 2010	See Niessen et al., 2010	DIAQoL-pet quality-of-life questionnaire for diabetic cats, which generates an average-weighted impact score (AWIS) to reflect pet and owner QoL (see Niessen et al., 2010, below).	Referenced from Niessen et al., 2010	States that the tool is validated
Guedes et al., 2018	Evaluation of tramadol for treatment of osteoarthritis in geriatric cats	Owner	Questionnaire	Global quality-of-life questionnaire which asks whether the cat's life had deteriorated during the study, was the same as before the study, or had improved, compared with QoL before the study.	Not referenced but is described as if is not unique.	No
Hartmann and Kuffer, 1998	Karnofsky's score modified for cats	Owner and veterinary surgeon	Questionnaire and veterinary observations	Karnofsky's score modified for cats: Two parts. Part 1: an owner questionnaire. In this the owner compares the behaviours of the cat now to the behaviour of the cat before disease was noticed and assigned a score (0= behaviour no longer present, 1= shown only rarely, 2= shown half as often as earlier times, 3= almost as often as earlier times, 4= as often as earlier times). Each behaviour score is then multiplied by a factor (different for each behaviour) and a	Unique named tool used for the first time	No

				number of points are assigned, up to a maximum number. The maximum overall score for part 1= 50. Part 2: observations by the vet. One of six scores is chosen to represent the general condition of the patient (5= completely normal, 4 = minor changes, 3= medium changes, 2= major changes, 1= severely diseased, 0= dead). This score is multiplied by 10 to give a second score of maximum 50. Scores from part one and part two added together and then referenced to the Index of Karnofsky which indicates the QoL, e.g. 100% = normal, no complaints, no evidence of disease.		
Hung et al., 2014	Bovine lactoferrin and piroxicam as an adjunct treatment for lymphocytic-plasmacytic gingivitis stomatitis in cats	Owner	Questionnaire	The owner's perception of the cat's QoL was scored from 1-10 where 1=worst quality of life and 10= the best QoL.	Unique tool, first use	No
Kooij et al., 2014	Effects of an iodine-restricted food on client-	Veterinary surgeon	Questionnaire	Scored by the veterinary surgeon from 1-5 where 1= very poor and 5 = excellent.	Unique tool, first use	No

	owned cats with hyperthyroidism					
Kulendra et al., 2014 [a]	Feline double pigtail ureteric stents for management of ureteric obstruction: short- and long-term follow-up of 26 cats	See Niessen et al., 2010	See Niessen et al., 2010	Assessment by questionnaire, based on DIA-QoL-pet- see Niessen et al., 2010	Referenced from Niessen et al., 2010	Yes
Lascelles et al., 2007	Evaluation of client-specific outcome measures and activity monitoring to measure pain relief in cats with osteoarthritis	Owner	Questionnaire	Owner asked if QoL was worse, the same, slightly improved, moderately improved or very improved. This assessment was termed: a "Global Assessment of Quality of Life"	Unique tool, first use	No
Lynch et al., 2011	Development of a questionnaire assessing health-related quality-of-life in dogs and cats with cancer	Owner	Questionnaire	"HRQoL" questionnaire asked owners to state from 1-5 their agreement with 3 statements for 8 domains, e.g. within the domain Happiness, one of the statements reads "My pet wants to play". Owners also asked to indicate current QoL from very poor to excellent on a visual assessment scale.	Unique tool, first use	No
Matei et al., 2017	Nutritional management of	Not clear	Not clear	States that the QoL was assessed, and that QoL scores improved (scores are	Unclear as not stated.	No

	overweight and obesity in dogs and cats			quoted in the results from -1 to +1 but it is not explained how these scores were calculated.		
Niessen et al., 2010 [a]	Evaluation of a quality-of-life tool for cats with diabetes mellitus	Owner	Questionnaire	DIAQoL-pet: Twenty-nine diabetes mellitus QoL specific items. For each item, the frequency with which it impacted the owner and pet's lives and how important the item was to the owner and pet were categorised e.g.: all the time/ often/ occasionally and this was translated into a numeric value. The frequency and importance values for each item were multiplied to give a score per item and these scores were averaged across all 29 items to give a single quantitative measure of QoL. An additional two separate overview questions were included: "I feel my pet's quality of life is…." and "If your pet did not have diabetes, his/her quality of life would be….."	Unique named tool used for the first time	Yes
Noli et al., 2016 [a]	Development and validation of a questionnaire to evaluate the QoL of cats with skin disease and their owners, and its	Owner	Questionnaire	The questionnaire was developed based on the "Dermatology life Quality Index" from human medicine and interviews with owners, to assess the impact of skin disease on cat, owner and families' lives and QoL. Answers were scored: 0 (not at all) to 3 (very much). Questionnaire contained 15 items, with seven	Unique tool, first use.	Criterion and construct validity described within the manuscript.

	use in 185 cats with skin disease			questions which focussed on the QoL of the cat, covering: mood, sleep, meals, playing/exploring, habit changes, therapies and vet visits.		
Pakozdy et al., 2013	Treatment and long-term follow-up of cats with suspected primary epilepsy	Owner	Questionnaire	Owner evaluated whether the cat's QoL was good/ impaired or bad, based on these definitions: Good= cat's life did not seem to be negatively influenced by the disease or treatment. Impaired= when the disease or treatment had a significant or important negative influence. Bad= when the owner considered euthanasia as result of the disease.	Unique tool, first use	No
Reynolds et al., 2010	Perceptions of quality of life and priorities of owners of cats with heart disease	Owner	Questionnaire	Owners asked about the cat's overall QoL and completed a questionnaire on the importance of 8 individual parameters on their cat's QoL. Parameters= appetite, human interaction, interaction with other pets, desire and ability to engage in play, comfort while resting or sleeping, normal grooming activity, appropriate use of the litter box and desire to go outside. These parameters were rated from 1-10 where 1= no importance and 10 = extremely important. Owners also asked:	Unique tool, first use	No

				1. Whether administering medication had a harmful effect on the cat's QoL (1= no effect to 10= extreme effect) 2. About the balance between giving medications to maintain or improve QoL but at the same time potentially reduce life expectancy, what would the owners consider the ideal balance? (1= low QoL but long lifespan to 10= high QoL but short lifespan.		
Ritz et al., 2007	Effect of feline interferon-omega on the survival time and quality of life of cats with feline infectious peritonitis	See Hartmann and Kuffer, 1998	See Hartmann and Kuffer, 1998	Karnofsky's score modified for cats.	Referenced from Hartmann and Kuffer, 1998	No
Ruda and Heiene, 2012	Short- and long-term outcome after perineal urethrostomy in 86 cats with feline lower urinary tract disease	Owner	Questionnaire	Overall QoL after surgery graded from 1-3.	Unique tool, first use	No
Rush et al., 2015 [a]	Assessment of the responsiveness	See Freeman et al., 2012	See Freeman et al., 2012	CATCH- see Freeman et al., 2012	Referenced from	Yes

	of the Cats' Assessment Tool for Cardiac Health (CATCH) Questionnaire				Freeman et al., 2012	
Sabhlok and Ayl, 2014	Palliative radiation therapy outcomes for cats with oral squamous cell carcinoma (1999-2005)	Owner	Questionnaire	Owner subjective assessments made of post-treatment QoL, based on: an observable decrease in tumour size, an improved ability to eat and return to grooming.	Unique assessment, first use.	No
Taffin et al., 2016 [a]	Evaluation of a modified Karnofsky score to assess physical and psychological well-being of cats in a hospital setting	See Hartmann and Kuffer, 1998	See Hartmann and Kuffer, 1998	Karnofsky's score (see Hartmann and Kuffer, 1998) with some aspects removed as not pertinent to hospital setting, for example: catching mice.	Referenced from Hartmann and Kuffer,1998	Yes
Tatlock et al., 2017 [a]	Development and preliminary psychometric evaluation of an owner-completed measure of	Owner	Questionnaire	A 22 -item questionnaire which covered seven domains on the topics of: interaction with surroundings and humans, gastrointestinal signs, physical activity, vocalisation, appetite, sleeping, pain, general health, toileting habits, hydration, weight loss, grooming and general	Unique tool, used for the first time	Yes, validation is described within this manuscript

	feline quality of life			happiness. Each item was rated for the preceding four week period using a five point Likert scale, from “not at all” or “strongly disagree, up to: “a great deal” or “very much” or “strongly agree”.		
Theobald et al., 2013	Clinical outcome in 19 cats with clinical and magnetic resonance imaging diagnosis of ischaemic myelopathy (2000-2011)	Owner	Questionnaire	Owner perception of QoL, no scale given. Reported as “poor” for some cases and for other cases, that the QoL negated the need for clinical re-evaluation.	Unique assessment, first use.	No
Tzannes et al., 2008	Owners 'perception of their cats' quality of life during COP chemotherapy for lymphoma	Owner	Questionnaire	Using a linear analogue scale, owners were asked to rate their cat’s QoL on a scale of 1-10 (1= QoL could not be worse, 10 = QoL could not be better) pre-cancer, after diagnosis but before chemotherapy treatment, and during chemotherapy treatment. Owners also asked to rate how they thought the cat perceived their own QoL, identify aspects they considered important to their cat’s QoL and describe the cat’s experience of chemotherapy as “all good days”,	Unique tool, first use	No

				"more good days than bad days", "more bad days than good days" or "all bad days".		
Williams et al., 2017	Factors which influence owners when deciding to use chemotherapy in terminally ill pets	Owner	Questionnaire	QoL rated by owners on a scale from 1 (low) to 10 (high) and embedded within a questionnaire, alongside other key themes. Owners were asked to rate the potential impact of chemotherapy on 13 statements, as acceptable or unacceptable, to assess the impact of chemotherapy on QoL. For example: "My pet does not play during chemotherapy". Other statements covered drinking, eating grooming, activity, awareness, trembling, sleeping, good days vs bad days, play behaviour, depression and diarrhoea.	Unique tool used for the first time, created based on information from Tzannes et al., 2008; Reynolds et al., 2010; Belshaw et al., 2015	Not stated.

651 QoL, quality of life

652 [a]By the authors name denotes one of the 12 manuscripts where a validated tool was used

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Figure legends

Fig. 1. Flow chart to show number of manuscripts excluded according to the inclusion and exclusion criteria and number of tools extracted.

Fig. 2. Flow chart to show how many tools of each type were found.

[b] The two manuscripts by Adamelli et al were both found in the search done as part of this systematic review. They both reference the same tool, originally published in Marinelli et al., 2001. However, the manuscript by Marinelli et al, 2001 was not found in the results from this systematic review search.

(V) is used to show a tool which had been validated.