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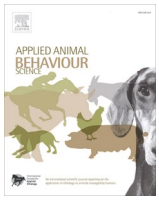



Exploring the quality of life in cats: How caretaker perceptions shape simple and systematic assessments

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ABSTRACT

Assessing animals' quality of life (QoL) often relies on caretaker reports providing insights into behavioural and health changes, but possibly overlooking key welfare factors. Understanding which aspects shape caretakers' perceptions of their cats' QoL and how these perceptions align with structured, multi-domain welfare assessments can help improve the validity and usefulness of QoL tools. We hypothesised that health, age, outdoor access, enrichment, and human–animal interactions influence caretakers' perceptions of their cats' QoL, and examined how these perceptions relate to structured, multi-domain welfare assessments. We used a single caretaker rating of overall QoL (QoL_scale) and explored its relationship with a systematically derived measure (QoL_extensive) based on behavioural, emotional, and health indicators. Caretakers (N = 421) completed an online survey on their characteristics and health (e.g. age, body condition, signs of good/impaired health, medical needs), husbandry (social environment, outdoor access, environmental features, e.g. resting places, enrichment), human-animal interactions, cat behaviour (e.g., frequency of different behaviours towards conspecifics and caretakers including play, aggression) and impressions on emotional states. A principal component analysis (PCA) on 54 of these behaviour, health and emotional states items was used to derive a comprehensive measure of QoL (QoL_extensive). This measure comprised six components: (1) Vitality, (2) Attentiveness, appetite, and enjoyment, (3) Negative emotions, (4) Healthy appearance, (5) Affection towards familiar humans, and (6) Aggression towards familiar humans. Two regression models examined predictors of QoL_scale and QoL_extensive, incorporating factors such as health condition, medical needs, body condition, outdoor access, human-animal interactions and enrichment. For QoL_scale, the six QoL_extensive components were also included to investigate how they relate to the simple assessment. Our findings revealed that caretaker ratings (QoL_scale) were mainly shaped by visible health and emotional states, with attentiveness, appetite, and enjoyment showing a positive ($\beta = 0.25$, $p < 0.001$) and negative emotions showing a negative association ($\beta = -0.21$, $p < 0.001$). Structured assessments (QoL_extensive) highlighted the importance of age ($\beta = -0.29$, $p < 0.001$), body condition ($\beta = 0.16$, $p = 0.001$), and affiliative human–animal interactions ($\beta = 0.17$, $p = 0.001$), underscoring the central role of human-animal relationships in welfare. The weak correlation ($r = 0.295$, $p < 0.001$) between the two measures suggests they capture only partly related aspects of feline welfare. Overall, caretaker judgments and structured welfare indicators reflect related but distinct QoL aspects, confirming our objective that comprehensive, multi-domain assessments are required to capture feline welfare accurately.

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1. Introduction

Quality of life (hereafter: QoL) is a concept that has been widely discussed in healthcare since the mid-1900s (Elkinton, 1966; Huxley, 1959; Long, 1960). It has also become essential for evaluating how clients perceive their pets' illnesses and treatments (Mullan, 2015; Yeates and Main, 2009). Although many definitions of animal QoL have been proposed (Noble et al., 2019; Piotti et al., 2021; Wiseman-Orr et al., 2006; Wojciechowska and Hewson, 2005), there is no single, widely accepted definition (Belshaw et al., 2015; Fulmer et al., 2022). Currently, several definitions of animal QoL exist. For some, it is synonymous with animal welfare (DeGrazia, 1998; Fraser and Duncan, 1998; Mullan, 2015; Mullan and Main, 2007; Scott et al., 2007; Wemelsfelder, 2007; Wojciechowska and Hewson, 2005), but even the concept of welfare lacks a universally accepted definition. Historically, animal welfare has focused on preventing abuse and neglect (e.g., Brambell, 1965; Broom, 1991), while current concepts such as "The five Domains" that are widely accepted and used as a working definition in the present study focus strongly on mental states (Beausoleil and Mellor, 2015; Mellor et al., 2020). QoL emphasises the broader flourishing of an animal's welfare, including psychosocial and emotional aspects (McMillan, 2000; Wilson, 1998; Wojciechowska and Hewson, 2005). The World Health Organisation (WHO) describes QoL as an individual's perception of their place in life, shaped by the cultural context, value systems, goals, expectations, and concerns relevant to them (Noble et al., 2019). This definition highlights that QoL is a subjective experience, reflecting how one feels about their life rather than how others view it. It is influenced not only by external circumstances but also by what holds personal significance and their capacity to derive satisfaction from life (Wiseman-Orr et al., 2006). Since QoL is inherently subjective, assessments should ideally come from the perspective of the individual experiencing it. While this can already be challenging in human healthcare, it can be even more difficult to achieve in veterinary care (Wiseman-Orr et al., 2006). However, caretakers, like parents who act as proxies for their children (Eiser and Morse, 2001), serve as trusted assessors for their pets' well-being.

Europe's domestic cat (*Felis catus*) is estimated, based on available industry data, at approximately 129 million in 2023 (PetfoodIndustry, 2024). In 2022, available estimates indicated more than 1.9 million cats in Austria (Statista Research, 2023) and approximately 15.7 million in Germany (PetfoodIndustry, 2024). Given their widespread presence in European households, understanding how cats are typically housed is essential for discussing their welfare. Housing practices for domestic cats vary widely across the globe. While historically afforded a mix of indoor and outdoor freedom, modern constraints, ranging from urbanisation and safety concerns to environmental and wildlife protection, have transformed how cats live alongside humans (Linklater et al., 2019). Furthermore, although both cats and dogs followed the commensal pathway of domestication (Driscoll et al., 2009). Cats seem to maintain a strong repertoire of behaviours from their wild ancestors, such as hunting, crepuscular activity, and territorial marking (Bradshaw, 2018; Pongrácz and Lugosi, 2024). When these behavioural needs are unmet, whether due to lack of stimulation, restricted movement, or poor social compatibility, cats may experience compromised welfare, often expressed through problem behaviours such as inappropriate elimination, excessive vocalisation, aggression, or furniture scratching (Heidenberger, 1997; Sandøe et al., 2017). The underlying reasons for these behavioural problems are distressing for the animals. Their behavioural expression may also strain the cat-caretaker relationship, sometimes leading to surrender or abandonment (Patronek et al., 1996). Environmental provisions such as toys, scratching posts, and hiding spots are recommended to mitigate welfare concerns (Ellis et al., 2013). However, their effectiveness is shaped by broader factors, including spatial layout, resting site availability, and opportunities for behavioural choice. Cats' responses to these environmental features vary according to their needs, health status, and social context. Co-housing with other pets can restrict access to key resources and lead to chronic stress or avoidance behaviours (Bernstein and Strack, 1996; Thomson et al., 2018). Finally, age and underlying health conditions can influence how cats interact with their surroundings, with older cats and those with chronic illness often exhibiting reduced mobility, play, or sociability (Bijsmans et al., 2016; Freeman et al., 2016). Despite these known welfare challenges, existing assessment tools often prioritise medical or physical health indicators, providing an incomplete picture of QoL. Caretakers may also unintentionally overlook or misinterpret signs of distress or unmet needs, particularly when behavioural expression is subtle (Giuffrida et al., 2018). Most existing feline QoL instruments, such as the CHEW questionnaire (Freeman et al., 2016), focus predominantly on physical health and disease status. Even though it includes some aspects of their interactions with humans, these items primarily reflect general social behaviour (e.g., overall friendliness or avoidance) rather than more details on the cats' reactions to humans. However, the quality of these human-animal relationships is a key welfare factor that affects emotional states and overall well-being (Waiblinger et al., 2006). It should therefore be consistently included in QoL assessments in more detail, yet this dimension remains underrepresented in most QoL assessment tools. Thus, there is a growing need for accessible, evidence-based tools that reflect the multidimensional nature of cats' QoL within the home environment. Addressing this gap requires tools that explicitly incorporate relational dimensions alongside behavioural and environmental factors.Doit et al. (2021) conducted a systematic review to evaluate the QoL assessment tools for domestic cats. They identified significant limitations, including the predominance of disease-specific tools, the lack of detailed assessments, and the reliance on overly simplistic methods (e.g., single-word or single-scale evaluations). Hence, we argue that a more comprehensive approach to feline QoL assessment is necessary, one that considers not only health-related factors but also psychological well-being, social relationships, and the physical environment. This multidimensional perspective offers a more precise and actionable understanding of cats' welfare, capturing aspects that single-scale evaluations might miss.

We aimed to identify the factors that shape caretaker perceptions of their cats' QoL and examine how these align or differ from more systematic welfare indicators. Thus one objective of this study was to determine which demographic, health, environmental, and human–animal interaction variables predict caretaker-rated QoL and to assess how this subjective rating relates to a structured, multi-domain measure. At the same time, we wanted to provide an easy tool that can be used for routine monitoring by caretakers, clinicians, or welfare professionals, helping to detect specific domains (i.e., health, behaviour, environment, or social relationships) where welfare improvements may be needed. Based on previous research highlighting environmental, behavioural, social, and health-related influences, we hypothesised that a combination of demographic, health, environmental, and human–animal interaction variables ′ would predict the overall caretaker rating of QoL. To examine convergence between the two measures, we developed a concise assessment tool (hereafter referred to as **QoL_scale**) and evaluated its correlation with a broader QoL assessment incorporating aspects such as husbandry and cat behaviour (**QoL_extensive**). This comparison allowed us to examine whether caretakers' overall judgment of their cat's QoL aligned with a more detailed and systematic evaluation, and whether the two measures captured distinct aspects of cats' welfare. Although both measures are based on caretaker reports, the structured format of QoL_extensive incorporates multiple indicators, which helps lessen subjective bias and assess welfare more consistently and comprehensively than a single global rating.

2. Subjects, materials and methods

2.1. Ethical statement

The project proposal and questionnaire were submitted to the

University of Medicine Vienna ethics committee. Since the study relied solely on an anonymous online questionnaire collecting human opinions and involved no direct contact with humans or animals, the committee confirmed that no further ethics approval or registration was necessary, in accordance with Austrian national legislation and guidelines for good scientific practice. Data collection and processing were conducted solely under the legal authority of § 2 f Abs. 5 of the Austrian Research Organisation Act (FOG). Consistent with Article 89(1) of the General Data Protection Regulation (GDPR; DSGVO), data can be stored indefinitely for scientific research. Participation was voluntary, with informed consent obtained electronically before taking part.

2.2. Questionnaire design

The questionnaire was developed through a literature review and discussions among team members, including veterinarians, welfare experts, behavioural and cognitive scientists, and an educational psychologist. Several questions were adapted from existing questionnaires (i.e., Arhant et al., 2024; Bijsmans et al., 2016; Delgado and Reevy, 2018; Duffy et al., 2017; Freeman et al., 2016; Howell et al., 2017; Stella and Croney, 2019; Tatlock et al., 2017; Windschnurer et al., 2022).

A draft version of the questionnaire was tested with participants from the target group and experts from the University of Veterinary Medicine Vienna to point out incomprehensible wording and possible problems. The average time to complete the whole questionnaire was 30–40 min. The final questionnaire comprises 81 questions with sub-questions, organised into sections. At first, participants were asked general questions about cat ownership and characteristics (i.e., age, breed, sex). If the participant owned more than one cat, they were asked to answer all questions about the cat whose name came first in the alphabet (Windschnurer et al., 2022), referred to as the focus cat in the manuscript. In the first section, participants were asked about their cat's behaviour in the last 7 days (e.g., whether the cat had problems getting up after lying down, or if the cat's movements were slow). Participants were asked to rate the frequency of the different behaviours on a six-point scale (i.e., 1 = never, 2 = rarely, 3 = sometimes, 4 = frequently, 5 = usually, 6 = always). The same frequency scale was used for the following sections. In the second, third, fourth and fifth sections, we included questions about the appearance of fur (looked shiny, soft, matted), eyes (e.g. looked clear), and the physical appearance (e.g. felt muscled, looked athletic or fit) within the past 7 days. In the sixth and seventh sections, participants were asked about their perception of the cat (e.g. friendly, vigilant, frightened, relaxed) in the last 7 days. The eighth and ninth sections consisted of questions about the cats' reaction towards humans in the same household (i.e. avoiding, hiding, greeting, and being affectionate towards household members). For the tenth section, participants were asked to rate their cat's QoL on a scale from zero (appalling) to 100 (excellent). At the end of this section, body condition was indicated by selecting one of five illustrations depicting thin, underweight, ideal, overweight, and obese cats, shown from the side and from a bird's-eye view (see Fig. 1). In addition, owners reported the cat's body weight (kg). Our illustrations in Fig. 1 were created by K. Galunder and adapted from the WASAVA iCatCare obesity guideline (2020).

Following this, participants were asked about their cat's general health, including the presence of illnesses, behavioural problems, and medical needs (i.e., considering the level of intervention and invasiveness). Another section contained questions about the frequency of different types of human-animal interactions (e.g. talking to the cat, relaxing with the cat, playing, clicker training) as well as the interactions and social environment with other cats and animals in the household, using the 6-point frequency scale. Then, participants were asked about housing conditions (e.g., frequency of access to fresh grass, scratching posts, resting areas, toys, opportunities to leave the main living area, e.g. through a cat flap, access to at least one litter tray per cat, resting places, litter trays and food areas being in quiet areas). In the final section, participants were asked to provide some demographic information. Some sections of the questionnaire, such as the temperament assessment from Feaver et al. (1986), were excluded from this analysis because we prioritised factors more closely linked to perceived QoL. These other aspects will be addressed in future research.

Additionally, certain parts of the questionnaire were automatically skipped if the caretaker answered that specific questions did not apply (e.g., a cat not on medication led to skipping medication details). Moreover, there were no mandatory questions, but participants could choose not to answer questions. Consequently, the number of responses per question could vary. Therefore, we consistently report the number of valid answers, as indicated in the following, (n_{total}) per question.

2.3. Data collection

The survey was published online via SurveyMonkey between November 2021 and February 2022. It was advertised online via social media, posters on the campus of the University of Veterinary Medicine Vienna, and TASSO-Haustierzentralregister für die Bundesrepublik Deutschland e.V., TASSO e.V., the largest free companion animal registry in Europe, which operates primarily in German-speaking countries. It includes over 10 million registered companion animals, of which approximately 4 million are cats (see https://www.tasso.net/Presse).

In the introduction section of the questionnaire, participants were informed about the general aim of the study, namely, to assess cats' behaviour and welfare by examining various aspects of their daily lives. They were also provided with information regarding anonymous data processing, data protection regulations, and the general requirements for participation, which included being at least 18 years old, completing the questionnaire only once, and consenting to the anonymous analysis and publication of their data. Providing informed consent was a prerequisite for including the data in the later analyses.

2.4. Data analysis

The statistical analyses were performed using SPSS 29.0 (Armonk, NY, USA). The descriptive analysis focused on the characteristics of the participants and their cats. Before conducting the actual analysis, the collected data were prepared for subsequent steps. Specifically, the variable for cat age was recoded from months to years, and cat weight was standardised to kilograms. A thorough plausibility check was conducted on the questionnaires before analysis and involved verifying data entry, checking for consistency, ensuring values were within appropriate ranges, and detecting potential duplicates. Given the large sample size, parametric statistical methods were considered appropriate for regression analyses in line with the Central Limit Theorem (Field, 2000).

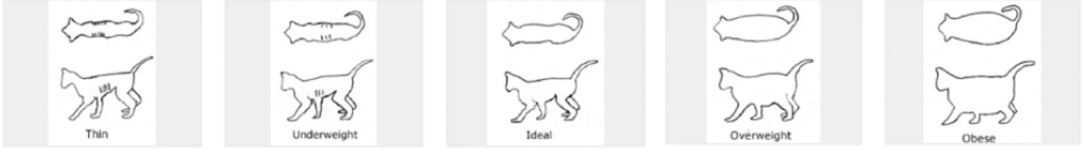

Fig. 1. Body condition of the focus cats. Body condition had to be indicated by choosing between five pictures showing underweight, normal and overweight cats, always from the side and in a bird's-eye view, drawings of too thin, thin, ideal weight, overweight, and obese.

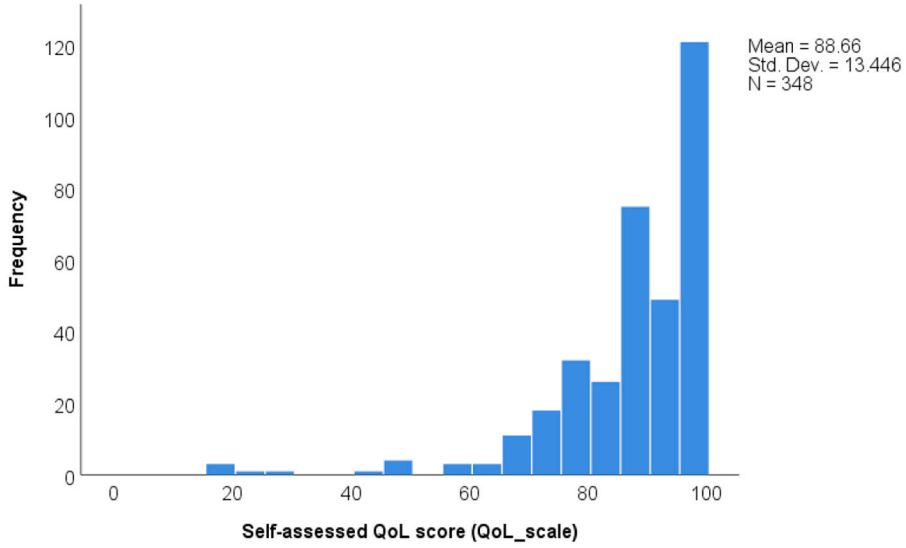

Fig. 2. Self-assessed QoL score (QoL_scale). Participants (N = 348) were asked to rate their cat's QoL on a scale from zero (appalling) to 100 (excellent).

Correlational analyses were conducted using Spearman's rank correlation, as several variables were ordinal or deviated from normality.

To reduce the number of items in the questionnaire, principal component analyses (PCA) were conducted for each section in the QoL. Before performing PCA, the suitability of the data was assessed using the Kaiser-Meyer-Olkin (KMO) test and Bartlett's test of sphericity. A KMO value greater than 0.6 and a p-value less than 0.05 for Bartlett's test were accepted as the threshold levels (Pallant, 2020). Once data suitability was confirmed, a PCA with Varimax rotation was conducted to assess the dimensionality of the items. To determine the number of components to retain, multiple criteria were applied: the Kaiser criterion (eigenvalues > 1), scree plot inspection, parallel analysis, and the interpretability of the extracted components (Pallant, 2020). For loading items on components, we chose 0.3 or greater as a threshold for an item to be included in the respective component. We set the limit at 0.3 because loadings exceeding 0.3–0.4 are frequently considered thresholds in psychological and behavioural studies (Miller et al., 2006). If an item was loading onto multiple components, it was included in the component where its loading was higher, in case of a minimum loading difference of 0.2 between components. This was done because, in earlier studies, the rule was applied that it was included in the component where its loading exceeded 0.6, provided that its loadings on all other components were below 0.4 (Gilhofer et al., 2024; Schneidewind et al., 2024), which also resulted in a minimum loading difference of 0.2.

Scale reliability was evaluated using Cronbach's α coefficients, with a threshold of $\alpha \geq 0.70$ indicating acceptable reliability (Pallant, 2020). For scales with fewer items where Cronbach's α fell below 0.70, inter-item correlations between 0.20 and 0.50 served as an alternative reliability measure, as low item counts can reduce Cronbach's α (Briggs and Cheek, 1986). Each scale derived from the PCA was labelled according to the semantic content of its items. Mean scores for each component were calculated to align with the original question scales, using imputed means where necessary. In negative loadings, items were recoded (scale reversed) before calculating mean scores.

A new variable was developed to quantify the perceived invasiveness of medication administered to cats. It was based on three items: (1) whether the cat received any medication (yes = 1, no = 0), (2) the type of medication (e.g., oral = 1, topical = 2, injection = 3), and (3) how stressful the process was for the cat (rated on a 5-point Likert scale, 0 = not at all stressful, 4 = extremely stressful). Responses were summed into a composite score ranging from 0 (no medication administered) to 15 (highest medication). Higher values, therefore, reflected cats receiving more invasive treatments that were also perceived as more stressful.

A second new variable, free-roaming, was created from four subquestions in question 12 ("How regularly does your cat typically have access to the following areas?"), covering access to a balcony without a protective net, a fenced garden, an unfenced garden, and other outdoor areas. If participants reported at least one type of access occurring at least once per week, they were coded as 1 = having outdoor access. All other cats were coded as 0 = no outdoor access. Thus, the variable is binary (range 0–1), representing the presence or absence of regular free-roaming opportunities. Finally, body condition was recoded into a binary variable (0 = ideal, former score 3; 1 = not ideal, other scores than 3).

To analyse predictors of cats' QoL, we developed two multiple linear regression models using the QoL_scale and QoL_extensive measures. The first model predicted the caretaker-assessed global QoL score (QoL_scale, 0–100 rating) from a broad set of 20 predictors. These included demographic and health variables (cat age, presence of a chronic health condition, body condition score); environmental and caregiving factors (outdoor access, level of medical intervention, access to adequate activity, resting and elimination areas, dietary variety and sensory enrichment, comfort and security, possibility to express natural behaviours and controllability in relation to outdoor access, promoting of play and various occupational activities, and human–animal interactions—both relaxing and stimulating); as well as the six PCA-derived components (Vitality, Attentiveness, appetite and enjoyment, Negative emotions, Healthy appearance, Affection towards familiar humans, Aggression towards familiar humans). Additionally, to assess the unique contribution of demographic, health, environmental, and human–animal interaction factors without the direct influence of the PCA-derived components, we ran a separate regression model excluding the six QoL_extensive subscales (see Supplementary Material, Table S1). However, for interpretation, we retained the complete model, as these subscales represent key behavioural and emotional dimensions that are central to caretakers' actual assessments of QoL.

The second model used the composite QoL_extensive score as the dependent variable. Predictors included the same set of demographic, health, and environmental variables, but, of course, not the six PCA components themselves, as these formed the outcome measure. Predictors with high multicollinearity or substantial missing data were removed, leaving 14 variables in the final model.

All analyses checked regression assumptions such as normality, homoscedasticity, linearity, and multicollinearity. Listwise deletion was applied in all models, with predictors entered simultaneously via the

enter method. To maintain relevance for individually housed cats, cat–cat relationship parameters were excluded from the regression models, but their correlations with QoL measures were tested separately using Spearmancorrelations. Finally, correlations between QoL_scale, the six PCA components, and the overall QoL_extensive score were also analysed, using pairwise deletion for missing data. This approach was also applied to factors not included or not considered significant in the regression models to identify potential univariate associations with QoL_scale that stronger predictors in the multivariate analyses might have masked.

Regarding significance levels, we refer to $p \leq 0.05$ as statistically significant and $p > 0.05 \leq 0.10$ as a trend.

3. Results

3.1. Respondent and household characteristics

A total of 446 German-speaking people responded to the call to participate in this survey. Because some items were optional or conditionally displayed, the number of valid responses (n) varies across variables; therefore, we report the specific number for each analysis (i.e., n_{total}). Most participants (53.6%) came from Germany, 44.6% from Austria and 1.8% from other European countries. Most participants were female (90.4%, male: 9%, diverse 0.6%), and the mean age was 43 ± 13 years ($n_{total} = 331$). A high proportion of participants had a university degree (42.8%) or a working-class background (29.5%, $n_{total} = 332$). 10.2% of the participants worked professionally with cats ($n_{total} = 336$).

Most participants grew up with cats (58.1%, $n_{total} = 427$) and had kept cats for an average of 19 ± 12 years ($n_{total} = 401$), with durations ranging from one month to 60 years. On average, they had lived with their focus cat for 6 ± 5 years ($n_{total} = 401$). Among the 426 respondents who reported household size, 33.8% lived with two cats and 41.1% with three cats. Looking at the 349 respondents who answered the question on multi-cat ownership, 65.9% reported living with more than one cat, while 34.1% kept only one. In addition to cats, 29.5% of these respondents also kept other animals.

3.2. Focus on cat characteristics and health

Before adoption or acquisition, 39.7% (n = 150) of cats were kept exclusively indoors, 20.6% (n = 78) had both indoor and outdoor access, and 20.4% (n = 77) were kept exclusively outdoors. Meanwhile, 19.3% (n = 73) of caretakers were unsure of their cat's previous living situation. In the week before the survey, 38.8% (n = 147) of cats were kept entirely indoors, 30.6% (n = 116) mainly indoors, and 28.5% (n = 108) had regular access to both indoor and outdoor environments. Only a small number of cats were mainly outdoors (1.3%, n = 5) or always outdoors (0.8%, n = 3). These data were used to develop a new variable named "free-roaming," which indicates whether the cat had regular outdoor access.

The mean age of the cats was 7 ± 4 years ($n_{total} = 380$), and their sex was evenly split: females intact (2.1%) and spayed (49.1%), and males intact (2.3%) and neutered (46.5%) ($n_{total} = 385$).

Most cats were European Shorthairs (58.1%), followed by mixed breeds (13.4%) and other breeds (8.1%) ($n_{total} = 372$). Purebred cats were generally less common, with British Shorthairs at 7.0% and Maine Coons at 4.0% being the most frequently reported pedigree breeds. All other breeds individually made up less than 2% of the sample. 25.4% of cats had a medical condition ($n_{total} = 343$), and 13.7% were receiving medication ($n_{total} = 344$). Most participants rated their cats' overall health as very good (43.1%) or excellent (32.7%) ($n_{total} = 343$).

Finally, most participants picked the picture showing an ideal body condition of their cats (61.2%) ($n_{total} = 343$). Respondents selected images of underweight, thin, ideal, overweight, and obese cats at rates of 1.7%, 8.5%, 61.2%, 27.1%, and 1.5%, respectively.

3.3. Functional areas of the housing environment

A principal component analysis (PCA) was conducted on 12 items to assess the cats' physical environment and separation in functional areas for activity, resting, hiding, feeding, drinking, and elimination (see Table 1). Three items were excluded from the final solution due to low or cross-loadings, resulting in a three-component structure based on nine retained items. The components were interpreted as Activity areas, Resting places, and Elimination areas, and together they accounted for 53.02% of the total variance. The data were suitable for PCA as indicated by a Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy of 0.658 and a significant Bartlett's test of sphericity ($\chi^2 = 314.115$, df = 36, $p < 0.001$).

3.4. Access to enrichment, predictability, controllability and security

A PCA was conducted on 20 items addressing broader aspects of cats' behavioural, environmental, and caretaking needs. Three items were excluded due to low or cross-loadings, yielding a four-component solution based on 17 items (see Table 2). The components were interpreted as the expression of natural behaviours and controllability in relation to outdoor access, Comfort and security, Dietary variety and sensory enrichment, and promoting play and various occupational activities. These four components accounted for 51.5% of the total variance. The data met the assumptions for PCA (KMO = 0.641; Bartlett's test: $\chi^2 = 548.043$, df = 78, $p < 0.001$).

3.5. Human-animal interactions

A separate PCA on 7 items related to human-cat interactions identified two components: Relaxing activities and Stimulating activities (Table 3). The two components explained 55.46% of the total variance.

Table 1
PCA of the frequency of providing various environmental features relevant to cat welfare. Based on n = 327 responses. Varimax and Kaiser normalisation were applied as the rotation method. The values indicate the items with the highest loadings for each component; loadings below 0.3 are not depicted. Items included in the final component are bold.

Questionnaire item (1 = never, 6 = always)	Components and loadings		
	Adequacy of activity areas	**Adequacy of resting places**	**Adequacy of elimination areas**
Access to several scratching areas	**0.754**		
Feeding areas are located far away from the litter box area	**0.695**		
Access to multiple water sources, positioned away from the feeding area	**0.551**		-0.335
Access to various toys and activities in different locations	**0.54**		
At least one safe retreat or elevated area		**0.835**	
At least one soft resting place		**0.819**	
Bedding is changed, and litter boxes are thoroughly washed at least once a week			**0.737**
Sleeping areas, litter boxes, and feeding stations are in quiet areas			**0.557**
Access to at least one litter box per cat			**0.538**
% variance explained	20.27%	17.25%	15.50%
Cronbach Alpha	0.752	0.510	0.284

Table 2
PCA of the needs. Based on n = 324 responses. Varimax and Kaiser normalisation were applied as the rotation method. The values indicate the items with the highest loadings for each component; loadings below 0.3 are not depicted. Items included in the final component are bold.

Questionnaire item (1 = never, 6 = always)	Components and loadings			
	Expression of natural behaviours and controllability in relation to outdoor access	Comfort and security	Dietary variety and sensory enrichment	Promoting play and various occupational activities
Access to fresh grass	0.800			
Opportunity to chase rodents, birds, reptiles, squirrels, rabbits or other small animals	0.787		-0.344	
Able to decide to leave the main living area independently, for example, through a cat flap	0.529			
Climbing opportunities, such as a scratching tree or shelves		0.794		
Possibility to scratch on a scratching post and/or on other scratching options such as cardboard pads		0.648		
I make arrangements for someone to care for this cat when I am away for more than 24 h		0.572		
This cat has its own resting area in a convenient location that provides some privacy		0.550		
Regular access to malt products			0.731	
Food to be hidden in different places and interactive toys for daily enrichment			0.575	
Use of Feliway or other synthetic facial pheromones			0.509	
I alternate the diet of this cat			0.500	
Access to a variety of toys and activities that change daily				0.793
Toys that mimic prey, such as toy mice or birds				0.775
% variance explained	13.7%	13.5%	12.5%	11.8%
Cronbach Alpha	0.563	0.420	0.461	0.578

Table 3
PCA of the human-animal interactions. Based on n = 338 responses. Varimax and Kaiser normalisation were applied as the rotation method. The values indicate the items with the highest loadings for each component, and loadings below 0.3 are not depicted. Items included in the final component are bold.

Questionnaire item (1 = never, 6 = always)	Components and loadings	
	Relaxing human-animal interactions	**Stimulating human-animal interactions**
I pet and/or cuddle my cat daily	**0.837**	
I have my cat with me while relaxing, i.e., watching TV	**0.765**	
Spending conscious time doing activities the cat likes (e.g., playing, cuddling, brushing, stroking, etc.)	**0.725**	0.337
I talk to my cat daily	**0.63**	
Clicker training with the cat		**0.778**
I brush or comb my cat's fur regularly		**0.63**
Playtime with the cat	0.327	**0.62**
% variance explained	33.7%	21.7%
Cronbach Alpha	0.732	0.469

The analysis was appropriate, supported by a KMO value of 0.770 and a significant Bartlett's test ($\chi^2 = 470.084$, df = 21, $p < 0.001$).

3.6. Behaviour towards other cats

A PCA on 12 items related to the behaviour towards other cats in the household identified three components: Affiliative behaviour, Aggressive interactions with body contact, and Mild agonistic interaction (Table 4). The three components explained 61.28% of the total variance. The analysis was supported by a KMO value of 0.823 and a significant Bartlett's test ($\chi^2 = 922{,}416$, df = 66, $p < 0.001$).

3.7. Caretaker perceptions of cat QoL (QoL_scale)

Cat caretakers, on average, rated their cats' QoL as 89 ± 13 on a scale of 0–100 (n = 348). Scores ranged from a minimum of 18 to a maximum of 100.

3.8. QoL_extensive

A principal component analysis (PCA) on overall QoL (originally based on 54 items, N = 317) identified six factors: Vitality, Attentiveness, appetite and enjoyment, Negative emotions, Healthy appearance, Affection towards familiar humans, and Aggression towards familiar humans. The six components accounted for 53.2% of the total variance. The data were deemed suitable for analysis (KMO = 0.881, Bartlett's test: $X^2 = 6746.034$, df = 903, $p < 0.001$). Eleven questions were

Table 4
PCA of the behaviour towards another cat. Based on n = 222 responses. Varimax and Kaiser normalisation were applied as the rotation method. The values indicate the items with the highest loadings for each component, and loadings below 0.3 are not depicted. Items included in the final component are bold.

Questionnaire item (1 = never, 6 = always)	Components and loadings		
	Affiliative behaviour	Aggressive interactions	Mild agonistic interactions
My cat and my other cat(s) showed mutual skin care/grooming	**0.891**		
Rested and/or slept in body contact or proximity	**0.838**		
Showed facial rubbing or body rubbing	**0.832**		
Played together	**0.819**		
The relationship of my cat, which I selected for the questionnaire, with the other cat(s) is good	**0.644**		-0.413
Pounced at the other cat		**0.759**	
Bit the other cat(s)		**0.750**	
Swatted my other cat(s)		**0.731**	
Mounted the other cat(s)		**0.675**	
My cat showed raised hair along the back or tail in response to my other cat (s)			**0.753**
Turned or folded ears, or stared at the other cat(s)			**0.714**
My cat is being driven away from important resources/places by other cat(s), e.g., sleeping place, litter tray, feeding place, and playing area			**0.593**
% variance explained	28.22	18.19	14.87
Cronbach Alpha	0.878	0.684	0.554

initially excluded due to loadings below 0.3 or double loadings with a difference of less than 0.2. The remaining 43 items were reanalysed, confirming the same six-factor structure without further item removal.

Component 1 comprised 12 items and explained 24.9% of the total variance. The factor loadings of these items ranged between 0.50 and 0.76. Items that loaded positively on this component included "Full of energy" (0.73), "Lively" (0.69), "Playful" (0.67), "My cat was positively occupied, e.g., because of play, hunting etc." (0.66), "Looked athletic or fit" (0.63), and "Body felt muscular" (0.53). Items with negative loadings were "Movements were slow" (–0.76), "Difficulty getting up when lying down" (–0.73), "Movements were stiff" (–0.72), "My cat was sluggish" (–0.72), "No energy to play" (–0.71), and "Slept more than usual" (–0.50). As these items collectively described behaviours and physical states reflecting overall energy and liveliness, the component was named "Vitality." Internal consistency was high, with a Cronbach's alpha of 0.918. **Component 2** comprised 9 items and explained 8.6% of the total variance. All items loaded positively on the component and included "Observed everything going on around" (0.71), "Seemed to enjoy exploring the surroundings" (0.69), "Curious about the surroundings" (0.68), "Seemed to enjoy the daily activities, such as observing the surroundings" (0.61), "Vigilant" (0.58), "Seemed satisfied after eating" (0.54), "My cat appeared alert" (0.50), "Had eye contact with me" (0.50), and "Seemed to have enjoyed the food" (0.48). These items described attentive, curious, and responsive behaviours, and were therefore interpreted as reflecting the cat's engagement with its environment and daily routine. The component was named "Attentiveness, appetite and enjoyment", with a Cronbach's alpha of 0.823. **Component 3** comprised 7 items and explained 5.6% of the total variance. Positively loading items were "Anxious" (0.88), "Seemed to be anxious in response to, e.g. noises, visits from non-household members" (0.77), "Hesitant" (0.68), "Nervous" (0.67), "Depressed" (0.52), "Showed signs of distress (e.g. yowling, hiding, etc.)" (0.51), and "Bored" (0.50). All items reflected internal emotional states associated with anxiety, fear, or low mood. Consequently, this component was labelled "Negative emotions". The internal consistency was acceptable, with a Cronbach's alpha of 0.789. **Component 4** comprised 6 items and explained 5.2% of the total variance. Positively loading items included "My cat's coat or fur looked shiny" (0.83), "My cat's fur or coat felt soft" (0.65), "Groomed as much as ever" (0.62), and "Eyes were clear" (0.49). Items loading negatively were "My cat's coat or fur looked dull" (–0.78) and "My cat's coat or fur was matted or felted" (–0.53). These items collectively described physical indicators of health and grooming status, and the component was therefore named "Healthy appearance". The internal consistency was acceptable, with a Cronbach's alpha of 0.794. **Component 5** comprised 4 items and explained 4.5% of the total variance. All items loaded positively: "Seemed to enjoy interactions with household members" (0.79), "Affectionate toward household members" (0.75), "Initiated interactions with household members" (0.74), and "Greeted household members when we have not seen each other for a while" (0.72). These items described affectionate and social behaviours directed toward familiar humans, and the component was accordingly labelled "Affection towards familiar humans". The reliability was good, with a Cronbach's alpha of 0.752. **Component 6** comprised 5 items and explained 4.4% of the total variance. Positively loading items included "Hissed at household members" (0.73), "My cat was irritable" (0.68), "Attacked household members, e.g. cat bit someone" (0.54), and "Growled at household members" (0.52). The item "Friendly" (–0.67) loaded negatively. These behaviours reflected irritability and hostility toward familiar individuals, and the component was named "Aggression towards familiar humans". Internal consistency was acceptable, with a Cronbach's alpha of 0.703. For the component matrix with factor loadings on all six items, see the supplementary material (Table S2).

When mean scores across the items included in each component were calculated, the lowest ratings were found for "Aggression towards familiar humans" and "Negative emotions" (see Table 5).

3.9. Predictors of QoL

3.9.1. QoL_scale

A multiple linear regression analysis was conducted to assess the predictors of the self-assessed QoL score (QoL_scale). The independent variables included demographic, health, environmental factors, age, presence of disease, body condition, the invasiveness of medical procedures, access to free-roaming areas, and access to adequate activity and resting areas. Measures related to human-animal interaction, including enrichment and activity adequacy, were also included. Furthermore, the model incorporated the six dimensions of the extensive

Table 5
Descriptive statistics for the six QoL components identified through principal component analysis (PCA) are presented below. Component scores were calculated as the mean of participants' ratings across all items within each component. For items with negative loadings, scores were inverted before averaging to ensure consistent interpretation. All items were rated on the same 6-point frequency scale: 1 = Never, 2 = Rarely, 3 = Sometimes, 4 = Often, 5 = Most of the time, 6 = Always.

QoL_extensive components	N	Min	Max	Mean	Median	SD
Vitality	366	1.50	6.00	4.88	5.08	0.87
Attentiveness, appetite and enjoyment	366	2.67	6.00	5.04	5.11	0.67
Negative emotions	354	1.00	5.57	1.80	1.71	0.64
Healthy appearance	364	2.17	6.00	5.67	5.83	0.54
Affection towards familiar humans	348	1.00	6.00	4.84	5.00	0.93
Aggression towards humans	354	1.00	4.00	1.31	1.20	0.39

QoL assessment (QoL_extensive), namely: Vitality, Attentiveness, appetite and enjoyment, Healthy appearance, Affection towards familiar humans, Aggression towards familiar humans, and Negative emotions. For an overview, see Table 6. The multiple linear regression model was statistically significant ($F(20, 302) = 7.11$, $p < .001$), indicating that the set of predictors explained significantly more variance in QoL scores than an intercept-only (null) model. The predictors accounted for approximately 27.5% of the variance in QoL scores (adjusted $R2 = 0.275$). Multicollinearity diagnostics revealed no significant concerns, as all tolerance values were above 0.1, and all VIF values were below 3. Our analysis revealed several significant predictors of the QoL for cats. The presence of illness was a significant negative predictor ($\beta = -0.19$, $p = 0.002$). Expression of natural behaviours and controllability in relation to outdoor access ($\beta = 0.20$, $p < 0.001$) was a significant positive predictor. Attentiveness, appetite and enjoyment ($\beta = 0.25$, $p < 0.001$) also contributed positively to QoL. Conversely, Negative emotions ($\beta = -0.21$, $p < 0.001$) were a significant negative predictor. For Access to adequate activity areas, a trend was found ($\beta = 0.11$, $p = 0.063$). Thus, caretakers reported a lower QoL for their cats when the animals were affected by a disease, exhibited more negative emotions, or experienced less frequent possibility for the expression of natural behaviours and controllability in relation to outdoor access, and exhibited fewer signs of Attentiveness, appetite and enjoyment. Moreover, they tended to report lower QoL_scale in case of less frequent access to adequate activity areas.

3.9.2. Predictors of QoL_extensive

The QoL_extensive identified slightly different predictors while using the same set of independent variables as the previous model, excluding the factors derived from the PCA that contributed to the QoL_extensive measure (Table 7). The overall model, which included 14 predictors, explained significantly more variance than a null model containing only the intercept ($F (14, 310) = 11.18$, $p < 0.001$) and explained approximately 30% of the variance in QoL scores (adjusted $R2 = 0.305$). Collinearity diagnostics confirmed that multicollinearity was not an issue, as all tolerance values exceeded 0.1, and all variance inflation factor (VIF) values were below 2, indicating low correlations among the predictors. Here, our analysis identified several significant predictors of the QoL for cats. Age was the strongest negative predictor of QoL_extensive, showing an inverse relationship: older cats received significantly lower QoL ratings ($\beta = -0.29$, $p < 0.001$). In contrast, ideal body condition was associated with higher QoL_scale ratings ($\beta = 0.16$, $p = 0.001$). Relaxing human-animal interactions, such as petting or calmly spending time with the cat, significantly contributed to higher QoL assessments ($\beta = 0.17$, $p = 0.001$). Similarly, higher frequencies of adequate access to activity areas were positively associated with QoL ($\beta = 0.12$, $p = 0.032$). Additionally, providing opportunities for play and diverse occupational activities was a significant positive predictor ($\beta = 0.16$, $p = 0.005$). Thus, older age, sub-optimal body condition scores, fewer relaxing human-cat interactions (e.g. petting or talking to the cat), less promotion of play and other occupational activities and reduced access to structured activity areas were all associated with lower QoL_extensive in cats.

3.10. Associations between cat-cat relationship factors and QoL

Affiliative behaviour was significantly and positively associated with the composite QoL_extensive based on the six factors ($\rho = 0.287$, $p < 0.001$, $n = 228$), but showed no significant correlation with the caretaker-assessed QoL_scale ($\rho = 0.066$, $p = 0.324$, $n = 227$). In contrast, mild agonistic (including piloerection, ear turning or staring, and being driven away from important places) behaviour was significantly negatively correlated with affiliative behaviour ($\rho = –0.349$, $p < 0.001$, $n = 228$) and positively associated with aggressive interactions ($\rho = 0.291$, $p < 0.001$, $n = 228$), but showed no significant relationship with either the composite score QoL_extensive ($\rho = –0.004$, $p = 0.956$, $n = 228$) or the caretaker-assessed QoL_scale ($\rho = –0.097$, $p = 0.145$, $n = 227$). Aggressive interactions were weakly but significantly negatively associated with the caretaker-assessed QoL_scale ($\rho = –0.152$, $p = 0.022$, $n = 227$), while showing no significant association with the composite score QoL_extensive ($\rho = 0.100$, $p = 0.131$, $n = 228$).

3.11. Associations between QoL_scale and QoL_extensive

The QoL_scale and the QoL_extensive composite scores were weakly and significantly correlated ($\rho = 0.295$, $p < 0.001$, $n = 348$). Among the six subscales of the QoL_extensive, the highest positive correlations with the QoL_scale were found for Vitality ($\rho = 0.391$, $p < 0.001$, $n = 348$), Attentiveness, appetite and enjoyment ($\rho = 0.389$, $p < 0.001$, $n = 348$), and Healthy appearance ($\rho = 0.229$, $p < 0.001$, $n = 348$). Weaker but still significant correlations appeared for Affection towards familiar humans ($\rho = 0.186$, $p < 0.001$, $n = 346$) and Aggressive towards familiar humans ($\rho = –0.228$, $p < 0.001$, $n = 348$), while Negative

Table 6
Linear regression model for the reported frequency of QoL_scale. n = 324. Significant predictors are bold, trends in italics. Y/N indicates binary predictors, coded as yes/no.

Predictors	B	Std. error	β	t	Sig.	Lower Bound (CI 95%)	Upper Bound (CI 95%)
(*Constant*)	55.69	15.289		3.643	0.000	25.604	85.776
Cat age (years)	0.21	0.166	0.082	1.286	0.200	-0.113	0.54
Chronic health condition (Y/N)	-5.44	1.709	-0.188	-3.180	**0.002**	-8.8	-2.072
Outdoor access (Y/N)	-1.04	1.748	-0.032	-0.597	0.551	-4.484	2.395
Ideal Body condition score (Y/N)	-0.76	1.309	-0.029	-0.578	0.564	-3.333	1.819
Level of medical intervention	0.18	0.491	0.021	0.369	0.712	-0.784	1.147
Relaxing human-animal interactions	-0.88	1.083	-0.046	-0.816	0.415	-3.015	1.248
Stimulating human-animal interactions	0.70	0.837	0.050	0.838	0.403	-0.946	2.349
Access to adequate activity areas	1.67	0.894	0.107	1.869	*0.063*	-0.089	3.429
Access to adequate resting areas	-0.08	2.034	-0.002	-0.039	0.969	-4.081	3.923
Access to adequate elimination areas	-0.61	0.784	-0.040	-0.774	0.440	-2.15	0.936
Expression of natural behaviours and controllability	1.62	0.452	0.195	3.588	**0.001**	0.732	2.509
Comfort and security	-0.88	1.139	-0.040	-0.771	0.441	-3.119	1.363
Dietary variety and sensory enrichment	-1.02	0.757	-0.074	-1.350	0.178	-2.513	0.468
Promoting play and various occupational activities	0.08	0.558	0.008	0.143	0.886	-1.018	1.178
Vitality	1.66	1.184	0.112	1.400	0.163	-0.673	3.988
Attentiveness, appetite and enjoyment	4.81	1.268	0.250	3.791	**0.001**	2.312	7.303
Negative emotions	-4.31	1.058	-0.212	-4.068	**0.001**	-6.387	-2.223
Healthy appearance	1.22	1.369	0.052	0.893	0.373	-1.471	3.916
Affection towards familiar humans	0.54	0.716	0.040	0.758	0.449	-0.866	1.95
Aggression towards familiar humans	-1.21	1.806	-0.035	-0.669	0.504	-4.761	2.346

Table 7
Linear regression model for the reported frequency of QoL_extensive. n = 325. Significant predictors are bold. Y/N indicates binary predictors, coded as yes/no.

Predictors	B	Std. Error	Beta	t	Sig.	Lower Bound (CI 95%)	Upper Bound (CI 95%)
(*Constant*)	3.21	0.336		9.562	0.000	2.552	3.874
Cat age (years)	-0.02	0.004	-0.292	-5.351	**0.001**	-0.027	-0.013
Chronic health condition (Y/N)	-0.05	0.043	-0.068	-1.207	0.228	-0.137	0.033
Outdoor access (Y/N)	0.001	0.044	0.001	0.021	0.983	-0.086	0.088
Ideal Body condition score (Y/N)	0.11	0.032	0.162	3.419	**0.001**	0.047	0.174
Level of medical intervention	-0.01	0.012	-0.029	-0.542	0.588	-0.031	0.018
Relaxing human-animal interactions	0.09	0.027	0.168	3.225	**0.001**	0.033	0.138
Stimulating human-animal interactions	0.02	0.021	0.064	1.116	0.265	-0.018	0.065
Access to adequate activity areas	0.05	0.023	0.119	2.159	**0.032**	0.004	0.093
Access to adequate resting areas	-0.02	0.051	-0.020	-0.411	0.681	-0.122	0.08
Access to adequate elimination areas	-0.02	0.02	-0.051	-1.029	0.304	-0.06	0.019
Expression of natural behaviours and controllability	-0.004	0.011	-0.016	-0.313	0.755	-0.026	0.019
Comfort and security	0.001	0.029	0.003	0.051	0.959	-0.055	0.058
Dietary variety and sensory enrichment	0.02	0.019	0.046	0.854	0.394	-0.021	0.054
Promoting play and various occupational activities	0.04	0.014	0.156	2.828	**0.005**	0.012	0.067

emotions showed a moderate negative correlation ($\rho = -0.342$, $p < 0.001$, $n = 348$).

4. Discussion

4.1. Comparing subjective and systematic assessments

Our results indicate that QoL_scale and QoL_extensive measure related but separate aspects of feline welfare, reflecting different focuses in caretaker-based versus structured evaluations. The two QoL measures capture related aspects of welfare, but they reflect different emphases: QoL_scale reflects the cues that caretakers seem to prioritise when judging their cat's QoL, whereas QoL_extensive incorporates a broader range of behavioural and environmental indicators assessed systematically. This difference indicates that caretakers mainly depend on visible health and emotional signals when assessing QoL, while structured assessments include welfare aspects that may not be as obvious in daily judgments, like environmental conditions and relationships. Instead of viewing this as a flaw in caretaker ratings, we argue that it emphasises the importance of combining subjective and systematic methods to achieve a more complete evaluation of feline welfare.

4.2. Determinants of caretaker-reported QoL (QoL_scale)

The regression model showed that QoL_scale ratings were significantly lower when cats were reported to suffer from a chronic health condition and when they displayed more frequent *Negative emotions* (e.g., anxious, nervous, bored). This is in line with previous research showing that physical illness and pain are among the strongest determinants of reduced QoL in companion animals, and that negative affective states are closely linked to impaired welfare and poorer QoL assessments (e.g., Mullan, 2015; Wemelsfelder, 2007). In contrast, higher *Attentiveness, appetite and* enjoyment (e.g., observed everything going on around, seemed to enjoy exploring the surroundings, seemed to have enjoyed the food) were associated with higher ratings. This finding is consistent with studies indicating that behavioural engagement, positive affect, and maintained interest in the environment are key indicators of good welfare and positive quality of life in cats and other companion animals (Freeman et al., 2016). Body condition score was not a significant predictor of QoL_scale. This lack of association likely reflects a form of "assessment blindness," whereby caretakers fail to recognise or acknowledge the welfare implications of their cat's weight status. Obesity in cats is well-documented to reduce activity levels (de Godoy and Shoveller, 2017) and shorten lifespan (Kealy et al., 2002), yet caretakers often underestimate these risks or normalise excess weight (Endenburg et al., 2018; Sloth, 1992). Caretakers may also derive psychological rewards from indulgent feeding practices or interpret weight gain as an expression of care, which can mask negative welfare consequences (Rohlf et al., 2010). As such, while body condition is a crucial welfare factor, our results highlight a disconnect between systematic health risks and subjective QoL assessments made by caretakers.

Taken together, these findings suggest that caretakers are highly sensitive to visible health problems apart from body condition score, as well as overt behavioural and emotional changes (e.g. expression of negative emotions, enjoyment). Expression of natural behaviours and controllability in relation to outdoor access (e.g., access to fresh grass, opportunities to chase prey, ability to decide to leave the main living area independently, for example, through a cat flap) also emerged as a significant positive predictor, highlighting the importance of behavioural fulfilment and controllability in perceived welfare. Perceptions of outdoor access for cats are shaped by cultural and demographic factors, leading to differences across countries and regions. In many European areas, outdoor access is seen to promote natural behaviours and improve welfare. In contrast, other regions prioritise risk prevention, wildlife conservation, or indoor housing. For instance, research from Australia shows a stronger preference for indoor containment, reflecting different cultural norms and conservation goals (Farnworth et al., 2011; Toukhsati et al., 2007). These regional variations are influenced more by cultural norms, urbanisation levels, and regulations than by universal welfare principles. (e.g., Foreman-Worsley et al., 2021; Windschnurer et al., 2022).

By contrast, dietary variety and sensory enrichment, promotion of play and various occupational activities (e.g., toys and food puzzles), and relaxing and stimulating human–animal interactions did not significantly predict caretaker-assessed QoL. This suggests that caretakers may prioritise observable behaviours and emotional states, such as visible signs of activity, attentiveness, appetite, and expressions of distress, over interactive enrichment when judging their cats' welfare. Access to adequate activity areas (e.g., scratching posts and climbing opportunities) showed only a trend towards significance, indicating a possible but weaker contribution. Outdoor access itself was not significant, despite its emphasis in the literature (Bradshaw, 2018; Linklater et al., 2019), which could indicate that enriching indoor environments providing opportunities for natural behaviour (e.g., offering fresh grass) may be just as crucial for caretaker perceptions of welfare as outdoor access. On the other hand, the binary variable "outdoor access yes/no" may have been too simplistic, as it does not capture the quality and quantity of outdoor experiences, which can vary widely. In follow-up studies, a more detailed outdoor access variable that also reflects the quantity and quality should be used, since the significant positive relationship between QoL and the opportunity to express natural behaviours and controllability in relation to outdoor access (e.g., access to fresh grass, opportunities to chase prey, or the ability to leave the main living area independently, for example through a cat flap) indicates that outdoor access could have an impact.

Overall, our predictors align with previous work emphasising health

and environmental enrichment as central to feline QoL (Bijsmans et al., 2016; Foreman-Worsley and Farnworth, 2019; Freeman et al., 2016), with enrichment captured in our analysis through items such as "access to various toys and activities in different locations" and "access to adequate activity areas". By contrast, our finding that body condition was not a significant predictor diverges from epidemiological work linking obesity with reduced activity and lifespan (Lund et al., 2005; Sloth, 1992), suggesting that caretakers may under-appreciate the welfare implications of weight status. However, unlike earlier instruments, our results also highlight the importance of including human–animal interactions, even though they did not significantly predict QoL_scale in this model. Their value emerged more clearly in the QoL_extensive measure (see below).

4.3. Determinants of the composite assessment (QoL_extensive)

The regression model for QoL_extensive identified cat age as a strong negative predictor, with older cats scoring lower on QoL, consistent with previous findings linking ageing to reduced vitality and welfare (Bijsmans et al., 2016; Freeman et al., 2016). By contrast, the presence of a chronic health condition and the level of medical intervention were not significant, suggesting that manageable illnesses do not necessarily diminish overall QoL. However, body condition emerged as a significant predictor, with an ideal body condition score associated with higher QoL. This aligns with evidence that owners' welfare assessments are strongly influenced by visible signs of health, such as weight, appetite, and mobility, rather than by the mere presence of disease (Baptista da Silva et al., 2022; Hanford and Linder, 2021). It therefore seems that when illness does not adversely affect body condition, overall welfare may stay acceptable to good.

Beyond these health-related effects, several environmental and social factors also contributed positively to QoL. Cats with greater access to activity areas and more opportunities for play and occupational activities achieved higher scores, underscoring the importance of environmental stimulation. In terms of social variables, relaxing human–animal interactions (e.g., enjoying contact with household members, showing affection, initiating interactions) were positively associated with QoL, whereas stimulating forms of interaction were not significant. This pattern suggests that calm, affiliative contact may be more strongly linked to overall well-being than more energetic or structured engagement.

Overall, while ageing remains a key challenge, daily management practices and the quality of the environment and social interactions appear to be stronger drivers of QoL than health status alone.

4.4. Comparison with existing QoL instruments

Freeman et al.'s CHEW questionnaire (Freeman et al., 2016) was designed to capture cats' physical, emotional, and social functioning but includes only limited aspects of their interactions with humans. Our findings align with CHEW regarding the effects of age and health status, as older cats and those with chronic conditions exhibited lower scores in our QoL models. However, whereas CHEW treats social functioning in relatively broad terms, our questionnaire explicitly distinguishes between affectionate and aggressive reactions towards familiar humans. In our analyses, only relaxing, affiliative interactions significantly predicted QoL_extensive, indicating that not all social contact is equivalent in its welfare impact. Moreover, while CHEW is validated for general health differentiation, it does not systematically incorporate environmental or enrichment dimensions such as access to activity areas or controllability, which emerged as key predictors in our dataset. Taken together, these differences indicate that our tool complements and extends CHEW's framework by emphasising relational and environmental determinants of feline QoL.

In contrast to CHEW (Freeman et al., 2016) and similar tools (Giuffrida et al., 2018; Noble et al., 2019; Tatlock et al., 2017), our overall questionnaire (both QoL items and potential predictors) captures the nuances of human–animal interactions by incorporating both relaxing and stimulating forms of contact. Human-animal interactions emerged as a significant predictor of QoL_extensive, suggesting that caregiver–cat relationships are integral to welfare. Hence, by bridging physical, behavioural, environmental, and relational domains, our tool provides a more holistic and comprehensive framework for assessing and improving feline QoL. In practice, analysing the relative scores of each domain allows for the identification of specific aspects of a cat's daily life, such as the quality of human–animal interaction, access to activity areas, or opportunities for play and exploration, where targeted welfare improvements might be most effective.

4.5. Divergent perspectives

The weak correlation between the two measures indicates limited agreement between QoL_scale and QoL_extensive, meaning that caretaker ratings capture only part of the variation identified by the structured assessment. Caretakers tend to rely primarily on visible health and behavioural cues, such as illness, negative emotions, or attentiveness and appetite, whereas QoL_extensive integrates a broader range of environmental and relational factors. Divergence may also reflect different caretaker priorities: for example, some may value outdoor access as a sign of welfare, while others restrict it for safety reasons, instead prioritising health and longevity. These contrasts illustrate that feline QoL is multifaceted and shaped both by cats' living conditions and by caretaker perceptions of what matters most.

4.6. Correlational patterns between subjective QoL_Scale ratings and QoL_extensive subscales

To further explore the role of human–animal relationship variables, we carried out additional univariate correlational analyses. This enabled us to identify potential associations that might not have appeared in the multivariate regression model due to shared variance with other predictors. Correlational analyses between QoL_scale and the six PCA-derived components of QoL_extensive revealed clear patterns. Vitality (e.g., full of energy, lively, playful) showed the strongest positive association with caretaker ratings, followed closely by Attentiveness, appetite and enjoyment (e.g., observed everything going on around, curious about the surroundings, seemed to have enjoyed the food). These associations highlight that caretakers are exceptionally responsive to visible signs of energy and engagement. Moreover, Attentiveness, appetite and enjoyment may serve as sensitive indicators of underlying health status, as they can be influenced by a range of physical and psychological conditions (Doit et al., 2021). Negative emotions (e.g., anxious, depressed, bored) were the strongest negative correlate, underscoring that signs of persistent emotional distress markedly reduce perceived QoL. Healthy appearance (e.g., coat looked shiny, fur felt soft, eyes were clear) was also positively related, although to a lesser degree, suggesting caretakers notice physical features but rely more on behavioural signals. Affection towards familiar humans (e.g., initiated interactions with household members, greeted household members) showed a smaller but still positive association with QoL_scale in the correlation analysis, pointing to the role of social bonds in shaping welfare perceptions. Finally, Aggression towards familiar humans (e.g., hissed at household members, attacked household members, growled at household members) was negatively associated with QoL_scale, though less strongly than Negative emotions, indicating that ongoing emotional distress may be perceived as more detrimental to well-being than occasional aggressive behaviour. However, in the regression model including other predictors, the human-animal relationship subscales did not emerge as significant predictors for the QoL_scale since other factors seem to influence the subjective assessment to a greater extent.

4.7. The role of social interactions with conspecifics

Social behaviour further illustrates differences between the two QoL measures. Affiliative interactions with other cats (e.g., grooming, resting together, and facial and body rubbing) were significantly related to QoL_extensive but not to QoL_scale, suggesting that the systematic composite score is more sensitive to husbandry and social housing conditions. This may reflect that caretakers notice affiliative behaviour only when it is particularly salient, whereas systematic assessment reflects it more consistently (e.g., Elzerman et al., 2020). By contrast, mild agonistic behaviour (e.g., chasing, hissing) showed no significant association with either QoL measure. However, its correlations with both affiliative and aggressive behaviours indicate that such interactions may reflect normal group dynamics rather than compromised welfare (Bernstein and Strack, 1996). Aggressive interactions were weakly but significantly negatively associated with the caretaker-assessed QoL_scale, while showing no significant association with the composite score QoL_extensive. As discussed in Section 4.2, caretakers may be more attuned to overt behavioural and emotional changes, particularly aggression, than to subtler affiliative behaviours like seeking contact, resting in proximity, or body rubbing. In well-established pairs or groups, affiliative behaviour is far more common than overt aggression, as serious fights rarely occur. In conflict situations, cats typically rely on threat displays or withdrawal rather than physical confrontation (e.g., Natoli and De Vito, 1991; Overall, 1997; Podberscek et al., 1991). This may explain why aggressive interactions correlated only with the caretaker-assessed QoL_scale but not with the more systematic QoL_extensive score.

4.8. Limitations

This study has several considerations worth noting. Both measures relied on caretaker reporting, which provides valuable first-hand perspectives on cats' daily lives but may also reflect individual differences in emotional attachment or interpretation of behaviours. Assessing QoL is inherently complex and shaped by multiple human and animal factors. Caretakers' evaluations are likely influenced by their personality, sociocultural background, education level, and even broader value orientations, which can affect how they perceive and interpret animal welfare. Similarly, individual cat characteristics (e.g., sociability, stress sensitivity, coping style, and activity level) modulate how environmental and social factors affect welfare. Because cats vary widely in these traits (e.g., Crowell-Davis et al., 2004; Ellis et al., 2013; Finka, 2022), husbandry practices or interactions that are beneficial for one individual may not have the same effect in another, and can even be experienced as aversive.

The sample mainly consisted of female respondents, which could have affected the reported QoL evaluations. Gender differences in attitudes toward animals, emotional involvement, and sensitivity to welfare cues are well-documented, with women generally showing more empathy and concern for animal welfare (e.g., Herzog, 2007). This gender imbalance might have influenced the interpretation of behavioural and emotional indicators. Since the study was not designed to investigate gender-based differences, responses were not analysed separately by gender.Additionally, a small percentage of respondents reported working professionally with cats, potentially affecting their evaluation of QoL. Professional experience might enhance sensitivity to subtle health or behavioural signs compared to non-professional caretakers. However, including these respondents was suitable because the study aimed to broadly capture caretaker perceptions, including those with practical experience in feline welfare assessment. This subgroup was not analysed separately due to its small sample size.

The sample, drawn mainly from German and Austrian households, offers cultural specificity yet may not capture the full diversity of cat-keeping practices elsewhere, particularly given that the reported rates of behavioural problems differ significantly depending on the reporting context (such as owner surveys versus clinical samples). These two countries were not analysed separately because cross-country comparisons were beyond the scope of this study.

Finally, while PCA and regression provided a structured approach to analysing patterns in the data, the absence of veterinary assessments or direct behavioural observations means the results are best understood as reflecting caretaker-perceived welfare rather than clinically verified health outcomes.

4.9. Implications and future directions

Taken together, the findings indicate that QoL_scale and QoL_extensive serve complementary functions. QoL_scale reflects caretaker perceptions shaped by health and emotional cues, while QoL_extensive integrates broader environmental, social, and management-related indicators. This distinction is important: while caretaker input is essential for understanding everyday welfare, systematic and structured assessments are necessary to evaluate housing quality and overall management. Future research should test whether QoL_extensive predicts long-term welfare outcomes, including housing quality and health trajectories, more accurately than caretaker ratings. Longitudinal studies, combined with veterinary exams and behavioural observations, would clarify how each type of measure captures QoL over time. Extending this work cross-culturally will also be crucial for developing a robust and universal tool to assess feline QoL. Future research should also explicitly explore how caretaker traits, like gender and professional experience with cats, impact QoL assessments.

5. Conclusions

This study shows that caretakers' perceptions of their cats' QoL capture only part of the picture. Visible health signs and salient behavioural cues, such as attentiveness, appetite, and expressions of negative emotions, primarily shaped overall QoL_scale ratings. In contrast, QoL_extensive identified additional welfare-relevant factors, including age, body condition, environmental enrichment, and the quality of affiliative human–cat interactions. These findings support our hypothesis that caretaker judgements and structured welfare assessments slightly differ in their focus.

The weak correlation between the two measures further indicates that they assess related but distinct constructs. While both approaches capture important aspects of vitality and emotional expression, only QoL_extensive incorporates environmental and relational domains that caretakers may overlook. This distinction is particularly relevant given that many existing feline QoL tools focus primarily on health-related indicators.

A key advantage of our approach is that it allows comparison of relative score profiles across welfare domains, facilitating the identification of specific targets for intervention. This may support veterinarians, behaviourists, and caretakers in addressing not only health concerns but also issues related to enrichment, social compatibility, and environmental management.

Overall, this study provides an evidence-based framework that clarifies how subjective caretaker ratings and structured welfare assessments complement each other. By integrating both perspectives, this multidimensional approach offers a more robust basis for monitoring and improving feline welfare in everyday contexts and monitor QoL across time.

CRediT authorship contribution statement

Ines Windschnurer: Writing – review & editing, Writing – original draft, Supervision, Methodology, Formal analysis, Data curation, Conceptualization. **Zsófia Virányi:** Writing – review & editing, Methodology, Conceptualization. **Akos Pákozdy:** Writing – review & editing, Methodology, Conceptualization. **Raffaela Lesch:** Writing – review &

editing, Supervision, Project administration, Methodology. **Christine Arhant:** Writing – review & editing, Supervision, Project administration, Methodology, Conceptualization. **Katharina Galunder:** Writing – review & editing, Software, Methodology, Conceptualization. **Andrea Sommese:** Writing – review & editing, Writing – original draft, Visualization, Project administration, Formal analysis, Data curation.

Declaration of Generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the authors used Grammarly and ChatGPT-5 for grammar correction. After using this tool/service, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

Approval of the submitted version of the manuscript

Please check this box to confirm that all co-authors have read and approved the version of the manuscript that is submitted. Signatures are not required.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supporting information

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