Validation of a structured questionnaire as an instrument to measure chronic pain in dogs on the basis of effects on health-related quality of life

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Objective—To validate the use of a novel questionnaire as an instrument for measurement of chronic pain in dogs through its impact on health-related quality of life (HRQL).

Animals—108 dogs with chronic degenerative joint disease and 26 healthy dogs.

Procedures—Questionnaire responses were subjected to factor analysis (FA) and questionnaire scores to discriminant analysis to evaluate construct validity. Questionnaire scores were used to explore the potential of this instrument for minimizing respondent bias and for evaluative purposes.

Results—FA results revealed a sensible factor structure accounting for 65% of the variance in data, with factors identifiable as domains of HRQL in dogs affected by chronic pain. Further evidence for construct validity was provided when questionnaire scores were used to discriminate, on the basis of 218 questionnaires, between dogs with clinician-awarded pain scores of 0 and dogs with pain scores ≥ 1 (88% discrimination, with 95% of no-pain group dogs and 87% of some-pain group dogs correctly categorized). Use of the questionnaire provided minimized respondent bias.

Conclusions and Clinical Relevance—Validation of the questionnaire as an instrument for discriminative and evaluative measurements of orthopedic chronic pain through its impact on HRQL in dogs was provided. Use of the questionnaire, with further testing and refinement, may support improved clinical decision making, facilitate development of evidence-based therapeutic options for chronic diseases, and help veterinarians and owners define humane end points in dogs.

Impact for Human Medicine—Information gained here may provide improved measurements of clinical change in animal studies that use dogs with naturally occurring chronic pain to evaluate novel human treatment protocols. (*Am J Vet Res* 2006;67:1826–1836)

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Abbreviations

HRQL	Health-related quality of life
QL	Quality of life
GUVQuest	Glasgow University Veterinary School Questionnaire
FA	Factor analysis
DJD	Degenerative joint disease
LDA	Linear discriminant analysis

For people, HRQL differs from health status in being referred to as a uniquely personal perception,[1] in which respect it is similar to global QL. The World Health Organization has defined QL as the perception of an individual's position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns—as a broad-ranging concept affected in a complex way by their physical health, psychological state, personal beliefs, social relationships, and relationship to salient features of their environment.[2] Because QL is currently perceived by most researchers to be a subjective construct, the goal of its measurement is to access that subjective perception.[3]

Health-related quality of life has not been previously defined for animals, and no widely accepted definition for QL in animals exists. Some have equated QL in animals with well-being (eg, Clark et al[4]) or with welfare (eg, Fraser et al[5]). There has been a growing focus in animal welfare measurement on the subjective experience of an animal (eg, Dawkins[6] and Duncan and Fraser[7]), while recognizing the difficulty of such measurement. Recent definitions of QL in animals proposed by McMillan[8,9] emphasized, as do current conceptualizations of QL in humans, the perspective of the individual.

It seems reasonable and potentially valuable to adopt a similar conceptualization for QL in animals as for QL in humans, and we propose the following definition, intended to be relevant in any circumstances (including those of ill health): QL is the subjective and dynamic evaluation by the individual of its circumstances (internal and external) and the extent to which these meet its expectations (that may be innate or learned and that may or may not include anticipation of future events), which results in, or includes, an affective (emotional) response to those circumstances (the evaluation may be a conscious or an unconscious process, with a complexity appropriate to the cognitive capacity of the individual). Consequently, HRQL is the

subjective evaluation of circumstances that include an altered health state and related interventions.

The development of a structured questionnaire for the measurement of chronic pain, through its impact upon HRQL, has been reported previously.[10] This questionnaire was designed for use by the dog owner or caregiver who was required to rate the behavior of a familiar animal, to provide a valid measure of the impact of chronic pain on HRQL. Development of the questionnaire followed established psychometric approaches[11-13] combined with a novel focus on the rating of descriptors on the basis of simple words or phrases, rather than more complex items, and on the rating of behaviors that were interpreted to some extent as expressions of affect.

Validity is the most fundamental attribute of a questionnaire instrument.[14] It provides evidence that the questionnaire can be used as an instrument to measure the construct that it was designed to measure. Pain and HRQL are subjective and complex phenomena, for which the criterion-referenced standards for measurement are self-reports. Where self-report is not possible and an instrument to measure pain or HRQL is designed for use by a proxy rather than by the patient, validation is an iterative process for which a variety of approaches have been established in the human health measurement field. Two important types of validity that are commonly sought for new questionnaire instruments are content validity and construct validity.

Content validity is a measure of the extent to which the items included in a questionnaire instrument are relevant and adequate for the purpose and is established by the methods used during scale construction to identify which variables are relevant to the measurement of interest and to generate and select the items that are necessary to address those variables.[12] The content validity of the questionnaire used in the study reported here was established during the process of its development.[10]

Face validity is related to content validity. A questionnaire that has face validity is one in which the items appear to be (on the face of it) measuring what the questionnaire is intended to measure. This kind of validity does not improve the psychometric properties of a questionnaire, but it generally increases its acceptability to the respondent. A disadvantage of face validity, and also of the direct estimation scales that are commonly used in psychometric questionnaires, is that when the intention of questions is obvious, the risk of respondent bias is higher.[12] This can increase reliability while decreasing the validity of the instrument.[15] The problem of respondent bias is widely recognized in health and social science[16-19] and has been identified in those required to quantify pain in animals.[20] Developers of questionnaire instruments often fail to acknowledge this important problem, which can be addressed with a range of strategies intended to make it difficult for the questionnaire respondent to respond in a consistently biased fashion or to identify those who are attempting to do so.

The developers of the GUVQuest acknowledged the risk of respondent bias[10] and designed the questionnaire in such a way as to minimize this problem, for example, by including relatively large numbers of (simple) items and by including positive and negative descriptors for most types of behavior. In addition, as recommended by Vaillancourt et al,[21] the full title of the questionnaire (ie, Glasgow University Health-related Dog Behavior Questionnaire) made no mention of pain or assessment because it was felt that these concepts might bias respondents, either consciously or unconsciously.

Evidence for the construct validity of a questionnaire instrument is provided when the responses obtained fit the hypothetical construct upon which the questionnaire was developed. The hypothetical construct upon which the GUVQuest was developed was that chronic pain in dogs has a substantial impact upon QL, similar to the impact upon QL of chronic pain in humans, and that such impact is revealed by changes in behavior that can be observed and reported by the dog owner. A number of approaches exist to examine the construct validity of a new questionnaire, and these include factorial validity and known-groups validity.

Factorial validity requires the analysis of relationships between questionnaire item responses with a multivariate statistical technique called FA. Groupings of items revealed by such analysis, which are also related on clinical or other grounds, are termed factors. If an interpretable factor structure underlies the responses to questionnaire items and if this underlying factor structure fits the construct upon which the questionnaire was developed, then some evidence has been provided for the validity of the questionnaire and also for that hypothetical construct.[22]

A useful factor model captures a reasonable amount of the total variance in the data, with higher figures representing better models. Because FA is capable of providing any number of factor models for a given data set, it is up to the instrument developer to decide upon the most satisfactory factor model and number of factors it contains, which is a vital step in questionnaire instrument development.[23] For any factor model, the association between each item and the underlying factors is expressed in factor loadings of an item (values between 0 and 1), with higher loadings representing closer associations. Factor loadings at > 0.3 or at > 0.4 are generally considered to be moderate or high,[24,25] and those > 0.6 may be considered to be high or very high, depending on the type of scale associated with an item.[24] Loadings may be positive or negative, but the signs of the loadings are relatively, not absolutely, important. Factor analysis has been used in the development of a number of human pain and, particularly, HRQL questionnaires, with the factor models revealed in this way accounting for a range of variances.[26-31] The factors identified in these studies (in factor models that accounted for 45% to 68% of the variances in the data) were interpreted as domains that included physical functioning, social functioning, role functioning, vitality, mental health, problematic symptoms, fatigue, emotional function, activities, autonomy, environment, pain intensity, affect, cognition, and stoicism. Factor analysis has also been applied to questionnaire instruments that measure the temperament

of dogs and have been designed to obtain relevant information from owners of guide dogs[32] and pet dogs.[33] From 57% to 63% of the variances were accounted for by the factors identified in these studies, which were interpreted as aspects of fear and aggression, trainability, attachment, anxiety, appetite, chasing behavior, and excitability.

Apart from factorial validity, other approaches to construct validation depend upon the extent to which the performance of a questionnaire instrument reflects the hypothetical construct upon which it was developed. In this approach to validation, predictions are made about how scores obtained with the new questionnaire will differ between groups, after treatment, and over time or relate to other measures of change, and these predictions are then tested. For example, a questionnaire instrument should be able to distinguish correctly between groups that would be expected to have quite different scores. This is called extreme groups[22] or known-groups[34] validity. Such an approach has been used in a number of studies[35-38] intended to validate questionnaires developed as instruments to measure pain and HRQL of infants and children.

Although a role exists for discriminative questionnaire instruments to determine the presence of chronic pain, for clinical use, the evaluative capability of a questionnaire is more important. That is, a questionnaire instrument must be able to detect change over time within a patient[34] so it can be used to monitor clinical change and assess the effectiveness of treatment, regardless of whether that treatment is active or palliative. The validation of a questionnaire for such purposes requires a longitudinal study and an examination of the extent to which clinical change is reflected in changes in scores over time for patients receiving pain-relieving treatment.

The purpose of the study reported here was to validate the use of a novel questionnaire (ie, the GUVQuest[10]) as an instrument for measurement of chronic pain in dogs through its impact upon HRQL. To evaluate the construct validity of the questionnaire, field testing was performed with a group of clinically affected dogs and a group of healthy control dogs. Factor validation was performed on item responses, and known-groups validation was performed on questionnaire scores for which a practical scoring method was developed. Subsequently, to evaluate the extent to which the design of the GUVQuest was able to minimize respondent bias, a comparison was made between the responses of owners to direct questioning about pain in their dogs and the scores generated from responses of owners to the questionnaire that were used to discriminate between dogs with clinician-awarded pain scores of 0 and those with a diagnosis of chronic DJD and clinician-awarded pain scores ≥ 1. Finally, to explore the evaluative ability of the instrument, a comparison was made between scores obtained over time for dogs in a pain-free control group and dogs in a clinical group receiving treatment for DJD.

Materials and Methods

Questionnaires—The questionnaire was to be completed at the first consultation and (in modified form) at each follow-up consultation by owners of dogs receiving treatment for a chronic and painful condition and (in modified form) by owners of healthy dogs that were not affected by chronic pain. The core of each questionnaire was identical for all versions, consisting of 109 simple descriptor items, each with an associated 7-point (0 to 6) Likert-type rating scale (this is a scale on which responses are framed on an agree-disagree continuum). Also included in relevant versions of the questionnaire were transition questions about global changes in a range of behavioral and HRQL domains (activity, pain, sociability, aggression, anxiety, enthusiasm, happiness, and mobility) and demographic questions about the dog and its environment and about the questionnaire respondent. A short clinician questionnaire was associated with each owner questionnaire and was principally designed to provide a rating of pain by the examining clinician (on a 0 to 10 numerical rating scale) and, on follow-up occasions, a rating of clinical change (on a 7-point Likert-type scale).

Animals—Recruitment was performed over a period of approximately 18 months. Over that period, owners of all new cases of dogs with chronic orthopedic conditions attending the University of Glasgow Faculty of Veterinary Medicine Small Animal Hospital and those attending an acupuncture clinic in a local general veterinary practice were invited by the examining clinician to complete an initial owner questionnaire. The examining clinician also completed the relevant clinician questionnaire. Dogs were recruited into a longitudinal study if they met the following criteria: clinically affected with DJD; likely to be seen again by the same clinician on ≥ 2 more occasions during the following 12 weeks; not affected with any impairments such as poor eyesight, deafness, cognitive dysfunction, or physical handicap not associated with the condition of interest; owned by the person completing the initial questionnaire for ≥ 1 year and for longer than the owner believed the dog to have been unwell; and all questions in the initial owner questionnaire had been completed at the time of the initial clinical assessment. A group of healthy control dogs owned by staff of the University of Glasgow Faculty of Veterinary Medicine, assessed as being free from pain following examination by clinicians involved in scoring the clinically affected dogs, was recruited to the study.

Data capture and analysis—Data capture from all questionnaires was performed by author coding of questionnaire responses followed by manual data capture by a skilled data capture operator. Factor analysis was performed with a software program.[a] Data used were obtained from all questionnaires completed for dogs receiving treatment for DJD, for which ≥ 1 follow-up questionnaire had been completed. A principal components method of FA was used, and a varimax rotation was performed. Input variables were all item (descriptor) ratings. Loadings were sorted, and loadings of < 0.3 were zeroed. Guided by a scree test (in which the shape of a plot of eigenvalues is used to identify the point at which additional factors explain significantly less additional variance) and the Kaiser criterion (include all factors with eigenvalues > 0.1), the interpretability of a range of factor models was examined. Factors were interpreted on the basis of how those items loading onto a particular factor were related (and unrelated to items not loading onto that factor). A factor model was sought that accounted for an acceptable amount of the variability in the data, was readily interpretable, and did not include any factors containing only 1 or 2 items.

Development of questionnaire scoring—A score for each factor was obtained by calculating the mean rating for all items loading onto that factor. Scores for all factors were collated to provide a profile for each dog. Such a profile was

obtained for each time point at which the dog owner completed a GUVQuest.

Known-groups discrimination—Factor scores calculated for dogs receiving treatment for DJD with clinician-awarded pain scores ≥ 1 (ie, some pain) and those calculated for dogs with clinician-awarded pain scores of 0 (ie, no pain) were used to test the hypothesis that scores obtained with the questionnaire would be able to discriminate between dogs with chronic pain and dogs without chronic pain. This was done by use of a software program[a] with LDA and cross-validation.

Ability to guard against respondent bias—Among a number of supplementary questions asked (in addition to the 109 core items) was a question about whether the owner believed the dog to be in any pain, to which owners could choose to answer yes or no. For all questionnaires included in the LDA, responses of owners to this question were compared with the allocation of questionnaires to the some-pain or no-pain groups by use of the LDA rule on the basis of core items.

Evaluative ability—Scores obtained with the questionnaire were compared at different time points (first and last questionnaires completed) for dogs receiving treatment for DJD and for dogs in a control group without pain. In addition, evaluative ability was assessed by comparison of questionnaire scores with clinician-awarded pain scores that, in this study, provided a measure of clinical status at each examination (and therefore of clinical change between 1 examination and the next). To explore any relationship between questionnaire scores and this measure of clinical change, questionnaire scores for dogs receiving treatment for DJD were plotted against pain scores of 1 to 7 awarded to this group throughout their treatment.

Results

Recruitment and data capture—Owners of 108 dogs with DJD (94 from the small animal hospital and 14 from the general veterinary practice) completed initial questionnaires. Of these 108 dogs, 90 were enrolled in the longitudinal study (76 from the small animal hospital and 14 from the general veterinary practice). Of this group, at least 1 follow-up questionnaire was subsequently completed for a total of 73 dogs (59 from the small animal hospital and 14 from the general practice); no follow-up questionnaires were available for 17 dogs. The number of questionnaires completed for each dog in the small animal hospital group ranged from 2 to 8 (median, 2) and for each dog in the general veterinary practice group ranged from 2 to 7 (median, 4). Seventeen dogs initially recruited from the small animal hospital were not considered for enrollment in the longitudinal study because owners did not provide responses to all items in initial questionnaires. Owners of 26 healthy dogs completed an initial questionnaire, and 1 follow-up questionnaire was completed for 16 of these dogs. Data were captured from a total of 256 questionnaires completed for dogs with DJD and from 42 questionnaires for healthy controls.

FA—Factor analysis was performed on item responses obtained from 221 questionnaires, which were all questionnaires completed for dogs with DJD for which > 1 questionnaire was completed. A scree plot suggested that much of the variance in the data was accounted for by 7 factors, while the Kaiser criterion suggested that a model containing approximately 15 factors would be most appropriate. A careful examination of the items loading onto each factor was made, and the consequent interpretability was considered for a range of models, from a 7-factor model to a 15-factor model, taking into consideration the amount of variability in data that was accounted for by each of the factor models in this range. A model was sought in which statistically identified factors were interpretable as a range of HRQL domains hypothesized to be affected by chronic pain and that accounted for a reasonable amount of the variance (by comparison with similar questionnaires developed in the field of human pain and HRQL measurement and those developed for temperament testing of dogs by use of caregiver-completed questionnaires).

The most suitable model was determined to be the 12-factor model, which accounted for 65.2% of the variance and consisted of factors that were interpretable by the authors, from the identity of their associated items, as a range of HRQL domains for dogs similar to those reported to be affected by people with chronic pain and therefore included in HRQL questionnaires for humans. Factors were named, as far as possible, after 2 items loading heavily onto that factor and onto no other factor (factors 9 and 11 did not have sufficient items loading only onto those factors to permit this approach, so where necessary, suitable items with multiple loadings were chosen; **Tables 1 and 2**).

No simple relationship was found between the factors and items loading significantly onto them. Fewer than half of all items (48 items) loaded significantly onto only 1 factor **(Table 3)**. Of the remaining items, most (49 items) loaded onto 2 factors and a much smaller number of items loaded onto 3 factors (7 items) or 4 factors (5 items).

Although HRQL domains are not equivalent to behavioral domains (eg, an HRQL domain described as vitality may be associated with behavioral evidence of physical activity, mental alertness, and extroversion), the behavioral domains and associated descriptors appear to have contributed to the measurement of various HRQL domains in an appropriate manner. Relationships were determined between the behavioral domains in which disturbances were observed by owners of dogs affected with chronic pain, which were hypothesized to be relevant to the measurement of

Table 1—Factors in an interpretable 12-factor model identified through FA of item ratings obtained for dogs with DJD.

Factors	Percentage of variance accounted for by factor
Eager-keen	13.4
Stiff-sore	8.4
Listless-reluctant	7.8
Panicky-nervous	6.2
Aggressive-unresponsive	5.6
Whining-crying	4.8
Enthusiastic about food-interested in food	4.2
At ease-consistent	3.6
Confused-complaining	3.2
Attention seeking-comfort seeking	3.2
Sorrowful-sad	2.8
Stoical-accepting	2.0

Table 2—Named factors identified in an interpretable 12-factor model with items (descriptors) loading positively or negatively onto each factor.*

	Items (descriptors) loading onto factor with loadings of ≥ 0.3	
Factors	**Negative loading**	**Positive loading**
Factor 1: eager-keen	Eager, keen, inquisitive, energetic, outgoing, curious, lively, bouncy, bold, excitable, bright, boisterous, playful, nosy, alert, active, interested, fun-loving, sociable, stretching, confident, comfortable, athletic, fit, relaxed, contented, happy, easy-going, independent	Quiet, slowed, tired, lethargic, lackluster, sluggish, weary, subdued
Factor 2: stiff-sore	Stiff, sore, limping, pained, uncomfortable, awkward, slowed, resigned, tired, apprehensive, miserable, weary, pathetic or pitiful, unhappy, agitated, restless, unsettled, distressed, sorrowful, sad	Energetic, lively, bouncy, boisterous, playful, active comfortable, athletic, fit, relaxed, contented, happy
Factor 3: listless-reluctant	Slowed, resigned, miserable, lethargic, listless, lackluster, reluctant, sluggish, apathetic, weary, sleepy, depressed, dull, subdued, withdrawn, pathetic or pitiful, unhappy, unsociable, detached, sorrowful, sad, uninterested	None
Factor 4: panicky-nervous	Apprehensive, panicky, nervous, uneasy, frightened, upset, strained, anxious, cautious, agitated, panting, restless, distressed	Confident, easy-going, calm, laid-back
Factor 5: aggressive-unresponsive	Sociable, good-natured, even-tempered, friendly, affectionate, easy-going, placid	Withdrawn, unhappy, agitated, aggressive, irritable, grumpy, unsociable, compulsive, unresponsive, restless, territorial-protective
Factor 6: whining-crying	Compulsive, whining, crying, moaning, groaning, panting, disturbed, restless, unsettled, picky (food), off food, complaining	None
Factor 7: enthusiastic about food-interested in food	Picky (food), off food, sorrowful	Enthusiastic about food, interested in food, greedy, tireless
Factor 8: at ease-consistent	Anxious, agitated, inconsistent	Quiet, contented, good-natured, friendly, easy-going, consistent, calm, placid, laid-back, obedient, at ease
Factor 9: confused-complaining	None	Pained, miserable, depressed, dull, irritable, grumpy, moaning, groaning, confused, complaining, distressed
Factor 10: attention seeking-comfort seeking	Affectionate, attention-seeking, comfort-seeking, clingy, thirsty	Independent, detached
Factor 11: sorrowful-sad	Inquisitive, happy, territorial-protective	Unhappy, sorrowful, sad, uninterested
Factor 12: stoical-accepting	None	Thirsty, stoical, accepting

*Order in which items are listed indicates weight of loading, with earlier listing indicating higher loading.

such pain,[10] and the factors revealed by FA of responses obtained with the questionnaire developed from that hypothesis, each of which was interpreted as an HRQL domain (**Table 4**). For example, terms used to describe levels and types of activity were found to contribute to factors interpreted as HRQL domains relating to vitality, physical limitations, and lethargy, and terms used to describe extroverted and introverted behavior contributed to HRQL domains relating to vitality and to aggression.

Development of questionnaire scoring—On the basis of the 12-factor model in which each factor was considered to represent a domain of HRQL, a score for each domain was calculated by averaging the ratings for all items in the relevant factor. First, however, it was necessary to reverse the ratings given to those items loading with the opposite sign to the principal items for a factor. For those items, a score of 1 became a score of 5 and a 5 became 1, a score of 2 became a score of 4, a score of 6 became a score of 0, and so on.

Table 3—Items (descriptors) loading onto 1, 2, 3, or 4 factors in the 12-factor model.

No. of factors loading onto	Items (descriptors)
1 factor	Accepting, aggressive, alert, apathetic, at ease, attention-seeking, awkward, bold, bright, cautious, clingy, comfort-seeking, confused, consistent, crying, curious, disturbed, eager, enthusiastic about food, even-tempered, excitable, frightened, fun-loving, greedy, inconsistent, interested, interested in food, keen, limping, listless, nervous, nosy, obedient, outgoing, panicky, reluctant, sleepy, sore, stiff, stoical, strained, stretching, tireless, uncomfortable, uneasy, upset, unresponsive, whining
2 factors	Active, affectionate, anxious, apprehensive, athletic, boisterous, bouncy, calm, comfortable, complaining, compulsive, confident, depressed, detached, dull, energetic, fit, friendly, good-natured, groaning, grumpy, independent, inquisitive, irritable, lackluster, laid-back, lethargic, lively, moaning, off food, pained, panting, pathetic or pitiful, picky (food), placid, playful, quiet, relaxed, resigned, sluggish, sociable, subdued, territorial or protective, thirsty, tired, uninterested, unsettled, unsociable, withdrawn
3 factors	Contented, distressed, happy, miserable, sad, slowed, weary
4 factors	Agitated, easy-going, restless, sorrowful, unhappy

Table 4—Relationship between behavioral domains and factors as revealed by FA of responses obtained from the questionnaire.

Behavioral domains	Factors*
Activity	Factor 1: eager-keen Factor 2: stiff-sore Factor 3: listless-reluctant
Comfort	Factor 2: stiff-sore Factor 6: whining-crying Factor 9: confused-complaining
Appetite	Factor 6: whining-crying Factor 7: enthusiastic about food-interested in food
Extroversion-introversion	Factor 1: eager-keen Factor 5: aggressive-unresponsive
Aggression	Factor 5: aggressive-unresponsive
Anxiety	Factor 4: panicky-nervous
Alertness	Factor 1: eager-keen
Dependence	Factor 1: eager-keen Factor 10: attention seeking-comfort seeking
Contentment	Factor 2: stiff-sore Factor 3: listless-reluctant Factor 11: sorrowful-sad
Consistency	Factor 8: at ease-consistent Factor 2: stiff-sore
Agitation	Factor 4: panicky-nervous Factor 6: whining-crying Factor 8: at ease-consistent
Posture and mobility	Factor 1: eager-keen Factor 2: stiff-sore
Compulsion	Factor 5: aggressive-unresponsive Factor 6: whining-crying

*Factors included are those with loadings of ≥ 0.3 for at least a third of the items of the relevant behavioral domain.

This was the method used by Hsu and Serpell[33] when developing a questionnaire for measuring temperament in pet dogs. The scores generated in this way for the GUVQuest provided a profile of HRQL domain scores for each dog at each time point.

Known-groups discrimination—The LDA with cross-validation was performed on the HRQL domain scores calculated for 218 questionnaires that had associated clinician pain scores, of which 39 had been completed for dogs in the no-pain group (ie, composed of control-group dogs and dogs with DJD that had pain scores of 0 at end of treatment [n = 23 dogs]) and 179 had been completed for dogs in the some-pain group (dogs in DJD group with pain scores ≥ 1 [n = 73]; range of pain scores were awarded as follows: score of 1 [28], 2 [29], 3 [43], 4 [25], 5 [20], 6 [23], 7 [7], and 8 [4]). Some of the dogs were in both categories at dif-

Table 5—Comparison of clinician-awarded pain scores with owner responses to the direct question of pain and results of LDA of HRQL scores obtained from questionnaires completed for dogs classified a priori as belonging to some-pain or no-pain groups on the basis of the clinician-awarded pain scores.

		Owner response to question of pain (No.)		Questionnaire group allocation (No.)	
Clinician pain score	No. of questionnaires	Yes	No	Some pain	No pain
0	39	0	39	2	37
1–8	179	94	85	155	24

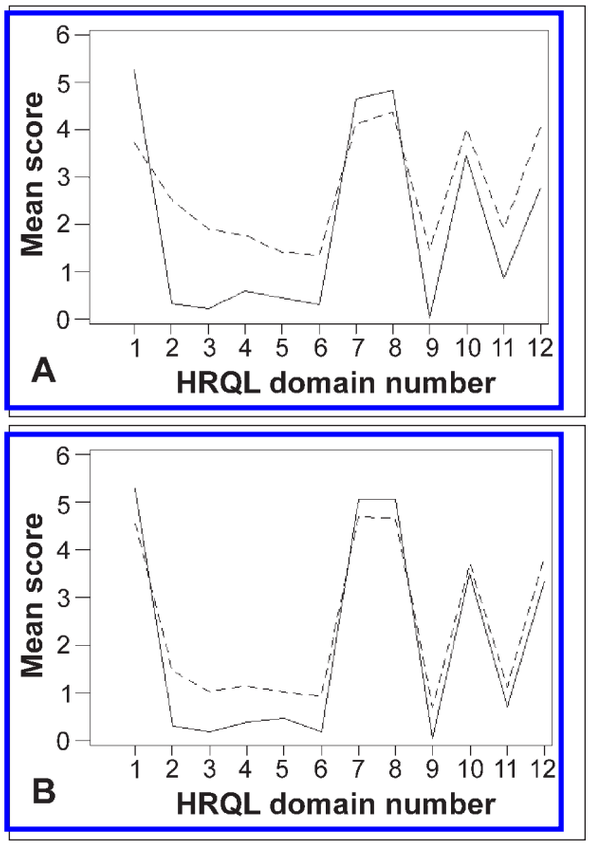

Figure 1—Mean score versus HRQL domain number providing a mean HRQL profile for the initial questionnaires completed (A) and the last questionnaires completed (B) for dogs with chronic orthopedic pain (dashed line) and for dogs in the healthy control group (solid line).

ferent times during the longitudinal study; hence, the total number of dogs for which questionnaires were included in this analysis was 89.

Results of LDA analysis of HRQL domain scores revealed that these domains were able to discriminate between questionnaires completed for dogs with pain scores of 0 and those completed for dogs with DJD that had pain scores ≥ 1 in 88% of all dogs for which pain scores were available (n = 218), with 95% of no-pain group dogs and 87% of some-pain group dogs being correctly categorized.

Ability to guard against respondent bias—Examination of questionnaires included in the LDA revealed that of 179 questionnaires completed for dogs with DJD and with clinician pain scores ≥ 1, owners had, on 85 occasions, answered no to the question of whether they

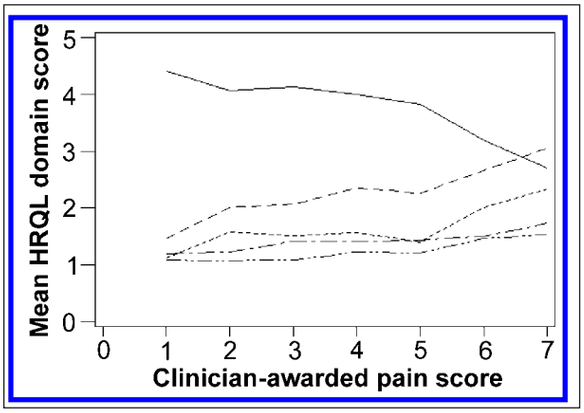

Figure 2—Relationship between clinician-awarded pain scores (1 to 7) and mean HRQL domain scores (domains 1 to 5: eager-keen [solid line]; stiff-sore [dashed line]; listless-reluctant [dotted line]; panicky-nervous [dashed 1-dot line]; and aggressive-unresponsive [dashed 2-dots line], respectively) obtained for 73 dogs during treatment for DJD.

thought their dog was in any pain (> 47% occasions; **Table 5**). On the basis of HRQL domain scores calculated from owner ratings of GUVQuest items, dogs were much more frequently correctly classified (according to a clinical diagnosis of DJD with pain scores ≥ 1) as having a chronic and painful condition, providing evidence for the ability of the GUVQuest as an instrument to minimize respondent bias.

Evaluative ability—The mean HRQL profiles obtained for a group of dogs with chronic orthopedic pain receiving treatment in the small animal hospital (n = 61), overlaid with profiles obtained for a control group of dogs without signs of pain (n = 16) obtained on 2 separate occasions (first and last questionnaires completed for each dog), were examined (**Figure 1**). The mean HRQL profile for the control-group dogs was similar on each occasion, whereas the mean HRQL profile following treatment of dogs in the clinical group was closer to the profile of the control dogs than it was to their profile at the beginning of treatment, with varying amounts of change for each domain.

Evaluation of the relationship between clinician-awarded pain scores (1 to 7) and mean scores for HRQL domains (factors) 1 to 5 obtained for 73 dogs (ie, all dogs receiving treatment for DJD in the small animal hospital and general veterinary practice and with relevant pain scores) revealed that the questionnaire-generated HRQL domain scores were correlated with clinical change (according to clinician-awarded pain scores; **Figure 2**). The demonstration that HRQL domain scores changed in a clear and predictable man-

ner with treatment of a chronic and painful condition, and that for such a treatment group, a relationship was found between HRQL domain scores and an existing measure of clinical change (clinician-awarded pain score), provided some preliminary evidence for the validity of the GUVQuest as an evaluative instrument.

Discussion

It is essential when developing a questionnaire instrument to be clear at the outset about what that instrument is intended to measure. Our questionnaire was intended to measure canine chronic pain through its impact upon HRQL. On the basis of our definition and conceptualization of HRQL in animals, it was clear that the GUVQuest should seek to measure the affective responses of dogs to their circumstances, which included a chronic and painful condition; the GUVQuest did so by the emphasis on behavioral expression of affective responses.

In FA, various established methods are used by which a decision on the number of factors to extract may be reached, including the use of the scree test and the Kaiser criterion, each of which has limitations.[23,39] Importantly, a good factor model is one in which the significantly derived factors are interpretable.[40] With current software programs, it is possible to rapidly perform FA with various values for the number of factors to be extracted and select the model that is most sensible on clinical or other grounds.[41] Although a larger number of factors will account for more of the variance, factors defined by only 1 (singlet) or 2 (doublet) observed variables are not considered desirable.[40]

Factor analysis revealed a sensible 12-factor model that accounted for > 65% of the variability in the data set from which it was created. By comparison in similar analyses, a 4-factor structure (including behavior, autonomy, environment, and psychological and somatic factors) for a QL questionnaire regarding infants[28] accounted for approximately 45% of the variance; a 5-factor structure (including physical functioning, emotional functioning, social functioning, and 2 school functioning factors) for self-report and proxy-report responses to items in a pediatric QL inventory[30] accounted for 52% and 62% of the variance, respectively; a 5-factor model (including unpleasant chest sensations, fatigue and emotional function, activity limitations, nocturnal symptoms, and environmental impact factors) for an asthma QL questionnaire[26] accounted for approximately 53% of the variance; and a 3-factor structure (including, dyspnea, fatigue, and emotional function factors) for a 16-item chronic heart failure questionnaire[27] accounted for 68% of the variance. Factor analysis of a questionnaire designed as an instrument to evaluate the behavior and temperament of guide dogs[32] extracted 8 factors (including stranger-directed fear and aggression, nonsocial fear, energy level, owner-directed aggression, chasing, trainability, attachment, and dog-directed fear and aggression) that together accounted for 63% of the common variance in item scores, and the FA of a more recent questionnaire designed to measure the behavior and temperament of pet dogs[33] revealed an 11-factor structure (including stranger-directed aggression, owner-directed aggression, stranger-directed fear, nonsocial fear, dog-directed fear or aggression, separation-related behavior, attachment or attention-seeking behavior, trainability, chasing, excitability, and pain sensitivity) that together accounted for 57% of the common variance.

The percentage of variance accounted for by the 12-factor model obtained in our study is within the range of that reported for self-report and proxy human HRQL questionnaire instruments in humans and questionnaires designed to measure attributes of dogs and to be completed by dog owners. The larger number of factors identified for the GUVQuest than for the HRQL questionnaires detailed here may be accounted for in 2 ways. Firstly, by the level of factor sought; in our study, we sought lower-order factors, compared with higher order factors identified in other models (eg, the pediatric QL inventory[30]). Secondly, because the intention of our study was to develop an instrument to measure chronic pain of any cause in dogs, it was important to seek evidence for the impact of chronic pain on all relevant HRQL domains, rather than focus on only specific domains, an approach that would be more appropriate for a disease-specific questionnaire instrument (eg, the asthma QL questionnaire[26] or chronic heart failure questionnaire[27]).

The lack of a so-called simple structure, in which the items only load substantially onto a single factor, is not unusual and has been observed in a recent study[23] of the factor structure of a well-known human pain questionnaire, of which the 78 items, like most of those of the GUVQuest, consist of simple, single-word terms. An examination of the GUVQuest items that loaded significantly onto > 1 factor revealed that most of these loadings were sensible, with behavior-related items loading onto appropriate HRQL domains.

Although interpretations of factors should be regarded as tentative, subject to confirmation by further research,[42] the factor structure revealed in our study was considered to compare well with the hypothetical construct upon which the questionnaire was developed. The range of factors (the nature of each one identified by the descriptors loading and not loading onto it) was interpretable as a range of domains similar to that included in some HRQL questionnaires for humans[43-46] as follows: vitality, physical limitation, lethargy, anxiety, aggression, emotional upset, appetite, emotional stability, mental disturbance, dependence, sadness, and stoicism. Such factors were considered to represent HRQL domains in companion animals of the kind that had been proposed in the literature[8,47,48] and that we had hypothesized to be affected by chronic pain in dogs. Consequently, our analysis was considered to have provided substantial evidence for the construct validity of the questionnaire.

Once the 12-factor model had been identified and the factors were interpreted as domains of HRQL, the items loading onto each factor were used to calculate a score for each HRQL domain. Such use of FA to reveal separately scored domains has been recommended,[12] and most HRQL measures are designed to generate a set, or profile, of HRQL domain scores for a subject.[49]

In calculating the domain scores, where factors contained positive and negative items, a manipulation

of item ratings was performed to ensure that the ratings given to 1 type of item did not obscure the ratings given to items of the other type within the same factor. Following such manipulation, the mean value for all item ratings within a factor was considered to represent the score for that HRQL domain. These HRQL domain scores were found by use of LDA to discriminate between dogs with pain caused by DJD and dogs that were clinically assessed to be without pain, achieving similar results to those reported for a proxy instrument for pain measurement in communicatively impaired children, which correctly classified 87.4% of pain and no-pain episodes and was considered by its developers to have reasonable ability to distinguish between pain and no-pain episodes.[35] Results of LDA in our study suggest that the questionnaire might have value as a discriminative instrument that could be used to alert the clinician to the possibility of chronic pain when this may not be readily apparent because the behavior changes associated with chronic pain tend to be subtle. Although the scores obtained in field testing did not, according to the clinician pain scores, correctly classify dogs as having chronic pain on approximately 13% of occasions, it must be recognized that the clinician pain scores may not themselves be reliable (it is for this reason that the development of a valid, reliable instrument to measure chronic pain was undertaken). Nevertheless, all of the dogs in the some-pain group had DJD, which is widely recognized to be a chronic and painful disease. Because of the risk of false-negative results, in clinical use, the questionnaire could not be used to rule out the presence of chronic pain. However, it might be used as an alarm signal for the possible presence of pain, as has been proposed by Gauvain-Piquard et al[50] for a scale to assess pain in young children with cancer. Such a purpose would be appropriate, provided that clinicians were aware of the level of risk of false-positive and, more importantly, false-negative results. It is recognized that a disproportionate number of the owners for dogs included in the healthy controls group are likely to have specialist knowledge, compared with owners of dogs included in the clinical groups.

A recent study[51] described the development of a discriminative questionnaire designed to measure nonphysical aspects of QL in dogs. The questionnaire was based on objective list theory, which suggests that optimal QL results when certain conditions are met, such as the satisfaction of basic physical needs, normal physiologic function, opportunities for social interaction, and minimal distress, an approach that the authors acknowledged has been criticized for its neglect of individual preferences. Although the authors hypothesized that sick dogs would differ from healthy dogs in certain aspects of QL, their initial data did not support this.[52] In discussing these findings, the authors suggested it is likely that certain factors were more important than others for different dogs, an acknowledgment of the importance of the perception of circumstances by an individual. In contrast to an objective list approach, the GUVQuest was developed with approaches that focused on accessing the subjective experience of the individual,[10] and our preliminary data suggest that this aim has been achieved because the GUVQuest discriminated effectively between healthy dogs and dogs with chronic orthopedic pain through the impact of the dog's state of health upon its QL.

In our study, a comparison of clinician pain scores with responses of owners to direct questioning about whether their dogs were in pain suggested that owners might be underreporting pain, perhaps because behavior changes associated with chronic pain can be insidious at onset or the changes, although identified, are not recognized as being related to pain or because owners are reluctant to recognize or to admit (either consciously or unconsciously) that their dogs may be in pain. This latter explanation illustrates the risk of biased responses, inherent in any questionnaire that has face validity. However, steps were taken in designing the GUVQuest to make it more difficult to respond in a consistently biased manner. The questionnaire contained a large number of items, and it included positive and negative items for most domains (with the meaning of the 0 to 6 scale reversed, accordingly), making it more difficult for the respondent to respond in a consistently biased fashion. Consequently, the GUVQuest should be useful where relevant and unbiased information is sought from dog owners who may have a tendency to underreport pain.

In a recent report[53] of the development of an instrument to measure HRQL in dogs with pain secondary to cancer, a simple questionnaire was devised for owner completion. Scores obtained with this questionnaire for dogs with cancer were significantly lower than scores obtained for healthy dogs and dogs with mild dermatologic disease. Each of the 12 items on the questionnaire could be scored from 0 to 3: the HRQL score for a dog was the sum of all item scores. However, all of the dogs in the cancer group were selected on the basis of owner reports of the presence of pain, thereby excluding from the group any owners who had a tendency to underreport pain. The questionnaire had good utility, being acceptable to respondents and easy and quick to complete. However, the face validity of the questionnaire appeared to be high, with consequent risk of biased responses being obtained from other owners who may be less willing to acknowledge pain in their dogs than were the owners included in that study.[53]

The measurement of outcomes other than cure is an important goal for the veterinary profession, particularly for chronic pain in which a complete cure may not be possible. An examination of the HRQL domain score profiles obtained at different time points for control dogs and dogs receiving treatment for DJD and of the relationship between HRQL domain scores and clinician-awarded pain scores for dogs receiving treatment for DJD provides preliminary evidence for the evaluative ability of the instrument. Such evidence, along with the evidence obtained for the discriminative ability of the instrument, suggests that the GUVQuest will prove useful in identifying dogs with chronic pain and in monitoring clinical change.

A recent study[54] measured the QL of human populations with different chronic diseases by use of a range

of measures and found that these appeared to have differing relative impacts on physical, social, and psychological functioning, which are often described as domains of HRQL, and that impact in these 3 domains appeared to make different relative contributions to the self-assessment of overall QL by the patient. Psychological functioning was found to contribute to overall QL for all disorders, but physical and social functioning contributed to only some disorders. Arnold et al[54] proposed clarification of existing confusion over the use of the term QL (or HRQL), which may be defined as the subjective evaluation of prevailing circumstances by the patient (as we have defined it) but is also used to describe a range of functional domains (including physical, psychological, and social domains) in which an impact of any cause, including disease, will influence that more general subjective perception of QL. In the case of the GUVQuest, the HRQL domains identified are considered to be domains through which the subjective perception of QL is revealed as indicators of QL, rather than domains in which the impact of health status has an influence on QL, as causal for QL. Consequently, it is anticipated that the questionnaire will prove to be generic for QL impact of any cause. Nevertheless, it is expected that different individuals will reveal their QL through different domains, so that a profile of scores, one for each domain, may yield important information that would be obscured in a global score. For example, 1 dog may reveal its disturbed QL initially though changes in appetite, whereas another may become less sociable or more aggressive before its appetite becomes affected. The extent to which the GUVQuest is generic will be revealed by field testing the questionnaire with populations affected by chronic pain and HRQL impacts of causes other than DJD.

The validation of the GUVQuest for veterinary use may have an important impact for human medicine. In 1976, an editorial[55] called upon the pain research community to investigate in animal species the existence of chronic pain syndromes that are similar to those suffered by man. To date, the human pain research community has paid little attention to the resource offered by the many (and increasing numbers of) dogs annually brought to the veterinary community with the kinds of chronic and painful conditions that are also suffered by man.[56] However, in a recent study,[57] dogs with advanced cancer or osteoarthritis, for which pain control medication had proved inadequate, were used to assess the efficacy of a new surgical treatment protocol for control of chronic pain in humans. Assessment of improvement following treatment was made on the basis of reduced limb guarding, increased activity, and improved demeanor. In future studies of this kind, a valid measure of chronic pain and HRQL in dogs will provide a useful tool with which to assess more sensitively and reliably any clinical change following treatment and thus evaluate the potential benefits of such treatment to people as well as to dogs.

Our results indicate that, with further testing (eg, test-retest reliability) and refinement (including refinement to maximize utility in any clinical setting), the GUVQuest will provide an HRQL profile for individual dogs that can be used to identify dogs with chronic pain and evaluate change in such dogs. Consequently, the GUVQuest will be highly valuable in supporting improved clinical decision making on a day-to-day basis, facilitating the development of evidence-based therapeutic options for chronic diseases, and helping veterinarians and owners to define humane end points to reduce pain.

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