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ORIGINAL RESEARCH

Development and validation of a chronic pain perception scale for dogs: Structural validity and reliability

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Abstract

Background: Chronic pain affects 20–37% of dogs, with osteoarthritis as the primary cause. Chronic pain contributes to behavioural problems, negatively affecting both dogs and their caregivers. Early detection is crucial. However, no standardised tool assesses caregivers' ability to recognise chronic pain.

Methods: This cross-sectional study developed the chronic pain perception scale (CPPS), a self-reported questionnaire assessing caregivers' ability to identify chronic pain in dogs with osteoarthritis. Psychometric properties were examined using exploratory factor analysis, confirmatory factor analysis (CFA) and composite reliability.

Results: The final version of the CPPS consisted of seven items grouped into two factors: motor/sensory expression and emotional expression. An initial CFA in a larger sample showed good fit (root mean square error of approximation [RMSEA] = 0.045, $p = 0.569$), but concerns about factor structure led to a second CFA in a smaller sample. The final CFA showed good fit (standardised root mean square residual = 0.036, goodness-of-fit index = 0.949, normed fit index = 0.966 and comparative fit index = 0.975), despite RMSEA (0.105, $p = 0.002$) indicating poor fit.

Limitations: The sample lacks diversity as it is composed mostly of women with internet access. Furthermore, as participants were all Portuguese, the tool's validity may not be generalisable to different languages and cultural contexts.

Conclusion: The CPPS is a valid tool for assessing caregivers' ability to recognise chronic pain in dogs with osteoarthritis, supporting both research and clinical practice. It may also help improve veterinarian–caregiver communication, enabling earlier detection and management of chronic pain.

INTRODUCTION

Pain is defined as an unpleasant sensory and emotional experience linked to actual or potential tissue damage.[1] Chronic pain, persisting beyond 3–6 months, is often associated with central sensitisation. While it may have an adaptive role in wild animals by increasing vigilance and preventing re-injury, in companion dogs, this heightened sensitivity is maladaptive due to the absence of such environmental pressures.[2]

Studies suggest that approximately 20–37% of dogs suffer from some form of chronic pain, with osteoarthritis being the primary cause, particularly in older dogs and large-breed dogs.[3–5] Without proper identification, it remains untreated, leading to poor quality of life and behavioural problems rooted in fear and anxiety, which can exacerbate over time.[2,6] Anxiety heightens pain sensitivity, which in turn elevates anxiety levels.[7,8] This creates a self-perpetuating cycle. Awareness of the often subtle signs of chronic pain in dogs is crucial to ensure that they receive appropriate and timely treatment.[9]

Chronic pain in animals leads to a decline in normal behaviour and has been identified as one of the main causes of behavioural problems in companion dogs.[8,7,10–15] In a metareview of the literature, Mills and colleagues stated that between 28% and 82% of behavioural problems are associated with pain, with osteoarticular pain being the most common cause. Physiological changes resulting from chronic pain, such as elevated cortisol levels, initiate stress responses that can have significant negative consequences.[5] These include increased reactivity, aggressive manifestations, compulsive behaviours and separation-related problems.[7,13,16]

Therefore, it is crucial to identify signs indicating chronic pain in dogs as early as possible. However, the signs of chronic pain can be subtle and non-specific. The observable signs may include anxiety, fear, inappropriate house soiling, vocalisation, reduced activity, reduced interaction with family members, or conversely, excessive proximity-seeking with their caregivers, muscle stiffness, alterations in the sleep cycle, muscle atrophy, persistent licking of a limb or specific body area, uneven nail wear due to chronic pain in one limb, or an arched spine with weight shifted to the forelimbs in cases of bilateral back pain.[6,8,10,15–17] The behavioural changes associated with chronic pain develop gradually and subtly, making them challenging to detect for both caregivers and veterinarians.[15,18]

According to the World Small Animal Veterinary Association guidelines for the recognition, assessment and treatment of pain, caregivers play a crucial role in identifying early signs of pain, as they are most familiar with their dog's behaviour.[19] The guidelines emphasise that behavioural changes can be so subtle that only those highly familiar with the dog can identify them.[19] However, not all caregivers detect these changes accurately, sometimes mistaking pain-related behaviours for ageing or temperament differences.[18,20]

Even when pain is recognised, communication barriers between veterinarians and caregivers can delay effective intervention.[15,20] Veterinarians play a key role in educating caregivers, yet challenges in conveying the severity of chronic pain often result in delayed diagnosis and treatment. Some caregivers struggle to accept an osteoarthritis diagnosis, particularly if their dog remains active, leading to reluctance in initiating treatment.[18,20] Additionally, the lack of standardised methods to assess caregivers' pain recognition complicates the issue.[6,15] Many veterinarians rely primarily on history taking and clinical examination without complementary diagnostic tools.[18] This highlights the necessity of validated instruments to assess caregivers' ability to recognise chronic pain, which could facilitate earlier detection and enhance treatment outcomes. By objectively assessing a caregiver's ability to recognise chronic pain—or their difficulty in doing so—such an instrument would help identify potential gaps in pain recognition, which can later inform clinical decisions and help with caregiver education. For example, if a caregiver's score places them in a low percentile (e.g., below the 25th percentile), this information may help them acknowledge potential gaps in their ability to recognise pain, thereby fostering the acceptance of medical recommendations and improving communication between veterinary professionals and caregivers.

Beyond ensuring animal welfare, early detection of chronic pain is crucial for preventing behavioural decline in dogs and reducing caregiver stress.[21–23] When pain remains undetected or untreated, its effects extend beyond the dog itself. While healthy dogs can positively influence caregiver wellbeing,[24] pain can lead to behavioural issues that strain relationships and increase caregiving demands.[22,23,25–28] Problematic behaviours may contribute to social isolation, as caregivers limit visitors or feel unable to leave home.[21] Clinical experience also suggests that these challenges often cause family disagreements over managing the dog's behaviour. From both an animal welfare and societal perspective, these issues are worsened by their link to pet abandonment[28,29] and euthanasia due to behavioural reasons.[22,30]

Despite the challenges in identifying chronic pain in dogs, few studies have examined how caregivers perceive pain-related behaviours. To our knowledge, only Ellingsen et al. have previously explored this topic, investigating the relationship between empathy, attitudes and pain perception.[31] However, their study did not distinguish between acute and chronic pain or validate the proposed scale.

This gap highlights the need for a validated tool specifically designed to assess caregivers' ability to recognise chronic pain in companion dogs. By developing such an instrument, it will be possible to establish a foundation for future research and practical applications in veterinary and animal welfare contexts. Therefore, this study aimed to develop a scale to evaluate caregivers' perception of chronic musculoskeletal pain in dogs before diagnosis.

MATERIALS AND METHODS

The study received approval from the Ethics Committee of the University of Évora (Ref. 22170) and was conducted in two phases. The first phase was dedicated to the development and validation of the scale, while the second phase was conducted to confirm the factorial structure of the scale using a new sample.

Phase 1

An initial set of 13 items was generated based on the categories of the Canine Brief Pain Inventory[32] and the Helsinki Chronic Pain Index,[28] both of which are scales designed to support owners in assessing chronic pain attributed to osteoarthritis. Additionally, six items reflecting behavioural changes were developed by the authors.

The content validity of the items was assessed by two expert reviewers. Both reviewers are veterinarians who are experts in pain management.[*] The reviewers reached full agreement on all items, preventing the calculation of a kappa coefficient due to the lack of variability. Given this complete agreement, the items were deemed valid based on expert consensus, as supported by the methodological literature suggesting that, when only two reviewers are available, content validity remains acceptable if no disagreements occur.[33,34] The final list of items included in the initial version of the CPPS can be seen in Table 1.

Participants and data collection

A non-probabilistic convenience sample of 595 participants was recruited for phase 1 of the study. Responses from 140 participants were used for

[*] Since the items were in Portuguese, the selection of experts was limited to veterinary professionals in Portugal.

TABLE 1 Final list of items included in the chronic pain perception scale

1.	Is joyful and lively[a]
2.	Licks one area of the body more frequently than before
3.	Always wants to lie down
4.	Has gradually stopped playing
5.	Vocalises by whimpering
6.	Walks relaxed for 30 minutes[a]
7.	Lately seeks out the guardian's proximity more often
8.	During walks, sits down and refuses to move
9.	Runs freely[a]
10.	Immediately jumps up on the sofa when invited[a]
11.	Has become less tolerant or more reactive to other dogs
12.	Does not always lie down when asked
13.	Exhibits stiffness in movements after getting up
14.	Goes up or down stairs even when unnecessary[a]
15.	Does not like to be touched or brushed
16.	Wakes up at night and walks around the house
17.	Is more anxious (agitated, restless, isolating, fearful)
18.	Is ready for another intense playtime after one[a]
19.	Shows more fearful behaviours

[a]Positive behaviours that could suggest the absence of pain when observed.

exploratory factor analysis (EFA), while the remaining 455 responses were used for confirmatory factor analysis (CFA).

A 19-item questionnaire (Supplementary material 1), constructed using the item list presented in Table 1, was disseminated through social media (Instagram) and direct contact with caregivers from different veterinary care practices, using Google Forms, between 11 July and 1 August 2023. The questionnaire was distributed in Portugal and administered in Portuguese. Only caregivers over 18 years old were allowed to participate. The participants were presented with the following instruction: 'Please consider an average-sized dog, 5 years old'. This was immediately followed by: 'Indicate the extent to which you believe the dog experiences pain in each of the situations described'. In each of the 19 situations presented (corresponding to the 19 items listed in Table 1), respondents rated the perceived pain experienced by the animal on a scale from 1 (appears not to be in pain) to 10 (appears to be in extreme pain). This abstract and standardised formulation was used to ensure consistency across participants and to allow, in future applications of the validated scale, its use with individuals who own dogs as well as those who do not. All questionnaire responses were mandatory to proceed, ensuring no missing data at the point of submission.

Phase 2

Participants and data collection

Due to some remaining uncertainties regarding the factorial structure of the CPPS (presented in the Results section), a second online questionnaire (Supplementary material 2) was distributed, following the same procedure as in phase 1, between 16 October 2023 and 25 April 2024. This second phase included a non-probabilistic convenience sample of 264 caregivers.

Exploratory and confirmatory factor analysis

EFA and CFA are statistical techniques used to understand the structure of a set of observed variables. EFA is used when there is no prior expectation about how the variables are grouped, helping to identify patterns in the data. In contrast, CFA is used to test a predefined structure, assessing whether the data fit a specific theoretical model.

In this study, EFA was used to explore the structure of the CPPS, followed by CFA to confirm the best-fitting model. Before performing these analyses, assumptions were checked to ensure data suitability. Following Marôco's recommendations,[35] sampling adequacy was assessed using the Kaiser–Meyer–Olkin (KMO) test, where values above 0.80 were considered good. Bartlett's test of sphericity was used to assess whether the correlation matrix significantly differed from an identity matrix, indicating sufficient correlations among variables. Statistical significance was set at a p-value of less than 0.05.

IBM SPSS Statistics 29 was used for data analysis. EFA was conducted using the principal component method with varimax rotation, and factors were retained based on Kaiser's criterion. Items with communalities below 0.50 were removed from the analysis.

CFA was performed to validate the factor structure identified in EFA. According to Marôco's recommendations,[36] CFA was conducted using AMOS 27 (Analysis of Moment Structures, a software package within SPSS that is used for structural equation modelling), and model fit was evaluated using multiple indices.

The absolute fit indices assess how well the proposed model reproduces the observed data. The chi-squared test evaluates model fit, with values below 5 considered acceptable. The goodness-of-fit index (GFI) measures how well the model replicates the observed covariance matrix, with values above 0.90 indicating a good fit. The standardised root mean square residual (SRMR) assesses model error and residual variance, with values below 0.08 considered acceptable.

Relative fit indices compare the tested model to a baseline model, usually a null model assuming no correlations. The normed fit index (NFI) is an incremental fit index that compares the tested model to a null model, while the comparative fit index (CFI) assesses how well the tested model fits the data relative to an independent baseline model. In both cases, values above 0.90 indicate an acceptable fit.

The population discrepancy index measures the difference between the model and the expected population structure. We used the root mean square error of approximation (RMSEA), with values below 0.08 considered acceptable.

Two competing models were tested in CFA: (1) a one-factor model, in which all the items loaded onto a single latent factor, and (2) a two-factor model, based on the structure identified in EFA. To select between these models, we used statistical criteria to determine which provided the best balance between fit quality and parsimony. The Akaike information criterion (AIC) and Bayes information criterion (BIC) evaluate how well a model explains the data, with BIC placing greater emphasis on model simplicity. The Browne–Cudeck criterion (BCC) is a variation of AIC adjusted for better performance with smaller sample sizes. The expected cross-validation index (ECVI) assesses model stability and indicates its generalisability to new datasets. For all these criteria, lower values indicate a better model, as they reflect a good fit while avoiding excessive complexity.

RESULTS

Phase 1

Exploratory factor analysis

Of the 140 participants included in the EFA, 70% were female and 30% were male (with one participant choosing not to indicate their sex). The average age was 41 years (mean = 40.45, standard deviation [SD] = 11.95, range = 20–77).

EFA was conducted to determine the underlying structure of the CPPS. The KMO test returned a value of 0.86, and Bartlett's test was significant ($\chi^2(171) = 1190.50$, $p < 0.001$), confirming the adequacy of the dataset for factor analysis. Three items (7, 10 and 12) had communalities below 0.50 and were removed. The final EFA retained 16 items across three factors, explaining 64.88% of the variance.

After rotation, factor 1, which explains the most variance, appears to reflect the perception of the motor/sensory expression of chronic pain and where caregivers most frequently perceived the dog to be in pain. Factor 2 represents the perception of the absence of pain, and factor 3 reflects the perception of the emotional expression of pain. Factors 1 and 3 demonstrated very good internal consistency, while factor 2 showed good internal consistency.

Table 2 presents the factor weights for each item on each factor. The factor weights represent the loadings of each item on the respective factors in the EFA. These weights indicate the strength and direction of the association between each item and the factors, with higher values reflecting stronger correlations. Factor weights provide insight into how well each item contributes to the underlying factor it is associated with.

Confirmatory factor analysis

To validate the factor structure from phase 1, CFA was performed on a new sample of 455 caregivers, of whom 89% were female and 11% were male. The average age was 35 years (mean = 34.84, SD = 10.02, range = 18–72).

All the assumptions for CFA were verified, except for the absence of outliers, cases with missing values and variability of at least five points on the ordinal response scale. All cases with missing values in the scale items as a result of removal of the outliers were excluded, reducing the sample size to 386 caregivers. Subsequently, items 1, 6, 9, 14 and 18 were removed as they varied by less than five points on the response scale. These items constituted factor 2 of the EFA. Therefore, the model to be tested in the CFA included only factors 1 and 3 from the EFA, comprising a total of 11 items. Factor 3 is now referred to as factor 2. To achieve a good fit to the data, we used modification indices, removing items 3, 4, 5 and 11.

The model (Figure 1) demonstrated good fit indices, indicating that the modified structure of the CPPS aligns well with the sample under study. This is supported by absolute fit indices ($\chi^2(13) = 23.154$, $p = 0.040$; χ^2/df = 1.781, SRMR = 0.029, GFI = 0.984), relative indices (NFI = 0.972, CFI = 0.997) and population discrepancy index (RMSEA = 0.045, $p = 0.569$).

The final version of the CPPS (shown in Table 3) consisted of seven items organised into two factors. Factor 1 represents the motor/sensory perception, and factor 2 represents the emotional perception of chronic musculoskeletal pain in companion dogs.

The composite reliability (CR), that is, internal consistency, of the factors was acceptable, with CR = 0.68 for the motor/sensory expression of chronic pain and CR = 0.80 for the emotional expression of chronic pain.

In terms of convergent and discriminant validity, factor 1 had an average variance extracted (AVE) of 0.59, and factor 2 had an AVE of 0.75 (both greater than 0.50), indicating that the two factors have convergent validity.

Discriminant validity evaluates the extent to which items associated with a factor represent that factor exclusively. For two factors to be discriminant, the AVE of each factor must be greater than the shared variance between them (square of the correlation between factors).[36] The correlation between the factors was 0.90 (see Figure 1), translating into $r^2 = 0.81$. Since this value is higher than the AVE of both factor 1 and factor 2, it does not allow a clear distinction between the motor/sensory factor and the emotional factor.

Finally, testing the criterion-related divergent validity was not possible, as Ellingsen et al.[31] no longer had access to the instrument used in their study and were therefore unable to provide it.

Due to the reliance on modification indices, it became necessary to validate the scale with a new sample. Additionally, clarifying the factor structure and comparing the quality of the two-factor model with the single-factor model were required.

Phase 2

In the second phase, CFA was performed on a sample of 264 caregivers. Of these, 92% were female and 8% were male, with a mean age of 36.39 years (SD = 10.88, range = 18–82).

TABLE 2 Exploratory factor analysis: factor weights for chronic pain perception in dogs with osteoarthritis

Item	Factor 1: Motor/ sensory expression	Factor 2: Absence of pain	Factor 3: Emotional expression
4. Has gradually stopped playing	0.854	−0.075	0.096
3. Always wants to lie down	0.816	−0.004	0.094
2. Licks one area of the body more than before	0.732	−0.032	0.246
5. Vocalises by whimpering	0.731	−0.382	0.197
13. Exhibits stiffness in movements after getting up	0.697	0.062	0.450
8. During walks, sits down and refuses to move	0.695	0.001	0.226
11. Has become less tolerant of or more reactive to other dogs	0.690	0.147	0.305
15. Does not like to be touched or brushed	0.517	−0.107	0.508
6. Walks relaxed for 30 minutes[a]	0.110	0.750	−0.112
14. Goes up or down stairs even when unnecessary[a]	−0.223	0.738	0.283
18. After an intense playtime, he is ready for another one[a]	−0.142	0.736	−0.262
9. Runs freely[a]	−0.111	0.727	0.265
1. Is joyful and lively[a]	0.245	0.656	−0.322
16. Wakes up at night and walks around the house	0.311	0.032	0.796
17. Is more anxious (agitated, restless, isolating, fearful)	0.478	−0.117	0.722
19. Shows more fearful behaviours	0.558	−0.076	0.620
Variance explained	31.05%	17.61%	16.22%
Cronbach's alpha	0.90	0.77	0.84
Mean	6.31	1.83	5.50
Standard deviation	1.89	1.16	2.02
Number of items in each factor	8	5	3

[a]Positive behaviours that could suggest the absence of pain when observed.

A model similar to the one used in phase 1 was constructed, with factor 1 representing motor/sensory perception and factor 2 representing emotional perception of chronic musculoskeletal pain in companion dogs. As shown in Figure 2, all items in the model had high factor loadings (≥0.5). The model demonstrated an acceptable fit, evidenced by the ratio of the chi-squared statistic to degrees of freedom ($\chi^2(13) = 50.731$, $p < 0.001$; $\chi^2/\text{df} = 3.902$). Additionally, the model showed a good fit based on other absolute fit indices (SRMR = 0.036, GFI = 0.949). The relative fit indices also indicate a very good fit (NFI = 0.966, CFI = 0.975). The population discrepancy index (RMSEA = 0.105, $p = 0.002$) suggests an unsatisfactory fit. However, according to Marôco,[36] this index is often overestimated in small samples and may not be appropriate for sample sizes of less than 400.

Next, a one-factor model, shown in Figure 3, was constructed. All items also had high factor loadings (≥0.5) in this model. Overall, the model had a similar fit to the data as the two-factor model ($\chi^2(14) = 112.601$, $p < 0.001$; $\chi^2/\text{df} = 8.042$; SRMR = 0.0415, GFI = 0.879, NFI = 0.925, CFI = 0.934, RMSEA = 0.164, $p < 0.001$).

To assess the relative performance of the two alternative models, information criteria such as AIC, BIC, BCC and ECVI were examined. The two-factor model had lower values across all indices (Table 4). Therefore, it is the model with the best fit to the data and is also the most stable in the population.

Regarding CR, both factors exhibited adequate values ($CR_{Factor1} = 0.78$ and $CR_{Factor2} = 0.91$). Factorial validity is assumed, as the standardised factor weights exceed 0.5 for each factor. The AVE was 0.81 for factor 1 and 0.88 for factor 2, indicating that the factors have convergent validity. The factors also exhibited discriminant validity ($r^2 = 0.79$).

DISCUSSION

This study developed and validated the CPPS, a tool for assessing an individual's ability to recognise chronic osteoarthritis pain in companion dogs before a clinical diagnosis. Exploratory and confirmatory factor analyses identified a two-factor structure with two distinct but correlated factors, motor/sensory perception and emotional perception of chronic pain, that both fall under the broader construct of chronic pain perception. The scale demonstrated strong psychometric properties, meeting all criteria for reliability and validity.

Its concise format makes it suitable for research on human–animal interactions, veterinary pre-consultation assessments and screening for professional activities involving dogs, such as animal-assisted therapy and dog training. From a clinical perspective, the CPPS provides veterinarians with an objective tool to assess caregivers' ability to recognise osteoarthritis pain-related behaviours in dogs.[15]

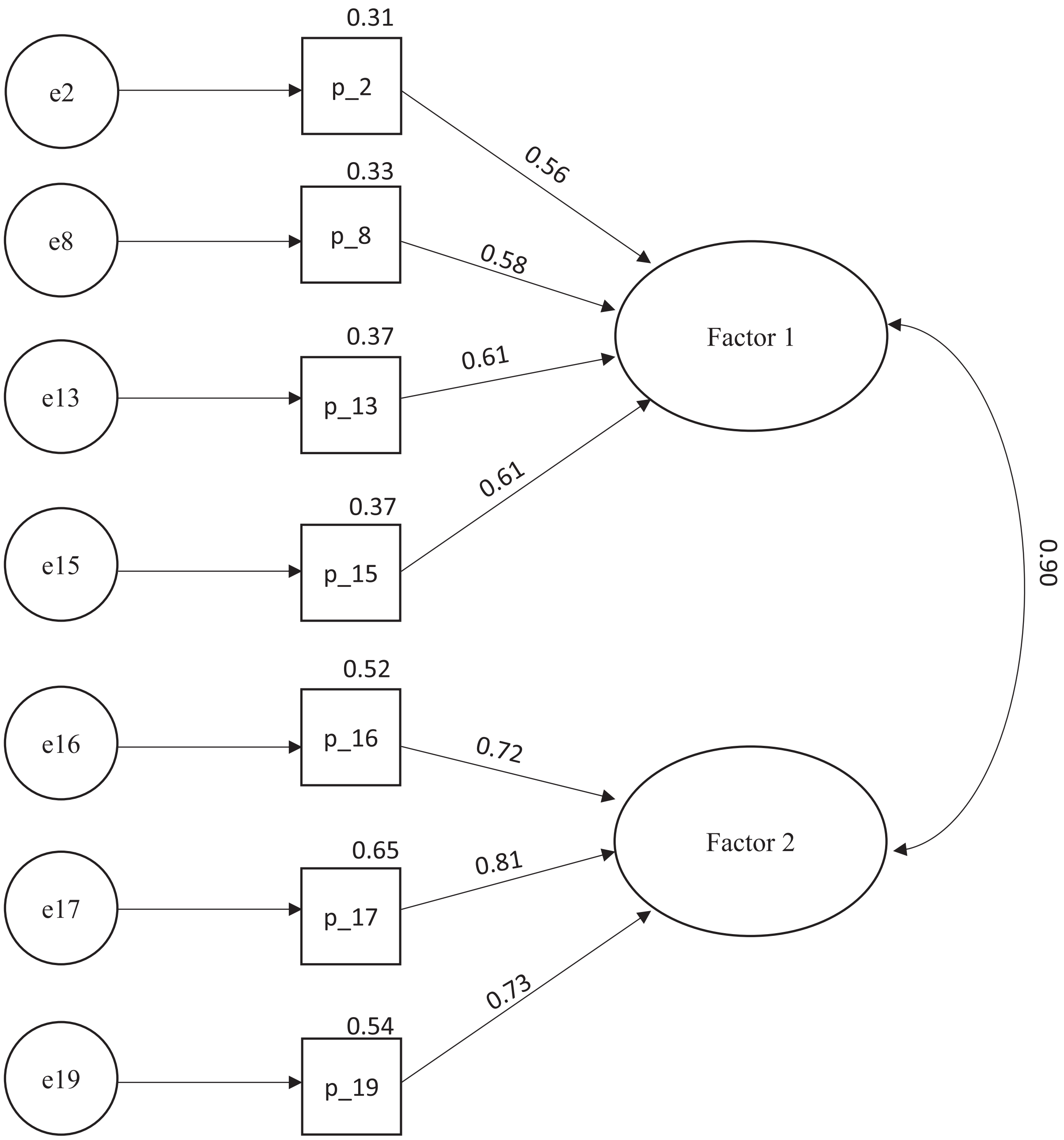

FIGURE 1 Confirmatory factor analysis of the chronic pain perception scale. This model illustrates the relationships between observed variables (rectangles) and latent factors (ovals), which represent underlying dimensions of chronic pain perception. The numerical values on the arrows indicate standardised factor loadings, expressing the strength of the association between each observed variable and its respective latent factor. Higher loadings suggest a stronger relationship. Error terms (circles) account for unexplained variance in each observed variable. The numerical values above the rectangles correspond to the proportion of variance explained (R^2) for each observed variable

TABLE 3 Final version of the chronic pain perception scale for companion dogs with osteoarthritis

Factor 1: Motor/sensory perception of chronic pain	
p_2	1. Licks one area of the body more than before
p_8	2. During walks, sits down and refuses to move
p_13	3. Exhibits stiffness in movements after getting up
p_15	4. Does not like to be touched or brushed
Factor 2: Emotional perception of chronic pain	
p_16	5. Wakes up at night and walks around the house
p_17	6. Is more anxious (agitated, restless, isolating, fearful)
p_19	7. Shows more fearful behaviours

By comparing individual scores to normative data, veterinary professionals can determine where a caregiver falls within the reference distribution[†] and identify those who struggle with pain detection. This allows veterinarians to demonstrate, in an evidence-based manner, when a caregiver lacks the ability to recognise chronic pain, facilitating targeted education and improving communication.[15,18] In turn, this

[†] To determine a person's percentile, we first calculate the *Z*-score, which shows how many SDs their value is above or below the sample mean. The *Z*-score is then converted into a percentile, indicating their relative position in the population. This process can be easily done using software such as Microsoft Excel, which automatically provides the corresponding percentile.

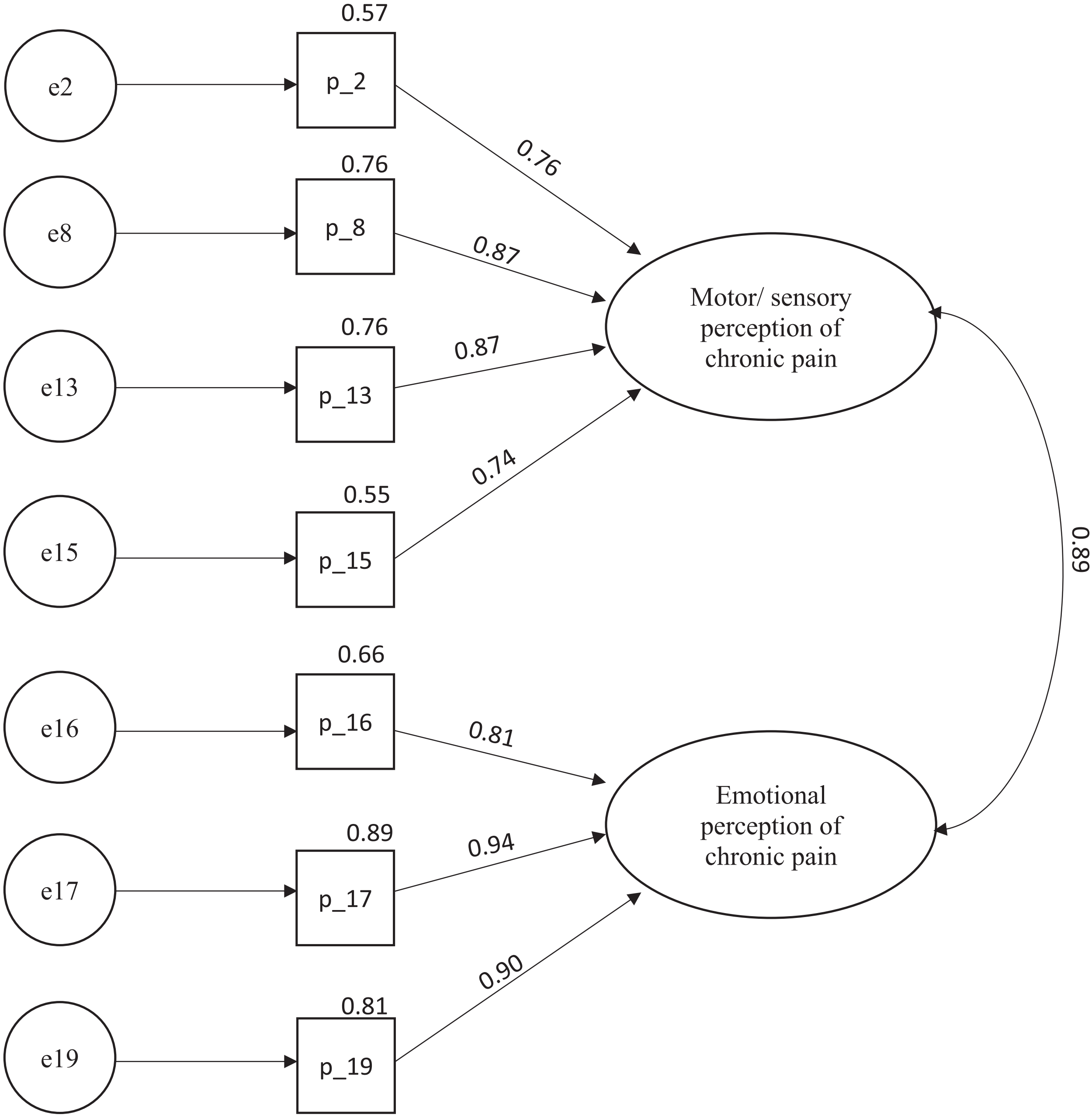

FIGURE 2 Confirmatory factor analysis (CFA) of the chronic pain perception scale: two-factor structure. This CFA model tests a two-factor structure, where observed variables (rectangles) load onto two distinct latent factors (ovals). The factor loadings (numerical values on the arrows) represent standardised correlations between observed variables and latent factors, with higher values indicating stronger associations. Error terms (circles) account for unexplained variance in each observed variable. The numerical values above the rectangles correspond to the proportion of variance explained (R^2) for each observed variable. This model assumes that chronic pain perception is best explained by two distinct but related latent factors rather than a single overarching factor

process may help caregivers better understand their limitations in pain recognition and be more receptive to veterinary recommendations, including pain management interventions.[18,20]

With this scale, we aim to support the early detection of chronic pain associated with osteoarthritis, improving the wellbeing of companion dogs and their caregivers[7,18] and thus reducing the risk of abandonment or euthanasia when behavioural issues caused by chronic pain become unmanageable.[22,28–30]

However, this study has some limitations. The sample was a non-probabilistic convenience sample, which may limit generalisability. Additionally, the participant pool was predominantly female, which could introduce bias, as sex differences may influence pain perception. Another limitation is that the CPPS was validated exclusively in Portuguese, requiring further research to assess its applicability across different languages and cultural contexts. Additionally, while the CPPS demonstrated good construct validity, it was not possible to assess criterion-related divergent validity, as the measure developed by Ellingsen et al.[31] was unavailable for comparison. Another consideration is that participants were self-selected, potentially leading to a sample with a higher-than-average interest in canine welfare. This could mean that the scale's performance in a more diverse population, including caregivers with varying levels of

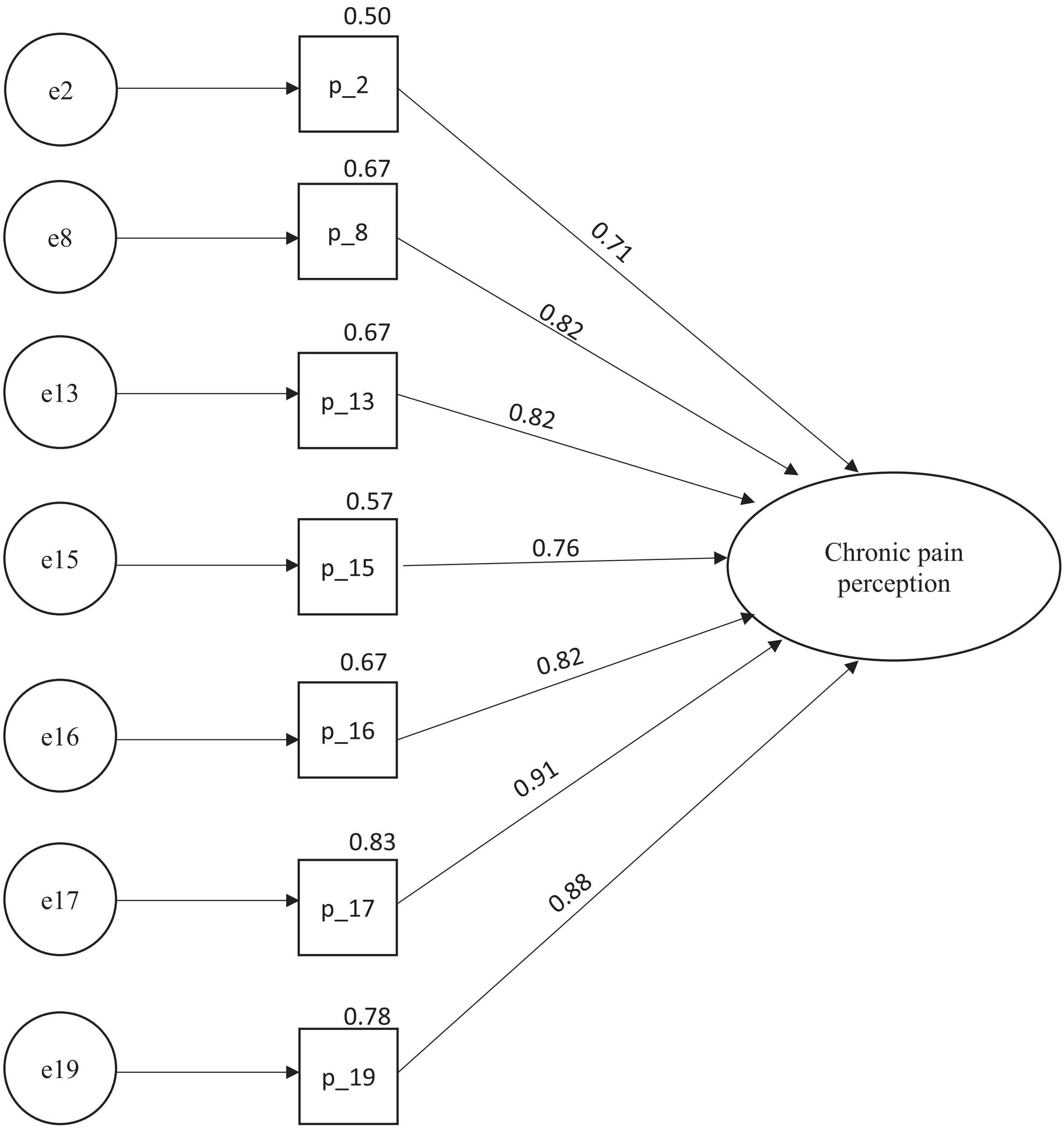

FIGURE 3 Confirmatory factor analysis (CFA) of the chronic pain perception scale: one-factor structure. This CFA model tests a one-factor structure, where all observed variables (rectangles) load onto a single latent factor (oval). The numerical values on the arrows represent standardised factor loadings, indicating the strength of the association between each observed variable and the general latent factor. Higher values suggest stronger relationships. Error terms (circles) account for unexplained variance in each observed variable. The numerical values above the rectangles correspond to the proportion of variance explained (R^2) for each observed variable. This model assumes that chronic pain perception is best represented by a single latent factor rather than two distinct but related latent factors

TABLE 4 Comparison indices for the two confirmatory factor analysis models

	AIC	BCC	BIC	ECVI
Two-factor model	80.73	81.67	134.37	0.31
One-factor model	140.60	141.48	190.66	0.54

Abbreviations: AIC, Akaike information criterion; BCC, Browne–Cudeck criterion; BIC, Bayes information criterion; ECVI, expected cross-validation index.

experience and veterinary professionals, requires further investigation.

Future studies should validate the CPPS in English and evaluate its reliability and validity across more diverse populations, including veterinary professionals, dog trainers, behaviourists and general caregivers. Additionally, research should investigate its broader applicability and potential role in enhancing canine pain assessment. Longitudinal studies could explore whether higher CPPS scores are associated with improved pain management and better welfare outcomes for dogs. Future research should also assess the CPPS's ability to detect changes over time.

Several factors may influence the accuracy of pain recognition, including the individual's sex, education, empathy levels and attitudes towards animals.[31] Examining these and other influences could inform the development of societal educational initiatives aimed at improving pain detection, facilitating earlier veterinary intervention and ultimately enhancing canine welfare.[6] Further research is also required to determine how caregivers' ability to recognise chronic pain affects both the development and management of behavioural problems in dogs.

CONCLUSION

This study developed and validated the CPPS, filling a critical gap in the assessment of people's ability to recognise chronic osteoarthritis pain in companion dogs. The scale demonstrated excellent internal reliability and strong validity, confirming its robustness for assessing pain perception in a structured and evidence-based manner. A key strength of the CPPS is its accessibility and ease of application. Unlike traditional caregiver-based assessment tools, this scale does not require respondents to own a dog, making it highly versatile. This characteristic expands its applicability to a wide range of fields, allowing so-called citizen science.

AUTHOR CONTRIBUTIONS

Maria Toscano Batista conceived and designed the study, managed the data processing, conducted the statistical analysis, contributed to results, discussion and conclusions and drafted the manuscript. Catarina Lavrador contributed to the study design, discussion and conclusions, critically reviewed the manuscript and provided detailed review regarding pain management. Gonçalo da Graça-Pereira contributed to the study design, discussion and conclusions, critically reviewed and improved the manuscript and provided detailed review regarding behaviour.

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CONFLICT OF INTEREST STATEMENT

The authors declare they have no conflicts of interest.

FUNDING INFORMATION

The authors received no specific funding for this work.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

The study was approved by the Ethics Committee of the University of Évora (Ref. 22170).

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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