UNIVERSIDADE ESTADUAL PAULISTA "JÚLIO DE MESQUITA FILHO"
FACULDADE DE MEDICINA

Marcela Carneiro de Oliveira

# Validated pain scales improve decision-making of untrained students to indicate analgesia in animals

Dissertação apresentada à Faculdade de Medicina, Universidade Estadual Paulista "Júlio de Mesquita Filho", Câmpus de Botucatu, para obtenção do título de Mestra em Anestesiologia.

Orientador: Prof. Dr. Stelio Pacca Loureiro Luna

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Orientador: Stelio Pacca Loureiro Luna
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1. Analgesia. 2. Animais - Proteção. 3. Cuidados pós-operatórios. 4. Dor pós-operatória. 5. Medição da dor.

Palavras-chave: Analgesia; Bem-estar animal; Cuidados pós-operatórios; Dor aguda pós-operatória; Medição da dor.

**ATA DA DEFESA PÚBLICA DA DISSERTAÇÃO DE MESTRADO DE MARCELA CARNEIRO DE OLIVEIRA, DISCENTE DO PROGRAMA DE PÓS-GRADUAÇÃO EM ANESTESIOLOGIA, DA FACULDADE DE MEDICINA.**

Aos 01 dias do mês de março do ano de 2024, às 08:00 horas, por meio de Videoconferência, realizou-se a defesa de DISSERTAÇÃO DE MESTRADO de MARCELA CARNEIRO DE OLIVEIRA, intitulada **Validated pain scales improve decision-making of untrained students to indicate analgesia in animals**. A Comissão Examinadora foi constituida pelos seguintes membros: Prof. Dr. STELIO PACCA LOUREIRO LUNA (Orientador(a) - Participação Virtual) do(a) Depto. de Cirurgia Veterinária e Reprodução Animal / FMVZ/Botucatu - Unesp, Profa. Dra. RENATA NAVARRO CASSU (Participação Virtual) do(a) Universidade do Oeste Paulista (UNOESTE), Profa. Dra. ALICE RODRIGUES DE OLIVEIRA (Participação Virtual) do(a) Depto. de Anatomia, Patologia e Clínicas Veterinárias / EMEVZ/Salvador - UFBA. Após a exposição pela mestranda e arguição pelos membros da Comissão Examinadora que participaram do ato, de forma presencial e/ou virtual, a discente recebeu o conceito final: aprovada _ _ _ _ _ _ . Nada mais havendo, foi lavrada a presente ata, que após lida e aprovada, foi assinada pelo(a) Presidente(a) da Comissão Examinadora.

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Prof. Dr. STELIO PACCA LOUREIRO LUNA

## AGRADECIMENTOS

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**Resumo**

**Objetivo** Nosso objetivo foi investigar se estudantes sem treinamento avaliam a dor aguda pós-operatória de forma semelhante a um especialista e comparar as indicações para analgesia de resgate com base nas opiniões dos estudantes versus sua pontuação nas escalas de dor validadas. Também analisamos como os fatores demográficos e pessoais afetaram a sua avaliação.

**Desenho do estudo** Prospectivo, encoberto, aleatorizado e transversal.

**Animais** Vídeos de um touro, um cavalo, um gato, um porco e uma ovelha.

**Métodos** Alunos do primeiro e terceiro anos de Medicina Veterinária e alunos do quarto ano de Zootecnia assistiram a um ou dois vídeos de animais com dor intensa, de uma ou duas espécies (touro, cavalo, gato, porco e ovelha). Alunos de diferentes turmas assistiram a vídeos de diferentes espécies. Os alunos desconheciam a intensidade da dor de cada animal, responderam se indicariam analgesia de acordo com sua opinião e pontuaram as escalas de dor validadas específicas para cada espécie. Suas pontuações foram comparadas com as pontuações de um professor sênior (especialista) que estava ciente da condição dolorosa apresentada pelos animais. Para a análise estatística, foram utilizados testes de qui-quadrado e modelos de regressão logística.

**Resultados** A indicação de analgesia de resgate segundo a opinião dos estudantes (81,12%) foi inferior à indicada com o uso das escalas (98,6%) ($p = 2.584e-06$). A maioria dos alunos (75%) pontuou dentro da margem de erro de 20% estabelecida a partir da pontuação do especialista para todas as espécies combinadas ($p = 2.897e-09$), para o touro ($p = 2.089e-08$) e o cavalo ($p = 8.868e-05$). Os alunos subestimaram a nota do especialista em 8 a 20%, exceto no caso do cavalo. O sexo, a idade, a experiência anterior do aluno em relação à dor e a experiência de trabalho na área da saúde ou em estágio na área da

medicina veterinária ou zootecnia não influenciaram a pontuação ou a indicação de analgesia. Os alunos que tiveram contato doméstico com as espécies que estavam avaliando tiveram maior probabilidade de pontuar exatamente o mesmo escore atribuído pelo especialista ($p = 0.0331$).

**Conclusões e relevância clínica** Estudantes não treinados podem detectar dor intensa em animais com precisão semelhante à de um especialista. O contato doméstico com a espécie melhora a capacidade dos alunos de pontuar a dor com o mesmo escore que um especialista. O uso de escalas de dor validadas otimizou a indicação para fornecer analgesia quando os animais sofriam dor intensa.

**Palavras-chave**: Analgesia, Bem-estar Animal, Cuidados Pós-Operatórios, Dor Aguda Pós-Operatória, Medição da Dor.

**Abstract**

**Objective** We aimed to evaluate if students without training assess pain similarly to an expert and to compare indications for rescue analgesia based on students´ opinions versus scale scoring. We also analyzed how demographic and personal factors affected their assessment.

**Study design** Prospective, blind, randomized, cross-sectional study.

**Animals** Videos of one bull, horse, cat, pig, and sheep.

**Methods** First- and third-year Veterinary students and fourth-year Animal Science students watched videos of a bull, horse, cat, pig, and sheep. The students were unaware of each animal´s pain intensity, responded as to whether they would indicate analgesia according to their opinion and scored the species-specific validated pain scales. Their scores were compared with a senior professor´s scores (expert).

**Results** The indication for rescue analgesia according to the students' opinion (81.12%) was lower than according to their scale scores (98.6%) ($p < 0.05$). Most students (75%) scored within the 20% margin of error of the expert score for all species combined ($p < 0.05$), the bull ($p < 0.05$) and horse ($p < 0.05$). Students underestimated the expert's score by 8 to 20%, except for the horse. Gender, age, student's previous experience with pain, and their experience in healthcare or in an internship did not influence their scores or indication for analgesia. Students who had domestic contact with the species they were evaluating were more likely to score the exact score assigned by the expert ($p < 0.05$).

**Conclusions and clinical relevance** Untrained students can detect intense pain in animals with a similar accuracy to an expert. Domestic contact with the species improves the ability of students to score pain like an expert. The use of scales optimized the indication for providing analgesia when animals were suffering intense pain.

**Keywords** Analgesia, Animal Welfare, Postoperative Care, Acute Postoperative Pain, Pain Measurement.

## Introduction

Body language is key component to expressing and detecting animal pain (Reid et al. 2007; Brondani et al. 2013; Tomacheuski et al. 2023). Whole-body behavioral changes are easily observed, clinically applicable, non-invasive, and can be assessed remotely (Luna et al. 2020; Monteiro et al. 2023).

Species-specific validated acute pain scales have improved the accuracy and reliability of assessing pain in almost all domestic species (Reid et al. 2007; Brondani et al. 2013; de Oliveira et al. 2014; Taffarel et al. 2015; Luna et al. 2020; Silva et al. 2020; de Oliveira et al. 2021; Haddad Pinho et al. 2022; Fonseca et al. 2023). Their cut-off analgesic rescue indicative scores assist in the decision-making for analgesic provision.

Although scales are the closest to gold standard methods to assess pain in animals, they present limitations. For example, pain scales have usually been validated in controlled studies by experienced and trained veterinarians. Personal and professional experiences (Catanzaro et al. 2016; Adami et al. 2023), age (Valros & Hanninen 2018), and gender (Doodnaught et al. 2017; Evangelista & Steagall 2021; Moody et al. 2022) may alter the final score attributed by different observers, and these differences can interfere with treatment decisions and conclusions about treatment efficacy (Benito et al. 2017). Although recent studies suggested that training may not be necessary to use the Glasgow Feline Composite Measure Pain Scale (CMPS-Feline) (Moody et al. 2022) and that the Feline Grimace Scale can be reliably used by assessors with different experience

levels (Evangelista & Steagall 2021), inexperienced evaluators may have difficulty using these tools (Barletta et al. 2016), and some veterinarians do not feel capable of adequately assessing pain in animals (Lorena et al. 2013; Morales-Vallecilla et al. 2019).

There are useful free accessible scales (www.animalpain.org) and applications available on the internet (Vetpain: https://play.google.com/store/apps/details?id=com.vetpain.app for Android and https://apps.apple.com/ca/app/vetpain/id6462712970 for IOS), to improve knowledge, provide training and enhance accuracy to assess pain in large, small, and lab animals.

We hypothesized that untrained undergraduate students with little or no experience in pain assessment do not score pain as accurately as an expert evaluator and that the use of scales optimizes the precision to indicate rescue analgesia in large and small animals suffering intense pain. Therefore, the current study aimed to investigate whether untrained students can similarly score pain scales and indicate rescue analgesia compared to an experienced evaluator and to compare the indication of rescue analgesia based on the students´ opinion and scale scoring. As a secondary objective, we evaluate the impact of demographic and personal factors on the pain scores assigned by students.

## Materials and Methods

This prospective, blind, randomized, cross-sectional study was previously approved by the Research Ethics Committee of the Botucatu Medical School, University of São Paulo State (UNESP) (CAAE 69754423.8.0000.5411), Brazil, and performed following the Brazilian General Data Protection Law (LGPD - 13.709/2018). The findings were reported according to the Strengthening the Reporting of Observational

Studies in Epidemiology (STROBE) (von Elm et al. 2007) and the Sex and Gender Equity in Research (SAGER) (Van Epps et al. 2022) guidelines.

Recruitment and selection of participants:

The participants included (n=83) were first (44) and third year (23) Veterinary Medicine and fourth-year Animal Science (16) undergraduate students from the School of Veterinary Medicine and Animal Science, UNESP, Botucatu, São Paulo, Brazil (Figure 1). Recruitment took place between August and September 2023, before classes were taught by the senior author (SPLL). Students from different classes completed the assessments on different days. Participation was voluntary and questionnaires were applied in the classroom. Since all students present in the classroom were invited to participate, it was not established a method for adequate representation of male and female participants in the study, therefore there was no sex or gender discrimination.

Inclusion and exclusion criteria:

The participants were at least 18 years of age and signed a free and informed consent form. Participants who refused to complete the consent form, returned incomplete assessment forms, or had already undergone any type of training in animal pain assessment were excluded (Figure 1).

The objectives and methodology of the study were explained to the students and included in the consent form. The participants could request exclusion from the study at any time and the privacy and confidentiality of their data were guaranteed.

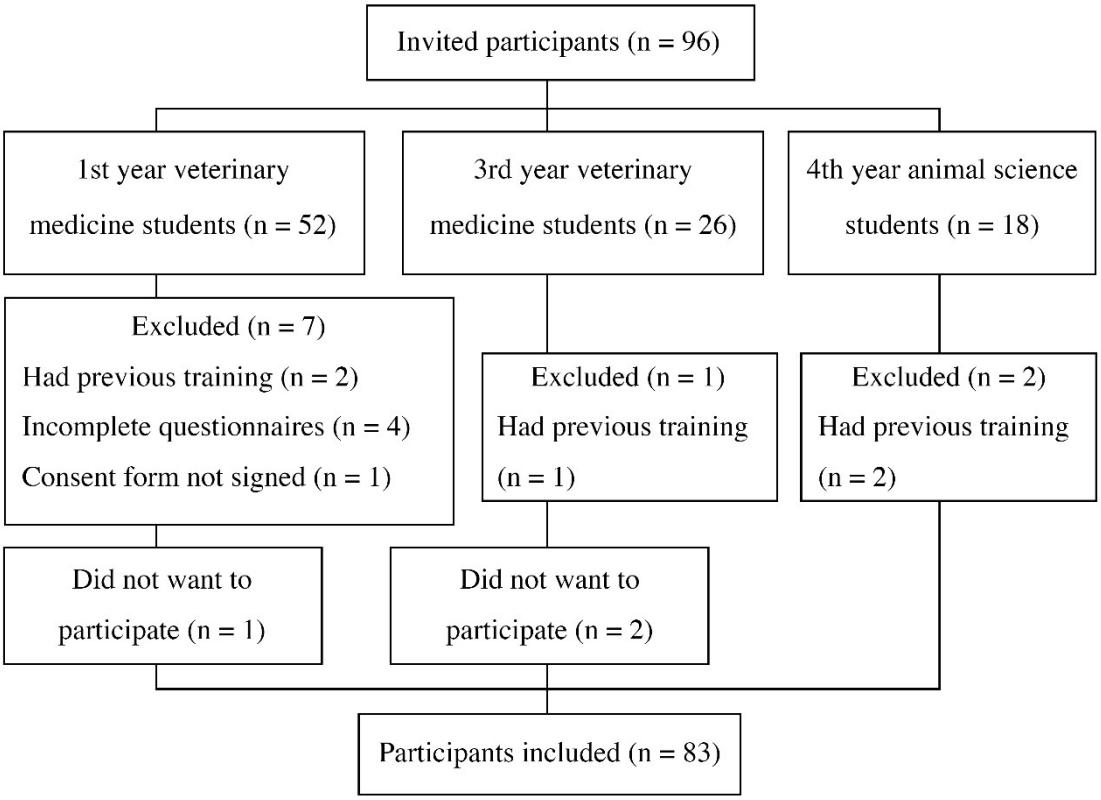


**Figure 1 -** Infographic of participants included and excluded in the study according to the number of students invited and the reasons for excluding participants.

Questionnaire:

Prior to video analysis, participants completed a questionnaire in Brazilian Portuguese, including full name, email, date of birth, self-reported gender, previous experience with pain assessment in animals, domestic contact with the species evaluated, personal experience with pain, and previous work and internship experience in healthcare.

Videos:

Four videos were selected from the website www.animalpain.org or the Vetpain® application and one video was selected from our data (one video of each species: bull, horse, cat, pig, and sheep – Table 1). The videos presenting an animal with acute

postoperative pain lasted between 2 and 5 minutes and were produced in previous studies, to develop and validate pain scales to assess postoperative pain (Luna et al. 2020; Silva et al. 2020; Barreto da Rocha et al. 2021; Belli et al. 2021; Tomacheuski et al. 2023). The current study did not have any involvement in the procedures which the animals underwent, including the anesthesia and analgesia provided. To ensure blind assessment, information such as age, sex, breed, type of procedure, and analgesic treatment were not retained for this study and students did not have access to this information. Only one video of each species was used to avoid the students' learning curve.

Videos were previously scored by the senior author of the study, a Diplomate of the European College of Veterinary Anaesthesia and Analgesia, responsible for the Animal Pain website and development of the species-specific pain scales, who was aware of the painful condition presented by the animals. His assessment was considered as the reference (expert) to compare with the students' assessments (Table 1).

Pain assessment scales:

Pain was assessed using the validated pain scales in Brazilian Portuguese and their respective scores suggestive of analgesic intervention: the Unesp-Botucatu cattle (UCAPS) (de Oliveira et al. 2014), horse (UHAPS) (Taffarel et al. 2015; Barreto da Rocha et al. 2021), feline (Short Form - UFEPS-SF) (Belli et al. 2021; Luna et al. 2022), pig (UPAPS) (Luna et al. 2020), and sheep (USAPS) (Silva et al. 2020) pain assessment scales, validated according to the COSMIM guidelines (Mokkink et al. 2010; Gagnier et al. 2021). To avoid influencing the responses, the assessors were unaware of the analgesic intervention point for each scale and there were no indicative scores on any scale.

**Table 1 -** Description of evaluated videos and scales used by each group of assessors and the expert's score.

| Species | Video (name on animalpain.org website or in possession of the authors) | Class | Mean ± standard deviation of scores assigned by students | Expert score and maximum scale score |
|---|---|---|---|---|
| Bull | Test 01 (animalpain.org) | 1st-year Veterinary Medicine | 8.23 ± 01.06 | 09 / 10 |
| Horse | Test 01 (animalpain.org) | 1st-year Veterinary Medicine | 8.14 ± 02.06 | 08 / 15 |
| Cat | #1 (in possession of the authors) | 3rd-year Veterinary Medicine | 10.30 ± 01.87 | 12 / 12 |
| Pig | Test 09 (animalpain.org) | 3rd-year Veterinary Medicine | 09.57 ± 02.23 | 12 / 18 |
| Sheep | Test 09 (animalpain.org) | 4th-year Animal Science | 09.94 ± 01.24 | 12 / 12 |

Assessments:

The scales were not previously presented to the students. Evaluators responded in Google Forms® using their own mobile devices. Participants scored one video of each species according to the class to which they belonged. All videos showed an animal with severe pain according to the expert's assessment; therefore, all pain scores were above the indicative cut-off point for analgesic intervention. The videos were displayed only once on the main screen of the classroom. After watching each video and before scoring the scales, students answered whether, in their opinion, they would administer rescue analgesia to that animal.

The species assessed by different student classes are expressed in Table 1 and were determined randomly (www.randomizer.org). The main authors (MCO and SPLL) were present throughout the study to guide the students on filling out the forms, however, they did not provide comments related to the video assessment. Students were not allowed to discuss the assessments.

Statistical analysis:

Data were exported from Google Forms to Excel® (Microsoft), where inclusion and exclusion criteria were verified. Statistical analyses were performed using R software in the RStudio integrated development environment (Version 4.2.1 – RStudio, Inc.). For all analyses, a significance level (α) of 5% was considered. The calculation of sample size was based on the chi-square test for proportion to detect a difference between the proportion of the same scores assigned by students compared to the expert *versus* those that assigned different values. For this purpose, the "pwr.chisq.test" function from package "pwr" was used to determine parameters to obtain the target power. Variables

were set as follows: effect size (w) 0.80; number of degrees of freedom (df) 1, level of significance (α value) 0.05, and power 0.80. This resulted in a minimum number of observations equal to 13 students.

Responses from all assessments and participants were combined and descriptive statistics was performed (n, frequencies; Table 2). In cases of incomplete questionnaires, the entire evaluation of that student for that animal was disregarded.

The analysis was based on measures of success compared to the expert. We used the chi-square test to detect a difference between the proportion of the same scores assigned by students compared to the expert *versus* those that assigned different values (0 = different and 1 = same) and to compare the proportion of students that assigned scores within or outside of the 20% margin of error (above and below) according to the expert score (0 = outside the 20% margin of error and 1 = within the 20% margin of error). The Pearson chi-square (stats::chisq.test) test was used to test: 1) the hypothesis that there was a difference between the decision to provide analgesic rescue according to the student´s opinion and the score assigned by the student using the scales, considering the cut-off point defined for analgesic intervention for each scale; 2) whether there was a difference between the analgesic indication by the expert and 2a) the students' opinion ("Do you think this animal should receive analgesia?" 0 = no and 1 = yes) and 2b) the students´ scale scores, based on the analgesic intervention point of each scale (UFEPS-SF, UPAPS, UCAPS, and USAPS: $< 4 = 0$ and $\geq 4 = 1$; UHAPS: $< 5 = 0$ and $\geq 5 = 1$), and 3) the difference between underestimation and overestimation of students' scores in relation to the expert's exact score (0 = no and 1 = yes). In addition, a delta value was calculated based on the difference between scores assigned by the students and the expert and subjected to an individual linear model (stats::lm) to test data normality. The residual

error of the model (stats::residuals) did not indicate adherence to a Gaussian distribution by histogram (stats::hist) and by Shapiro-Wilk test (stats::shapiro.test) even after the Box-Cox transformation (lambda -0.05159431) (car::powerTransform) for the delta values.

Four generalized linear models (stats::glm) (one for each dependent variable) were used to assess the matching of total scores (exact or within a 20% margin of error) and the provision of analgesic rescue according to the use of scales and students' opinions regarding the expert, considering gender, age, year of undergraduate course, personal experience with pain and pain assessment in animals, domestic contact with the evaluated species, and internship experience in healthcare. Multiple comparisons in the post-hoc test were adjusted using the Bonferroni procedure (lsmeans::lsmeans and multcomp::cld). Results were illustrated with box plots (ggplot2::geom_boxplot), violin plots (ggplot2::geom_violin), and bar charts (ggplot2::geom_bar).

**Results**

Participants:

Eighty-three of 96 students were included in the study: 44 (53%) and 23 (28%) of the first and third-year veterinary medicine course respectively, and 16 (19%) of the fourth-year animal science course (Figure 1). Students were aged between 18 and 32 years (20.62 ± 2.89) and were predominantly female (61/83; 73%). Regarding evaluators' previous experience with painful conditions, the majority of students had not undergone a surgical procedure under general anesthesia (58/83; 70%) and had not taken analgesics for chronic pain (53/83; 64%). In addition, most students had no prior experience with animal pain assessment (64/83; 77%), had no domestic contact with animals of the species evaluated (65/83; 78%), and had neither performed an internship

199 in the field of veterinary medicine or animal science nor had previous experience in
200 healthcare (49/83; 59%) (Table 2). Descriptive statistics related to the evaluation of each
201 species are shown in Table 3.

**Table 2.** Information and demographic data of participants. Data are displayed as frequency of students in each category.

| | Combined data | Bull | Horse | Cat | Pig | Sheep |
|---|---|---|---|---|---|---|
| Female | 61/83 (73.49 %) | 33/39 (84.62 %) | 36/44 (81.82 %) | 14/23 (60.87 %) | 12/21 (57.14 %) | 11/16 (68.75 %) |
| Male | 22/83 (26.51 %) | 6/39 (15.38 %) | 8/44 (18.18 %) | 9/23 (39.13 %) | 9/21 (42.86 %) | 5/16 (31.25 %) |
| "Have you ever undergone surgery under general anesthesia?" | | | | | | |
| No | 58/83 (69.88 %) | 31/39 (79.49 %) | 33/44 (75.00 %) | 16/23 (69.57 %) | 14/21 (66.67 %) | 9/16 (56.25 %) |
| Yes | 25/83 (30.12 %) | 8/39 (20.51 %) | 11/44 (25.00 %) | 7/23 (30.43 %) | 7/21 (33.33 %) | 7/16 (43.75 %) |
| "Have you taken analgesics for a chronic painful condition?" | | | | | | |
| No | 53/83 (63.86 %) | 25/39 (64.10 %) | 28/44 (63.64 %) | 18/23 (78.26 %) | 16/21 (76.19 %) | 7/16 (43.75 %) |
| Yes | 30/83 (36.14 %) | 14/39 (35.90 %) | 16/44 (36.36 %) | 5/23 (21.74 %) | 5/21 (23.81 %) | 9/16 (56.25 %) |
| "Do you have any experience with pain assessment in animals?" | | | | | | |
| No | 64/83 (77.11 %) | 32/39 (82.05 %) | 36/44 (81.82 %) | 15/23 (65.22 %) | 13/21 (61.90 %) | 13/16 (81.25 %) |
| Yes | 19/83 (22.89 %) | 7/39 (17.95 %) | 8/44 (18.18 %) | 8/23 (34.78 %) | 8/21 (38.10 %) | 3/16 (18.75 %) |
| "Do you currently or have you previously have had at home animals of the species evaluated in the study?" | | | | | | |
| No | 65/83 (78.31 %) | 37/39 (94.87 %) | 41/44 (93.18 %) | 11/23 (47.83 %) | 20/21 (95.24 %) | 13/16 (81.25 %) |
| Yes | 18/83 (21.69 %) | 2/39 (05.13 %) | 3/44 (06.82 %) | 12/23 (52.17 %) | 1/21 (04.76 %) | 3/16 (18.75 %) |
| "Do you have, or have you had any work/internship experience in the healthcare field?" | | | | | | |
| No professional or internship experience | 49/83 (59.04 %) | 31/39 (79.49 %) | 35/44 (79.55 %) | 02/23 (08.70 %) | 02/21 (09.52 %) | 12/16 (75.00 %) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Internship experience | 31/83 (37.35 %) | 7/39 (17.95 %) | 8/44 (18.18 %) | 21/23 (91.30 %) | 19/21 (90.48 %) | 2/16 (12.50 %) |
| Veterinary Technician | 1/83 (01.20 %) | 0/39 (0.00 %) | 0/44 (0.00 %) | 0/23 (0.00 %) | 0/21 (0.00 %) | 1/16 (06.25 %) |
| Human Health Professional | 2/83 (02.41 %) | 1/39 (02.56 %) | 1/44 (02.27 %) | 0/23 (0.00 %) | 0/21 (0.00 %) | 1/16 (06.25 %) |

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**Table 3 -** Proportion of the exactly matched scores and within the 20% margin of error between students' and expert's total score and of the students' scores below and above this margin of error.

| | Exactly matched scores | Underestimation | Overestimation | 20% margin of error | Below 20% margin of error | Above 20% margin of error |
|---|---|---|---|---|---|---|
| Combined data | 29/143 (20.28%) * | 85/143 (59.44%) † | 29/143 (20.28%) | 107/143 (74.82%) | 32/143 (22.38%) | 04/143 (02.80%) |
| Bull | 10/39 (25.64%) * | 24/39 (61.54%) † | 05/39 (12.82%) | 37/39 (94.87%) | 02/39 (05.13%) | 00/39 (00.00%) |
| Horse | 05/44 (11.36%) * | 17/44 (38.64%) | 22/44 (50.00%) | 35/44 (79.55%) | 05/44 (11.36%) | 04/44 (09.09%) |
| Cat | 08/23 (34.78%) | 15/23 (65.22%) † | 00/23 (00.00%) | 15/23 (65.22%) | 08/23 (34.78%) | 00/23 (00.00%) |
| Pig | 03/21 (14.29%) * | 16/21 (76.19%) † | 02/21 (09.52%) | 11/21 (52.38%) | 10/21 (47.62%) | 00/21 (00.00%) |
| Sheep | 03/16 (18.75%) * | 13/16 (81.25%) † | 00/16 (00.00%) | 09/16 (56.25%) | 07/16 (43.75%) | 00/16 (00.00%) |

* Statistical difference between students' scores exactly matched and different from expert´s scores ($p < 0.05$). † Statistical difference between underestimation and overestimation ($p < 0.05$).

Student scores compared to expert´s scores:

There was no difference between the proportion of indication of analgesic rescue given by the expert (100%) and students (141/143; 98.6%) in the combined data based on the cut-off point of the scales ($p = 0.478$) and for each species, however these proportions were greater than the indication of rescue analgesia according to the students' opinion (116/143; 81.12%) in the combined data (respectively $p = 1.456e-07$ and 2.584e-0). The score given by the students indicated more analgesic rescues based on the cut-off point of the scales than based on their own opinion in bull ($p = 0.03362$), horse ($p = 7.223e-05$), and pig ($p = 0.02747$)]), but not the cat ($p = 1$) and sheep ($p = 1$) (Figure 2).

Except for the cat ($p = 0.1444$), the proportion of scores assigned by students that were the same as the expert was lower than those assigned by students that were different from the expert for all combined species ($p = 1.177e-12$), the bull ($p = 0.002347$), horse ($p = 2.964e-07$), pig ($p = 0.001063$), and sheep ($p = 0.01242$). Otherwise, a greater percentage of students scored within the 20% margin of error of the expert score for all combined species ($p = 2.897e-09$), the bull ($p = 2.089e-08$) and horse ($p = 8.868e-05$), but not for cat ($p = 0.1444$), pig ($p = 0.8273$), and sheep ($p = 0.6171$) (Figure 2).

In general, students' mean scores underestimated the expert's score, both for combined data ($-1.03 \pm 1.98$) and for each species: bull ($-0.77 \pm 1.06$; -8.56%), cat ($-1.69 \pm 1.87$; -14.17%), pig ($-2.43 \pm 2.23$; -20.25%) and sheep ($-2.06 \pm 1.24$; -17.7%), except for horse ($0.14 \pm 2.06$; +1.75%) (Figure 3). The percentage of students who underestimated the expert´s score was significantly higher than those who overestimated for the general data ($p = 3.085e-11$) and for the bull ($p = 2.474e-05$), cat ($p = 1.066e-05$), pig ($p = 5.047e-05$) and sheep ($p = 1.566e-05$), except for horse ($p = 0.3907$). No students overestimated the expert's score for the cat and sheep (Table 3).

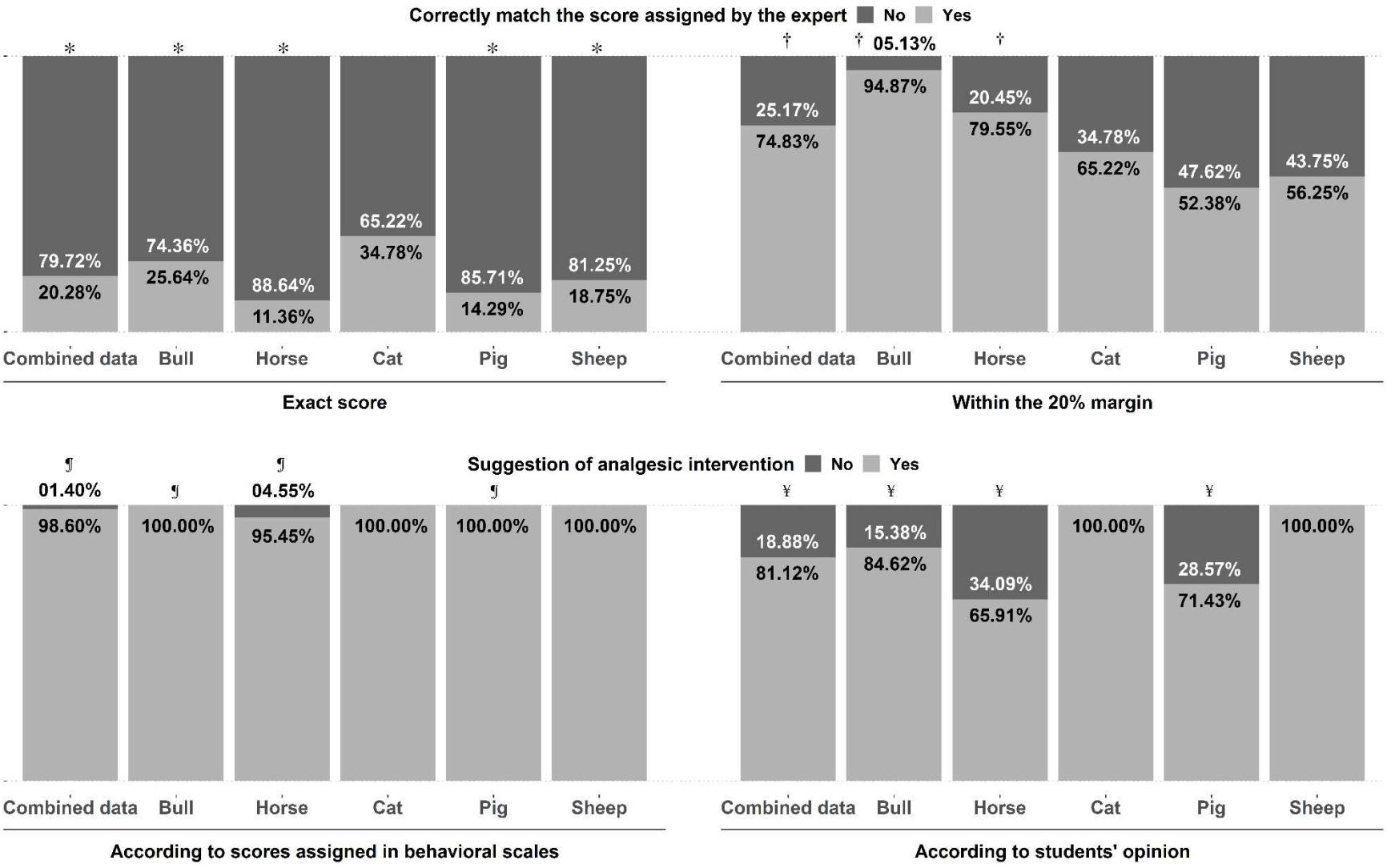
Correctly match the score assigned by the expert
No
Yes
*
*
*
*
*
*
79.72%
20.28%
74.36%
25.64%
88.64%
11.36%
65.22%
34.78%
85.71%
14.29%
81.25%
18.75%
Combined data
Bull
Horse
Cat
Pig
Sheep
Exact score
†
† 05.13%
†
25.17%
74.83%
94.87%
20.45%
79.55%
34.78%
65.22%
47.62%
52.38%
43.75%
56.25%
Combined data
Bull
Horse
Cat
Pig
Sheep
Within the 20% margin
Suggestion of analgesic intervention
No
Yes
¶
¶
¶
01.40%
98.60%
¶
100.00%
04.55%
95.45%
100.00%
100.00%
100.00%
Combined data
Bull
Horse
Cat
Pig
Sheep
According to scores assigned in behavioral scales
¥
¥
¥
¥
18.88%
81.12%
15.38%
84.62%
34.09%
65.91%
100.00%
28.57%
71.43%
100.00%
Combined data
Bull
Horse
Cat
Pig
Sheep
According to students' opinion

**Figure 2 -** Stacked bar chart representing a) the number of scores assigned by students that were different or equal (left) and within the 20% margin (right) to those assigned by the expert and b) the number of suggestions for analgesic intervention according to each scale's cut-off point (left) and based on students' opinions (right). * Failure to match the exact score assigned by the expert ($p < 0.05$). † Significantly more scores assigned by students within than out the 20% margin of error of the expert's score ($p < 0.05$). ¶ Significantly more analgesic suggestion according to students' scale scores compared to their opinion (left columns *versus* right columns) ($p < 0.05$). ¥ Significantly less analgesic suggestion according to students' opinion compared to expert's scale scores (100% in all cases) ($p < 0.05$).

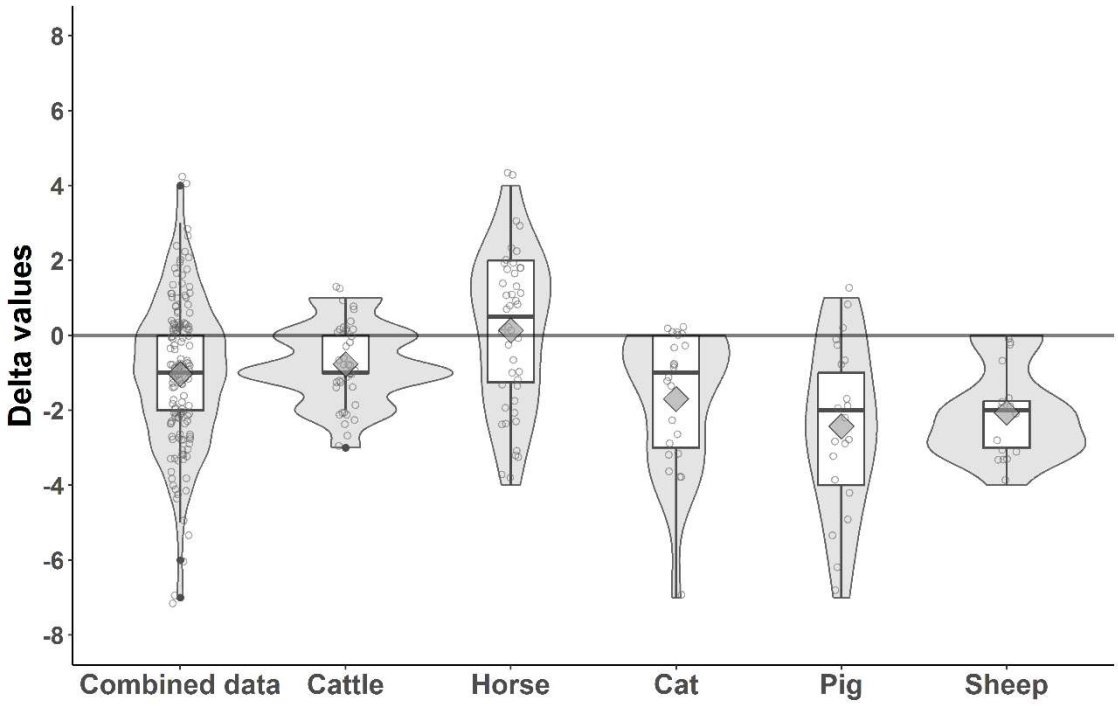


**Figure 3 –** Box plot and violin plot representing delta value based on the difference between scores assigned by the students and the expert. The bold line within the box represents the median, ◊ represents the mean value, the top and bottom box lines represent the interquartile range (25 to 75%), and the extremes of the whiskers represent the minimum and maximum values.

Logistic regression models:

Gender, age, student's previous experience with chronic or acute post-operative pain, and their experience in healthcare or with internship programs did not influence the student's pain scores and their indication for analgesic intervention.

Students who had domestic contact with the species they were evaluating were more likely to correctly match the exact score assigned by the expert compared to students who did not (0.381 vs. 0.172; $p = 0.0331$).

Students who already had some experience with pain assessment were less likely to suggest analgesic rescue according to their opinion compared to students who did not have this experience (0.676 vs. 0.853; $p = 0.0248$).

## Discussion

Our hypothesis was denied as there was no difference between the indication for analgesic rescue in animals suffering intense pain between the expert and untrained students when using validated pain scales and their cut-off point as a guide to provide analgesics. The ability to detect pain was improved when students used scales in comparison to their opinion. This result is in line with a survey carried out with veterinarians in Colombia, who reported finding it easier to identify than to quantify pain (Morales-Vallecilla et al. 2019).

Approximately 20% of the students would not indicate analgesic rescue according to their opinion, an alarming result considering animal welfare. Alternatively, the advantage of using the scales was that, even without any training and experience, only 1.4% of students would not indicate analgesic rescue for the animals. This suggests that the use of scales significantly improved the indication for providing analgesia when animals suffer intense pain, positively impacting animal welfare. In all cases, animals had high pain scores, therefore the accuracy to provide rescue analgesia might be worsened in case of moderate pain, when the behavioral signs are not so obvious.

Although pain management in animals has improved over time, assessing pain in individuals who do not verbalize their pain is challenging. The current study showed that only in the feline species, untrained undergraduate students' pain scores had a good match with an experienced evaluator. Except in the horse, most students

underestimated pain in the other species, however because their scores were above the cut-off point, if they were acting in clinical practice, almost all students would indicate rescue analgesia in animals suffering intense pain.

There is some evidence that a short training session observing pain behaviors improved recognition of rats suffering pain (Roughan & Flecknell 2006) and anecdotal evidence suggests that the lack of training offered by institutions is a possible cause for the insufficient knowledge of Brazilian scientists about pain assessment in animals (Tomacheuski et al. 2020). In cats training did not affect the decision for analgesic indication by unfamiliar assessors compared to experts using the CMPS-Feline (Moody et al. 2022), however differently from the current study, in that study unfamiliar assessors tended to overestimate pain scores. In that study although 73% of the participants had never previously used a pain scoring tool, 69% had already assessed pain without tools and 84% had handled cats suffering pain, therefore most participants had some experience in pain assessment which might explain their overestimation compared to our study where underestimation was observed. The Feline Grimace Scale can also be reliably used by trained veterinarians, veterinary students, and cat owners even with different experience levels (Evangelista & Steagall 2021). In the current study experience was not relevant for the correct detection of intense pain in animals when using pain scales. Therefore, although familiarity with the species evaluated seems to improve the ability to detect pain, it is still unclear whether experience and training significantly improve the accuracy of pain assessment in animals and further investigations are required.

Similarly to the current study, students tended to underestimate the anesthesiologists' CMPS-SF scores in dogs suffering intense pain (Barletta et al. 2016). Alternatively, in Doodnaught et al. (2017), study pain scores assigned by undergraduate

282 students were higher than by more experienced evaluators, however the dog presented
283 signs of sedation. In the same study there was no difference between experienced and
284 students´ scores of UFEPS and CMPS-Feline in cats (Doodnaught et al. 2017).
285 Underestimation of the expert´s mean pain scores in the current study was at most 20%
286 lower, which may be tolerable. From a clinical point of view, the appropriate indication
287 for analgesic rescue may be more relevant than the accuracy of the exact score compared
288 to the expert (Barletta et al. 2016).

289 Our secondary goal was to investigate whether demographic data and
290 personal experience with pain and with handling the evaluated species, would have any
291 influence on these results. Studies have reported that women have more empathy towards
292 pain than men (Sadeghiyeh et al. 2012; Christov-Moore et al. 2014). Female veterinarians
293 thought that small animals suffer more pain after surgery (Beswick et al. 2016) and
294 ascribed higher pain scores than male veterinarians (Williams et al. 2005; Catanzaro et
295 al. 2016; Evangelista & Steagall 2021). However, this view has been under debate
296 recently. For example, in cats, male evaluators scored higher pain scores (Moody et al.
297 2022), and in the current study, gender did not affect pain scores. A possible explanation
298 for these gender-different results may be associated with cultural and/or personal factors
299 and/or familiarity with the species and/or instruments, therefore the debate persists.

300 Age may be another factor that affects pain assessment. Younger
301 veterinarians assigned higher pain scores compared to older ones (Raekallio et al. 2003;
302 Lorena et al. 2014). In addition, an evaluator's previous experience with similar painful
303 conditions to those presented by the animals may (Catanzaro et al. 2016) or may not
304 (Doodnaught et al. 2017) influence pain scores. In the present study, students´ age, and
305 previous experience with internship programs or with personal post-operative or chronic

pain did not impact their assessment of pain scores. Otherwise, students who had domestic contact with the animal species they evaluated performed better in matching the expert´s score, possibly because more than 50% of the third-year students had cat(s) at home. However, the reason why students who had previous experience with pain assessment suggested less analgesic rescue based on their opinion is difficult to explain.

Evaluators watched the videos only once to promote uniform assessment and avoid a learning curve. One drawback of this method is that students might have missed important behaviors for proper assessment, which may have led to the underestimation of scores in relation to the expert. Furthermore, it is possible that because the students were not familiar with the scales before watching the videos, they did not know which behaviors they should pay attention to.

A limitation of the current study was that different groups assessed different species, which prevents to comparisons of inter-species effects of age and year of under-graduation. Our intention was to assess species other than only small animals, which are not normally studied, and we could not include too many videos in each class to avoid exhaustion of the observers. For this reason, only one video of each species was used.

The next step is to assess the performance of untrained students when evaluating moderate pain and, in cases where the results are unsatisfactory, to investigate the effect of training on the pain assessment performance.

## Conclusions

When using species-specific validated scales, although untrained students tend to underestimate intense pain, they indicate rescue analgesia in animals similarly to

329 an expert. Students' domestic contact with the species improves their ability to score pain
330 like an expert.
331
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