

REVIEW

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# How to objectively assess and observe maladaptive pain behaviors in clinical rehabilitation: a systematic search and review

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## Abstract

**Background:** Cognitive-affective factors influence the perception of pain and disability. These factors can lead to pain behaviors (PB) that can persist and become maladaptive. These maladaptive PB will further increase the risk of chronicity or persistence of symptoms and disability. Thus, clinicians must be prepared to recognize maladaptive PB in a clinical context. To date, in the context of assessment in a rehabilitation setting, PB in clinical settings are poorly documented. The main objective of this study was to identify direct observation methods and critically appraise them in order to propose recommendations for practice. As a secondary objective, we explored and extracted the different observable PB that patients could exhibit and that clinicians could observe.

**Methods:** We conducted a comprehensive review on four databases with a generic search strategy in order to obtain the largest range of PB. For the first objective, a two-step critical appraisal used clinical criteria (from qualitative studies on barriers to implement routine measures) and psychometric criteria (from Brink and Louw critical appraisal tool) to determine which observation methods could be recommended for clinical practice. For the second objective, we extracted PB found in the literature to list potential PB that patients could exhibit, and clinicians could observe.

**Results:** From the 3362 retrieved studies, 47 met the inclusion criteria for the first objective. The clinical criteria allowed us to select three observation methods. After the psychometric step, two observation methods were retained and recommended for clinical practice: the Behavioral Avoidance Test-Back Pain (BAT-Back) and the Pain Behaviour Scale (PaBS). For the second objective, 107 studies met the inclusion criteria. The extraction of the PB allowed us to list a large range of PB and classify the data in 7 categories of PB.

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**Conclusion:** Our results allowed us to recommend two observation methods for clinical practice. However, these methods have limitations and are validated only in chronic low back pain populations. With the extraction of PB presented in the literature, we contribute to better prepare clinicians to recognize PB in all patients who are experiencing pain.

**Keywords:** Pain behavior, Assessment, Protective behavior, Endurance behavior, Avoidance behavior, Musculoskeletal pain

## Introduction

The biopsychosocial model of pain strongly supports that in addition to biological and social factors, cognitive-emotional factors drive the experience of pain and disability [1–4]. According to a systematic review of the best practice care for musculoskeletal pain, the authors conclude that the assessment of psychosocial factors should be an essential part of the evaluation process [5]. This suggests that the evaluation of maladaptive cognitions and emotions should specifically be assessed by rehabilitation professionals.

According to the Fear-Avoidance Model, maladaptive cognitions (e.g., Pain catastrophizing) and maladaptive emotions (e.g., Fear of movement) may contribute to the development of avoidance-related pain behaviors (PB) [6]. In addition to the avoidance patterns, the Endurance-Avoidance Model proposes that thought suppression or distraction may lead to endurance-related pain behaviors [7], namely, the opposite of the avoidance behaviors. The persistence of these PB may lead to poor outcomes and are known risk factors for the recurrence of pain and chronicity [8–10].

PB are defined as “the behavioral alterations observed in individuals experiencing pain” [11] and consist of two main categories. The first category includes protective PBs, which is defined as “any action primarily aimed at minimizing the experience of pain, promoting recovery from injury, or reducing the probability of further injury” [11] (e.g. avoiding a threatening task). The second category includes communicative PBs, which is defined as “observable behaviors meant to communicate to others that one is experiencing pain” [12] (e.g. touching the painful area after task performance). Some could argue that protective PB may also serve as a communicative function when they are viewed by others, and that communicative behaviors may also serve to seek support or assistance from the patient’s social environment [11]. By definition, these categories are only applicable to avoidance behaviors.

However, since the definition of PBs covers a large range of behaviors such as vocalizations, sighing, rubbing, posture modification, and movement modification, the interpretation of the PB as adaptive or maladaptive is often difficult. A specific PB may be adaptive in the short term (e.g. relative rest after injury), but may

become maladaptive if it persists [9] or becomes more frequent [13]. A PB may have negative outcomes in the short term but may have a positive outcome in a long-term (e.g. a return to physical activity leads to an increase in pain in the short term, but a decrease in pain in the long term) [14, 15]. Moreover, the contextual and social environment can also modify the manifestations of the PB [16, 17].

As maladaptive pain behaviors can be expressed in many different ways [18], clinicians can often struggle to detect relevant findings in a clinical environment. Knowledge of maladaptive behaviors is critical in understanding, assessing, and treating persistent pain [19]. Yet, to our knowledge, there is no review documenting the observation methods to objectively assess PB in patients with musculoskeletal pain. The main objective of this study was to identify direct observation methods and critically appraise them in order to propose recommendations for practice. As a secondary objective, we explored and extracted the different observable PB that patients could exhibit and that clinicians could observe.

## Methods

### Design

We chose a *systematic search and review* to answer our main objective. This design combines the strengths of a critical review with a comprehensive search process that typically addresses broad questions to produce a synthesis of best evidence [20]. We aimed to answer this specific research question: What are the direct observation methods, adapted to clinical settings, to assess PBs in an adult population ( $\geq 18$  years-old) experiencing musculoskeletal pain. For our second objective, we chose a narrative review to present the PBs identified from the literature.

This review was registered with the PROSPERO database: CRD42018093102.

### Identification and selection of studies

For both objectives, four (4) databases (CINAHL, PubMed, PsycInfo, Scopus) were explored. Literature addressing observable pain behavior was examined using the most generic search strategy: (“pain behavior” OR “pain behaviour” OR “avoidance behavior” OR “endurance behavior” OR “avoidance behaviour” OR “endurance behaviour”) NOT (animal OR animals OR mice OR

mouse OR rat OR rats OR dog OR dogs OR rodent OR rodents OR murine OR adolescent OR adolescents OR child OR children OR pediatri\* OR “cognitive impaired” OR “cognitive impairment”) with title filter. The choice of a generic search strategy was based on the intention to target the largest range of studies on pain behavior. Also, we used title filter to focus on the literature that the purpose is specific to PB. Only literature published in English and French was included. This search was performed in March 2020 thus the search period was from inception to March 2020.

After removing duplicates, the screening of the records was made by two independent evaluators (CC, and FN) who screened the study titles and abstracts to identify eligible articles for the full-text review. For this first step, the selection was based on common criteria for the two objectives. To be included, the potential studies had to present content meeting three inclusion criteria. Because of the abundance of literature on the specific topics of pain in people with cognitive and communicative impairments, we decided to add two exclusion criteria (detailed inclusion/exclusion criteria are presented in Table 1).

The assessment for eligibility of the full-text articles was made by the same two independent evaluators (CC, and FN). This assessment presented specific criteria for each objective. For the first objective, two inclusion criteria were applied (Table 1). For the second objective, one inclusion criterion was applied (Table 1). Because pain is not specific to a condition, we broadened the selection of studies to include all populations for objective 2. The final decision on article inclusion was made by consensus. In case of disagreement, a third reviewer (YTL) was available to make the final decision.

**Table 1** Selection criteria

RECORDS SCREENING	
For the two objectives	
Inclusion criteria	1) Observable behaviors related to the experience of pain 2) Human participants 3) Adult participants (> 18 years-old)
Exclusion criteria	1) Participants with cognitive or communicative impairments 2) Studies in other language than English and French
FULL-TEXT ASSESSMENT FOR ELIGIBILITY	
For the first objective: <i>Observation methods to assess pain behaviors</i>	
Inclusion criteria	1) Participants with musculoskeletal pain 2) Use of a direct observation method with enough details to reproduce it
For the second objective: <i>Pain behaviors present in the selected literature</i>	
Inclusion criterion	1) behavior that can be directly observed by clinicians

**Critical appraisal of assessment tools (1st objective)**

Because one of the aims of a systematic search and review is to make recommendations for practice, we developed a triage process to further refine the selection before extracting the data. The triage process was based on clinical and psychometric aspects. We used the reported barriers to implement outcome measures from qualitative data to determine relevant clinical criteria [21, 22]. To be included, the tool had to meet each of these clinical criteria:

- The time to complete the observation method had to be equal or less than 10 min. In case of observation during a more comprehensive assessment (clinicians obtain more information than PB alone), this procedure had to be equal or less than 30 min.
- The scoring method had to be made without the use of videotaping.
- An interpretation of the score to help clinicians in their care plan had to be inherent to the tool.
- The tasks performed during the observation method had to require no special equipment and had to be made with commonly-used equipment (if required).

Afterwards, the studies that met the clinical criteria were methodologically appraised for their measurement (psychometric) properties based on the Critical Appraisal Tool (CAT) developed by Brink and Louw [23]. The CAT consists of a 13-item checklist to assess the validity and reliability of clinical instruments. We removed items three, seven, nine, and eleven as they were specific to concurrent validity and not relevant to the nature of our analysis. As other items were conditional, some items could be rated as not applicable. To estimate the study quality (based on the CAT), we used the ratio (percentage) between the number of items with a positive answer (yes) and the total number of relevant items [24]. We used a cut-off of 60%, where a given tool was rated > 60%, it was deemed acceptable and retained for further analysis [25]. All appraisal-related procedures were made by two independent evaluators (CC, FN). In case of disagreement, a third evaluator (YTL) was available to make the final decision.

**Data extraction and data analysis**

Two independent evaluators (CC, FN) extracted the data from the retained observation methods. A third evaluator (YTL) verified the extraction.

For the first objective, we extracted the data regarding: the aim of the observation method, its clinical administration, the observed PB, the scoring and its interpretation, the clinical benefits of the method, the result of the statistical analysis of validity and reliability, and the

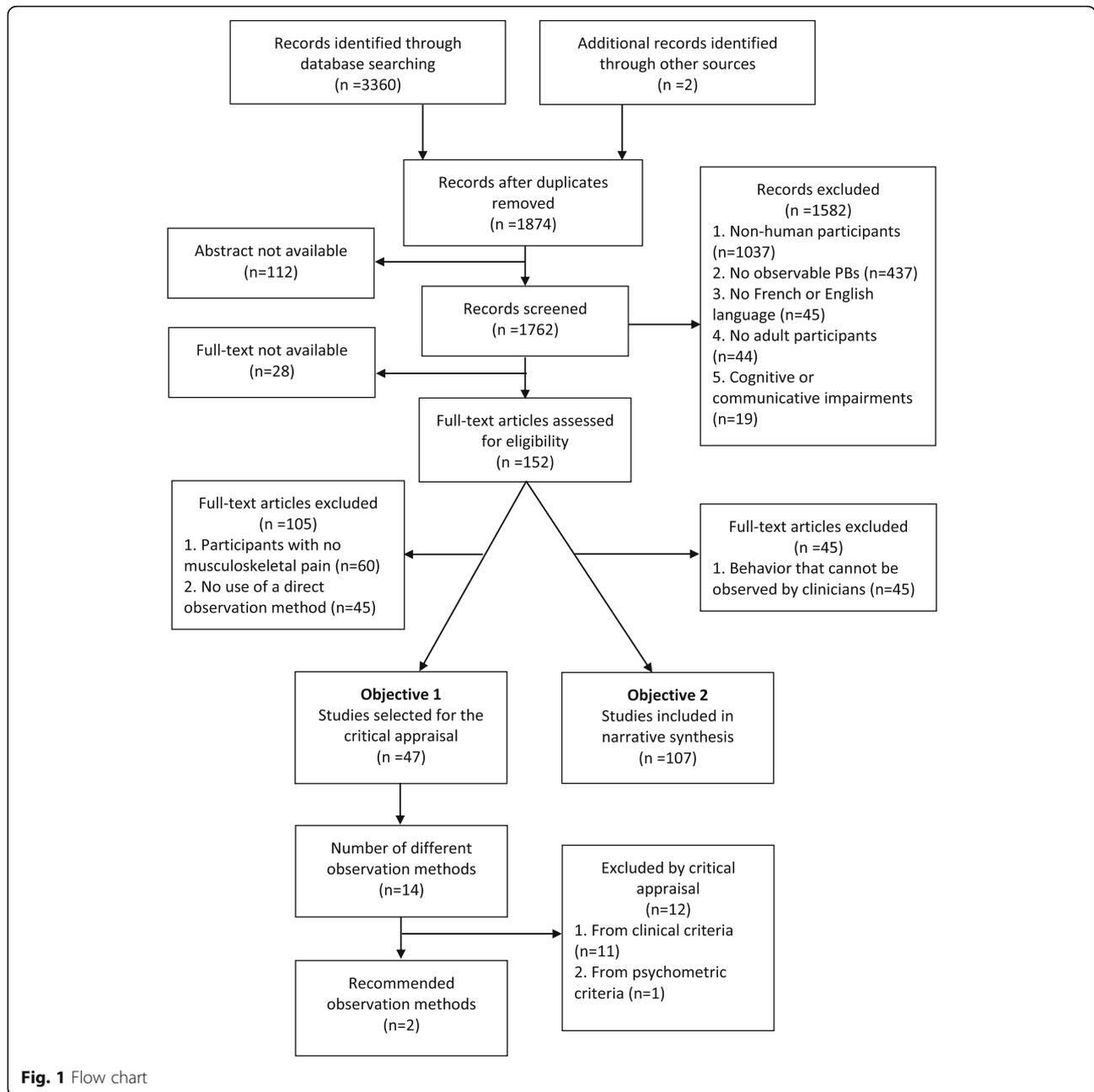


Fig. 1 Flow chart

target population. A narrative synthesis was made to inform clinicians about the characteristics of each recommended observation method. For the second objective, all observable PB were extracted and regrouped into homogenous categories.

## Results

### Selection of the studies

For the first objective, 3360 relevant articles were found in the various databases consulted. Two more articles were included after an exploratory hand search. After the removal of duplicates (1488 excluded), title/abstract

screening (1694 excluded with 112 abstracts not available), we obtained a pool of 180 articles. From this pool, 28 articles were not available and, 105 articles failed to meet our inclusion parameters, which left 47 articles for dedicated assessment (see Fig. 1 for the flow chart diagram).

### Critical appraisal

From the 47 articles, we found 14 different observation methods. From the 14 initial methods, 9 used videotaped sequences to determine the number of different PBs during task execution which considerably limit their use

in the clinic setting. Also, 11 observation methods did not propose an interpretation of the score which made it difficult to use these data to determine or adapt the

treatment plan. Table 2 presents the extracted data for the assessment of the clinical criteria. Only three observation methods met all clinical criteria: 1) the Behavioral

**Table 2** First step of the critical appraisal: clinical criteria appraisal

Method	Time to complete ≤ 10 min OR ≤ 30 min if part of a comprehensive assessment	Scoring method Not videotaped	Interpretation Does the method propose an interpretation of the score (severity, ...)?	No special equipment required	Decision (retain or reject)
Aung's method [26]	? We can assume < 10 min	✗	✗	✓	Reject
Behavioral Avoidance Test-Back Pain (BAT-Back) [27]	✓ < 10 min	✓ Specific rating according to the level of avoidance	✓ Range of possible scores is 0 to 60 (0 = no avoidance, 60 = every movement is avoided)	✓	<b>Retain</b>
Butler and Kozey's method [28]	? We can assume < 10 min	✗	✗	✗	Reject
Cinciripini's method [29]	? We can assume < 10 min	✗	✗	✓	Reject
Cold pressure method [30]	✓ 2-min	✗	✗	✗	Reject
Keefe and Block [31] (K&B) and modified K&B [32]	✓ 10-min	✗	✗	✓	Reject
Keefe's walk method [33]	? We can assume < 10 min	✗	✗	✓	Reject
Koho's method [34]	? We can assume > 10 min	✗	✗	✓	Reject
Moores' method [35]	? We can assume > 10 min	✓ Frequencies of PB	✗	✓	Reject
Pain Behaviour Scale (PaBS) [36]	✓ Part of a physical performance test of 10 to 15 min	✓ Frequencies of PB	✓ A total score of severity can be determined from 0 to 15	✓	<b>Retain</b>
Prkachin's method [18]	✗	✓ Number of PB	✗	✓	Reject
Test Instrument for Profile of Physical Ability (TIPPA) [37]	? Part of a comprehensive assessment but we can assume < 30 min	✓ Presence of PB	✓ A severity scale is proposed based on the number of activities with PBs	✓	<b>Retain</b>
Thieme's method [38]	✓ 8-min	✗	✗	✗	Reject
Watson's method [39]	? We can assume > 10 min	✗	✗	✓	Reject

? : unclear  
 ✗ : no  
 ✓ : yes

Avoidance Test-Back Pain (BAT-Back) [27], 2) the Pain Behavior Scale (PaBS) [36], and 3) the Test Instrument for Profile of Physical Ability (TIPPA) [37].

The methodology of the three selected observation methods was then evaluated using the CAT. The CAT was modified for the BAT-Back and the TIPPA, as these two methods only analyzed the inter-rater reliability. Items 5 (Raters blindness in intra-rater reliability), 6 (Variation of the order of examination), and 8 (Stability of variable) were not applicable. The BAT-Back obtained a percentage of 66.7%, the PaBS obtained a percentage of 77.8%, and the TIPPA obtained a percentage of 16.7%. Given the score below the a priori threshold of 60%, the TIPPA was not retained for further analysis. Table 3 presents the completed CAT scores for the 3 instruments.

**The clinically relevant characteristics of the recommended observation methods**

Table 4 presents the main characteristics of the two observation methods retained: the BAT-Back and the PaBS.

**Listing of the observable PB identified from the literature**

For the second objective, 3360 relevant articles were found in the various databases consulted. Two more articles were included after an exploratory research. After the removal of duplicates (1488 excluded), title/abstract screening (1694 excluded with 112 abstracts not available), we obtained a pool of 180 articles. From this pool, 28 articles were not available, 45 were excluded for failure to meet inclusion criteria, which left 107 articles for review. See Fig. 1 for the flow chart diagram.

Based on the extracted data from the 107 studies, 21 different groups of PB were identified. We grouped together similar PB and we classified these groups into 7 categories: (1) verbal and non-verbal communication, (2) sounds, (3) posture and movements, (4) inconsistent findings during clinical examination, (5) physical activities, (6) social and occupational activities, and (7) inappropriate use of. The complete listing and categories are presented in Table 5.

**Discussion**

To our knowledge, this study is the first exhaustive and comprehensive review to critically appraise observation methods to assess PB considering clinical and psychometric criteria, identify, and categorize PB described in the literature that patients can exhibit. Concerning the assessment tools, our review shows that observation methods easily applied in clinical practice are scarce. We extracted from the literature, a large spectrum of possible PB that may be observed, from subtle behaviors (e.g. drink water to delay task) to more obvious (e.g. avoidance of the painful task). Clinicians may benefit from awareness of the different PB clinical presentations to detect maladaptive behaviors in people with musculoskeletal pain, which often suggest the presence of cognitive-emotional factors that may interfere with the rehabilitation process.

The clinical criteria of our triage process allowed us to select 3 observation methods, but the psychometric assessment suggests that the TIPPA presented low methodological quality. Thus, we recommend the use of the PaBS or the BAT-Back in clinical practice since both of

**Table 3** Second step of the critical appraisal: psychometric criteria according to the Critical Appraisal Tool [23]

Item from the CAT	BAT-Back	PaBS	TIPPA
1 If human subjects were used, did the authors give a detailed description of the sample of subjects used to perform the (index) test?	Yes	Yes	No
2 Did the authors clarify the qualification, or competence of the rater(s) who performed the (index) test?	No	Yes	No
4 If interrater reliability was tested, were raters blinded to the findings of other raters?	No	Yes	No
5 If intrarater reliability was tested, were raters blinded to their own prior findings of the test under evaluation?	n/a	Yes	n/a
6 Was the order of examination varied?	n/a	No	n/a
8 Was the stability (or theoretical stability) of the variable being measured taken into account when determining the suitability of the time interval between repeated measures?	n/a	No	n/a
10 Was the execution of the (index) test described in sufficient detail to permit replication of the test?	Yes	Yes	No
12 Were withdrawals from the study explained?	Yes	Yes	Yes
13 Were the statistical methods appropriate for the purpose of the study?	Yes	Yes	No
Ratio between the number of items with a positive answer and the total number of "applicable" items	4/6	7/9	1/6
Percentage	66.7%	77.8%	16.7%
<b>Decision before extraction</b>	<b>Retain</b>	<b>Retain</b>	Reject

No: no information or insufficient information

Yes: sufficient information

n/a: not applicable

**Table 4** Recommended observation methods suitable for utilization in clinical settings

Tool	Behavioral avoidance test (BAT-BACK) [27]	Pain Behaviour Scale [36]
<b>What does the tool measure?</b>	Measures observable avoidance behaviors. May be used to plan graded exposure for patients with chronic lumbar pain or as a tool to measure therapeutic success.	Measures observable pain behaviors.
<b>How is the tool administered?</b>	The patient must approach the feared stimulus in a standardized environment to induce fear and avoidance reactions 1. Instructions are given to the patient 2. Demonstration of movements (bending forward, lifting a box ~ 8 kg, rotation) by the evaluator 3. Movements are executed by the patient (10 repetitions) 4. Assessment of behavior (according to 3 categories)	The patient performs a standardized sequence of physical performance tests 1. Repeated trunk flexion 2. Repeated sit to stand 3. Timed up and go 4. Loaded reach 5. 50-ft walk
<b>Observed PB</b>	Category 1: The movement is carried out as demonstrated by the evaluator. No avoidance or protective behavior. Category 2: The movement is carried out with protective behaviors (bended knees, keep the back straight by lifting or bending, move feet while turning, deep breaths, taking medication before the task, drinking water, seeking support, asking for help). Category 3: The patient avoids making the movement. If less than 10 repetitions, missing repetitions are scored as avoided.	The specific pain behaviors assessed are: - Sighing - Breath-holding, - Grimacing - Guarding - Rubbing - Antalgic gait
<b>Scoring and interpretation of the observation method</b>	Each repetition is scored as follows: Category 1 = 0 point Category 2 = 1 point Category 3 = 2 points Thus, a score of 0 means that the patient avoided no movement or did not engage in a protective movement, and a score of 60 means that the patient avoided all movements.	For each task, the intensity and severity of PB are rated as below: a) Intensity Presence or absence of each PB b) Severity For each task, determination of PB severity with a 4-point scale: 0. None 1. Mild 2. Moderate 3. Severe Finally, a total severity score (0–15) is obtained with the sum of the 5-task PB severity score.
<b>Clinical benefits</b>	<ul style="list-style-type: none"> <li>• Easy to administer and interpret</li> <li>• Short (approx. 5 min)</li> <li>• Requires little to no material</li> </ul>	<ul style="list-style-type: none"> <li>• Easy to administer</li> <li>• Short (10–15 min) and assess physical performance at the same time</li> <li>• Requires little to no material</li> <li>• Also informs on physical performance</li> </ul>
<b>Validity and Reliability</b>	<ul style="list-style-type: none"> <li>• The BAT-Back is a reliable and valid measure of pain avoidance behavior</li> </ul> Inter-rater reliability: good to excellent <ul style="list-style-type: none"> <li>• Internal consistency: excellent</li> <li>• Convergent validity and divergent validity were determined</li> <li>• Cross-cultural validity (Turkish) [40]</li> </ul>	<ul style="list-style-type: none"> <li>• The PaBS is a reliable and valid measure to assess the presence and severity of PB.</li> <li>• Inter-rater reliability: excellent</li> <li>• Intra-rater reliability: excellent</li> <li>• Agreement for each PB in each task between 95 and 100%</li> <li>• Perfect consistency for the absence/presence of PB</li> <li>• Acceptable construct validity</li> </ul>
<b>Target population</b>	People with chronic low back pain. (CLBP) Participants in the validity study were between 18 and 65 years old.	People with chronic low back pain Participants in this study were between 21 and 65 years old.

these scored well during the psychometric assessment. However, these two observation methods are only validated for people with chronic low back pain which limits the objective assessment of maladaptive PB of other musculoskeletal conditions. It is worth noting that these two observation methods present some differences and limitations. The first main difference involves instrument scoring. The BAT-Back proposes a score of avoidance, and more precisely physical avoidance (protective PBs) [27], as opposed to the PaBS, which proposes a severity score within a range of protective or communicative PBs

[36]. As a result, the PaBS allowed clinicians to evaluate a larger diversity of PB.

Clinicians must use caution when evaluating communicative PBs, as they are not always related to pain severity and pain-related disability [28]. Moreover, observers give more weight to communicative PBs than protective behaviors [28]. This overinterpretation and its consequences on clinicians' attitudes towards the patient may lead to reinforce these communicative PBs [28]. Thus, despite the lack of diversity in the PBs it assesses, the BAT-Back's focus on protective PBs may avoid this

**Table 5** Listing of observable pain behaviors found in the systematic search and review

	<b>Does the patient exhibit this PB? If yes, with the integration of the patient's context, beliefs, the frequency of this PB, etc., the clinician can interpret if the PB is adaptive or not and interferes with the rehabilitation process</b>
<b>Verbal and nonverbal communication</b>	
<i>Pain-related behaviors that can be verbalized or executed by the patient to communicate with the therapist about his/her pain</i>	
<ul style="list-style-type: none"> <li>• The patient stays focused on pain communication (e.g., always refers to his/her pain during conversation) [28, 29, 35, 41–56]</li> <li>• The patient stays focused on disability or impairments despite clinical improvements [43, 52, 54, 57–60]</li> <li>• The patient verbalizes hesitation or questions about his/her capacity to perform feasible tasks [42, 54, 55, 58, 61]</li> <li>• The patient asks for help for tasks he/she can perform independently (alone) [27, 44–46, 49, 55, 60, 62–65]</li> </ul>	
Touching/rubbing the painful area after task accomplishment [11, 18, 28, 29, 31–36, 39, 42, 45, 51–56, 58, 61, 66–111]	
<b>Sounds</b>	
<i>Pain-related behaviors that can be heard by the therapist when the patient performs tasks or activities</i>	
<ul style="list-style-type: none"> <li>• Groaning, Moaning, Whining, Whimpering, Crying, Screaming [11, 18, 27–30, 34, 35, 37, 39, 42, 44–47, 49–51, 53–59, 61–63, 67, 68, 70–74, 88, 97, 103–105, 107, 109, 111–114]</li> </ul>	
Sighing, Holding their breath, Taking a deep breath [11, 18, 27–36, 39, 42, 44, 50, 53–57, 61, 66, 68, 69, 71–74, 76–82, 85–87, 89–94, 96, 97, 100–103, 106, 107, 109–111, 115, 116]	
<b>Posture and movements</b>	
<i>Pain-related behaviors that can be seen by the therapist when the patient moves or remains in a static position</i>	
<ul style="list-style-type: none"> <li>• Overcautious/overprotective during movements <ul style="list-style-type: none"> <li>◦ Self-limiting range of motion</li> <li>◦ Stiff or rigid movements</li> <li>◦ Abnormally slow movements</li> </ul> </li> </ul>	
[11, 18, 26, 28, 29, 31–38, 42, 44–46, 49, 52, 53, 55, 57–59, 61–63, 66–69, 71, 72, 74–82, 85–87, 89, 90, 92–104, 106, 107, 109–111, 116–122]	
<ul style="list-style-type: none"> <li>• Strategies to minimize the threat and/or the load on the painful area during movement <ul style="list-style-type: none"> <li>◦ Avoids or minimizes lifting, bending</li> <li>◦ Bending knees, kneeling, keeping the back straight</li> <li>◦ Moving the feet while rotating</li> <li>◦ Imbalance on the distribution of body weight</li> </ul> </li> </ul>	
[11, 18, 27, 28, 30, 32, 33, 37, 42, 45, 50, 52–59, 61–63, 66, 67, 69–71, 74–89, 92–103, 105–110, 119, 120, 123, 124]	
<ul style="list-style-type: none"> <li>• Keeps distorted gait despite clinical improvements <ul style="list-style-type: none"> <li>◦ Limp</li> <li>◦ Drag one's leg</li> </ul> </li> </ul>	
[11, 29, 33–36, 39, 41, 45, 46, 48, 49, 52, 54–56, 58, 62–64, 73, 74, 83, 84, 88, 91, 105, 113, 115]	
<ul style="list-style-type: none"> <li>• Delays activity execution <ul style="list-style-type: none"> <li>◦ Drinks water between the order and the performance of a requested task/movement</li> <li>◦ Latency to initiate a requested task/movement</li> <li>◦ Misses therapy sessions if not reminded</li> </ul> </li> </ul>	
[27, 55, 58, 117, 120]	
<ul style="list-style-type: none"> <li>• Excessive rest [34, 35, 43, 44, 51, 54, 55, 60, 62, 63, 70, 74, 84, 88, 105, 118, 119, 124–128]</li> </ul>	
<b>Inconsistent findings during clinical examination</b>	
<i>Pain-related behaviors that can be provoked during the clinical examination</i>	
<ul style="list-style-type: none"> <li>• Discrepancies between: <ul style="list-style-type: none"> <li>◦ clinical findings and observed functional capacity or incapacity (dressing, ...)</li> <li>◦ the demonstrated range of motion during clinical examination and during distraction tasks</li> </ul> </li> </ul>	

**Table 5** Listing of observable pain behaviors found in the systematic search and review (Continued)

	Does the patient exhibit this PB? If yes, with the integration of the patient's context, beliefs, the frequency of this PB, etc., the clinician can interpret if the PB is adaptive or not and interferes with the rehabilitation process
[42, 129, 135]	
• Overreaction during examination [42, 129, 135]	
<b>Physical activities</b>	
<i>Pain-related behaviors that can be mentioned by the patient while talking about physical activities or performing tasks</i>	
• Avoid or minimize: <ul style="list-style-type: none"> <li>◦ leisure activities</li> <li>◦ housework</li> <li>◦ sports</li> <li>◦ sexual intercourse</li> </ul>	
[11, 33, 37, 43, 50, 51, 54–56, 60, 65, 67, 84, 125, 128, 130, 136]	
• Undertakes nothing outside therapy time despite therapist's encouragement [55]	
<b>Social and occupational activities</b>	
<i>Pain-related behaviors that can be mentioned by the patient while talking about social or occupational activities</i>	
• Avoids or minimizes spending time with people [50, 51, 55, 56, 62, 63, 74, 125]	
• Repeated work absences [51, 56]	
<b>Inappropriate use of</b>	
<i>Pain-related behaviors that can be mentioned by the patient while talking about or seen by the therapist</i>	
• Medication (prescribed or not) [27, 29, 45, 46, 51, 54–56, 58, 60, 67, 88, 105, 118, 119, 126, 127]	
• Healthcare system <ul style="list-style-type: none"> <li>◦ Asking for further specialized medical treatment [51, 55]</li> </ul>	
• Non-prescribed equipment <ul style="list-style-type: none"> <li>◦ TENS</li> <li>◦ Cane or crutch</li> <li>◦ Brace</li> </ul>	
[27, 29, 37, 39, 44, 46, 49, 52, 54, 55, 58, 62, 63, 67, 70, 86–88, 105, 119, 127]	

reinforcement, while providing information about pain severity and pain-related disability [28]. The difference in the type of PBs assessed does not seem to be a limitation.

The BAT-Back scoring can be confusing as it is based on a sequence of 3 movements. If a patient stops the sequence during the first movement, the remaining two are not performed, but scored as avoided movements, which can lead to an overestimation of avoidance [40]. Furthermore, as the first movement is bending forward, its scoring can be influenced (biased) by physical consequences of underactivity such as stiffness, shortness of muscles, among many other factors [40]. For example, if the patient bends to the knees or keeps his back straight, the BAT-Back considers that the patient engages in safety behaviors. Physical limitations, such as less flexible hamstrings may lead to an overestimation of patient avoidance. The score based on a sequence and the rating that can be influenced by physical or cognitive consequences of the patient's life are the main limitations of the BAT-Back. Another limitation of the BAT-Back is the tasks that are performed. Even if the 3 movements

of the BAT-Back are known to be fearful tasks for patients with low back pain, it is also well known that a patient can avoid certain tasks, but can perform others without avoidance [66]. The PaBS uses tasks from the physical performance assessment to evaluate PBs. With this strategy, the PaBS increases the number of tasks that are performed. However, all the tasks performed for the PaBS are in a sagittal plan whereas the BAT-Back uses movements in the sagittal and horizontal plans.

Our results also highlights the ubiquitous of the avoidance behaviors reported in the literature, as the types of most PB found in the literature were either protective or communicative. This discrepancy could be explained by the fact that the Fear-Avoidance Model was conceptually proposed in 2000 [6], whereas the Endurance-Avoidance Model was conceptually proposed 10 years later [9]; not surprisingly, much more literature is based on the Fear-Avoidance Model. Another reason relates to the behaviors themselves. Contrary to the avoidance response, pattern that is characterized by pain-related fear, catastrophizing, and behavioral avoidance [6], the endurance response pattern is characterized by thought

suppression, anxiety/depression, and task persistence (endurance behaviors) [7]. Thus, even if avoidance behaviors are subtle, they still remain observable [67]. On the other hand, as “endurers” carry out the task to the end despite a significant increase in pain [131], endurance behaviors seem less “observable” and could be better captured by a questionnaire. If a clinician suspects that his or her patient presents endurance behaviors when performing a task, it would seem more appropriate to use a questionnaire such as the Avoidance Endurance Questionnaire to assess the patient’s PB [125, 132–134].

The assessment of behavioral components is an integral part of a biopsychosocial approach. However, clinicians can feel uncomfortable in the assessment of psychosocial factors [26] and want the support of simple screening tools [29]. Also, because PB are dynamic (adapted in the short term and can turn into maladaptive behavior), it is essential to have the possibility of a rapid screening. With a screening perspective, we summarized the different observable PB found in the literature. Yet, when available, clinicians must also objectively document these with a proper tool. In this case, the PaBS or the BAT-Back can be used.

Our systematic search and review present some limitations. The first one concerns the clinical criteria used to select the observation methods. As no specific tools were available, we had to create our own grid based on data from the literature on the clinical integration of outcome measures in rehabilitation. The second main limitation concerns the clinical assessment tool (CAT) developed by Brink and Louw. Although cited in several studies ( $n = 40$ ), this CAT is not validated for this type of analysis.

## Conclusion

This is the first review to identify and critically appraise observation methods to assess pain behaviors in patients with musculoskeletal pain in clinical setting. The critical appraisal process allowed us to recommend two observation methods that are rapid to complete, with few equipment, and using tasks perceived as threatening by patients. These methods are the PaBS and the BAT-Back. However, these two tools are only validated for people with chronic low back pain. In order to help clinicians in the detection of possible maladaptive PBs in patients with various musculoskeletal conditions, we extracted the different PBs present in the literature and that patients can exhibit. This extraction allowed us to propose 7 categories of PBs. With that, clinicians can perform a screening of PBs, but not an objective assessment. Also, this review shows the ubiquitous of the avoidance behaviors in the literature. Thus, clinicians may use a questionnaire like the Avoidance Endurance Questionnaire to perform a global evaluation of behaviors that can be part of the two models of transition to chronicity.

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## Authors’ contributions

FN contributed to the conception, design, acquisition, analysis, interpretation of data and drafted the manuscript. CC contributed to the acquisition, analysis and interpretation of data. YTL contributed to the conception, design, interpretation of the data, and substantively revised the manuscript. APT, MSGL, GL, EL, and LL contributed to the conception, design, and substantively revised the manuscript. The authors read and approved the final manuscript.

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## Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author upon reasonable request.

## Declarations

### Ethics approval and consent to participate

Not applicable.

### Consent for publication

Not applicable.

### Competing interests

The authors declare that they have no competing interests.

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