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Measuring anger in patients experiencing chronic pain - A systematic review

Sommer, Isabelle ; Lukic, Nenad ; Rössler, Wulf ; Ettlin, Dominik A

Abstract: Anger is prevalent in chronic pain and has been associated with pain perception, disability, behavior and treatment outcome. Objectives were (1) to survey in the context of chronic pain the application (and omission) of validated anger self-report instruments, (2) to discuss the instruments found in the context of emotion theories and (3) to identify a possible instrument preference. A systematic search of textbooks and review articles was first performed on validated instruments designed to measure the cognitive, the motivational and the subjective feeling component of anger. Thereafter, a systematic review aimed at finding chronic pain studies from 2005 to 2019 reporting on these instruments. Textbooks and reviews listed 16 validated self-report anger measurement instruments. 28 papers applying four of these were identified and two new instruments were additionally detected. The State-Trait Anger Expression (STAXI) and its precursors were most commonly used. Studies on chronic low back pain patients prevailed. In conclusion, anger in chronic pain patients is reliably measurable at low cost with self-report tools. The STAXI-II qualifies best for this purpose based on its extensive validation history. The majority of instruments lack sufficient theoretical and psychometric adequacy. A more detailed exploration of the cognitive anger component in chronic pain patients in future research is recommended.

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Abstract

Anger is prevalent in chronic pain and has been associated with pain perception, disability, behavior and treatment outcome. Objectives were (1) to survey in the context of chronic pain the application (and omission) of validated anger self-report instruments, (2) to discuss the instruments found in the context of emotion theories and (3) to identify a possible instrument preference. A systematic search of textbooks and review articles was first performed on validated instruments designed to measure the cognitive, the motivational and the subjective feeling component of anger. Thereafter, a systematic review aimed at finding chronic pain studies from 2005 to 2019 reporting on these instruments. Textbooks and reviews listed 16 validated self-report anger measurement instruments. 28 papers applying four of these were identified and two new instruments were additionally detected. The State-Trait Anger Expression (STAXI) and its precursors were mostly used. Studies on chronic low back pain patients prevailed. In conclusion, anger in chronic pain patients is reliably measurable at low cost with self-report tools. The STAXI-II qualifies best for this purpose based on its extensive validation history. The majority of instruments lack sufficient theoretical and psychometric adequacy. A more detailed exploration of the cognitive anger component in chronic pain patients in future research is recommended.

Keywords	Anger; Chronic Pain; Psychometrics; Self Report; Surveys and Questionnaires

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Submission Files Included in this PDF

File Name [File Type]

19_07_08 Cover letter Anger_and_Pain_R2.docx [Cover Letter]

Reply_R2.docx [Response to Reviewers]

Highlights.docx [Highlights]

19_05_26 Abstract_R1.docx [Abstract]

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19_05_26 Fig 1 Anger_and_Pain_R1.docx [Figure]

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19_05_26 Table 1 Anger_and_Pain_R1.docx [Table]

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19_05_26 Online Appendix Books Review Articles identified_R1.docx [Table]

19_02_07 Conflict of interest.docx [Conflict of Interest]

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Zurich, July 08, 2019

Revised manuscript entitled “Measuring anger in chronic pain - a systematic review”

Dear Professor Fiedorowicz

Thank you for encouraging us to further “polish” our manuscript by shortening it <5000 words. After some more concise rephrasing, it is now 4888 words long.

In your mail of June 22, 2019, you mentioned: "You can simply highlight additions to the manuscript, I do not need to see all deletions or tracked changes and it is not necessary to submit two manuscript files." In response to reviewer 1, we added the following sentences:
Introduction: “In spite of available modern neuroscientific techniques (such as e.g. functional neuroimaging) for generating and testing novel theories, psychometrics in the clinic setting still relies on questionnaires.”
Discussion: "8/26 of the identified articles were published by the two leading authors Burns and Bruehl."

We hope our manuscript is now ready for publication and would like to express our gratitude to you and the reviewers for all efforts and patience.

Yours sincerely,

Isabelle Sommer
Wulf Rössler
Nenad Lukic
Dominik A. Ettlin

Reviewer 1

I realize that authors specifically partake to Spielberger's model of anger but again, this is not the sole model of anger, and it does not matter whether Averill, Spielberger, or others not mentioned (e.g. Barrett, 2017, How emotions are made) do not solely focus on anger. The mere fact that there are different and updated theories on emotion in general and on anger specifically that provide neuroscientific evidence to the nature of the underlying processes (e.g. Gilam & Hendler, 2015 as mentioned previously; or Kober et al, 2008) should at least be recognized appropriately that there are other psycho-neuro models of anger. Especially since we also know that emotions are not fully captured as "state-trait" like spielberger suggest but could be capture as much more dynamic and fluid in nature (Gross, 1998, JPSP; Gross, 1998, Review of General Psychology; Russell, 2009, Cognition and Emotion). This should be mentioned in the intro and will showcase not only that there are other constructs on which one can debate as to their overlap with anger (or not), but also the acknowledgement of other theoretical premises for anger, even though they might not have a direct link to a psychometric instrument such as the STAXI (that is indeed a separate issue).

In added the following sentence in the introduction in order to recognize psycho-neuro models of anger, yet we note that this review's topic is self-report instruments : "*In spite of available modern neuroscientific techniques (such as e.g. functional neuroimaging) for generating and testing novel theories, psychometrics in the clinic setting still relies on questionnaires.*"

My note that 8/26 of the identified articles related to the same two leading authors is not to suggest that there is bias in the search criteria, rather that because these authors conducted a third of the research on anger and pain, and they always used the STAXI, it is not surprising that the STAXI is being observed as the most prominent instrument. This should be noted when interpreting the results.

As per the reviewer's suggestion, we added the following sentence to the discussion sentence: "*8/26 of the identified articles were published by the two leading authors Burns and Bruehl.*"

I disagree with the authors and think that they can indeed report about anger instrument in the broad literature without going into details. This does not require additional queries or searches, rather contextualizing their findings and providing some citations. I'm sure they can capture briefly how their findings generalize beyond their specific focus on anger and pain. Relating to some reviews even by Spielberger and Novaco could be a path to support that. This is exactly as any other study which focuses on a specific sample and is asked about the level of generalizability, and this should be present in how they discuss their findings.

The editor asked us to shorten our manuscript below 5000 words. Therefore, we could not elaborate any further on this aspect and appreciate the reviewer's understanding for the space limitation.

Highlights:

- Among various self-report measures, the State-Trait Anger Expression (STAXI) and its precursors were most commonly used in patients experiencing chronic pain.
- The STAXI-II has the most extensive validation history.
- The majority of instruments lack sufficient theoretical and psychometric adequacy.
- Anger measures were most commonly applied in studies on chronic low back pain.

Anger is prevalent in chronic pain and has been associated with pain perception, disability, behavior and treatment outcome. Objectives were (1) to survey in the context of chronic pain the application (and omission) of validated anger self-report instruments, (2) to discuss the instruments found in the context of emotion theories and (3) to identify a possible instrument preference. A systematic search of textbooks and review articles was first performed on validated instruments designed to measure the cognitive, the motivational and the subjective feeling component of anger. Thereafter, a systematic review aimed at finding chronic pain studies from 2005 to 2019 reporting on these instruments. Textbooks and reviews listed 16 validated self-report anger measurement instruments. 28 papers applying four of these were identified and two new instruments were additionally detected. The State-Trait Anger Expression (STAXI) and its precursors were mostly used. Studies on chronic low back pain patients prevailed. In conclusion, anger in chronic pain patients is reliably measurable at low cost with self-report tools. The STAXI-II qualifies best for this purpose based on its extensive validation history. The majority of instruments lack sufficient theoretical and psychometric adequacy. A more detailed exploration of the cognitive anger component in chronic pain patients in future research is recommended.

Measuring anger in patients experiencing chronic pain - a systematic review

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Short Title: Measuring anger in chronic pain

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keywords: Anger, Chronic Pain, Psychometrics, Self Report, Surveys and Questionnaires

Abstract

Anger is prevalent in chronic pain and has been associated with pain perception, disability, behavior and treatment outcome. Objectives were (1) to survey in the context of chronic pain the application (and omission) of validated anger self-report instruments, (2) to discuss the instruments found in the context of emotion theories and (3) to identify a possible instrument preference. A systematic search of textbooks and review articles was first performed on validated instruments designed to measure the cognitive, the motivational and the subjective feeling component of anger. Thereafter, a systematic review aimed at finding chronic pain studies from 2005 to 2019 reporting on these instruments. Textbooks and reviews listed 16 validated self-report anger measurement instruments. 28 papers applying four of these were identified and two new instruments were additionally detected. The State-Trait Anger Expression (STAXI) and its precursors were most commonly used. Studies on chronic low back pain patients prevailed. In conclusion, anger in chronic pain patients is reliably measurable at low cost with self-report tools. The STAXI-II qualifies best for this purpose based on its extensive validation history. The majority of instruments lack sufficient theoretical and psychometric adequacy. A more detailed exploration of the cognitive anger component in chronic pain patients in future research is recommended.

Introduction

Anger and pain are negative emotions influencing each other through complex biological, affective, and behavioral mechanisms [49]. Studies demonstrated the adverse effects of anger on chronic pain, treatment outcomes, and social relations [21,48,49]. Specifically, anger can predispose to, exacerbate, be a consequence of, or perpetuate pain [9,14,19,38,49]. Hence, detailed anger assessment is important for comprehensive patient management, and also for quality of life maintenance in patients, relevant others, and caregivers alike [21,44,48,49]. Worldwide, 1 in 5 persons suffers moderate to severe levels of chronic pain [54,63,105]. Anxiety, sadness, and anger is frequent in individuals suffering from pain [14,43,49,74], but anger may have greater effects on chronic pain severity and vice versa [118] than any other negative emotions [42,43].

We first define and subsequently delineate anger from similar terms and concepts (hostility, aggression, frustration, etc). Anger can be conceptualized along three dimensions: *quality* (valence), *quantity* (intensity, frequency, and duration), and *form* [41,42,80]. Anger, by definition, is an unpleasant feeling on the *quality dimension* and entails disapproval. *Quantitatively*, anger varies in intensity on a continuum from a mild form (annoyance) to extremely high levels (rage or fury) [33,54]. It further varies in frequency from rarely feeling anger to feeling anger almost all the time, and in duration from transient to long-term. On the third dimension, anger is an emotion that can assume the *form* of a feeling, mood, or attitude[1]. This latter dimension is the most complex aspect of anger. According to Scherer's component process model of emotions the emotion of anger can be divided into five interrelating components: 1) a *cognitive* (appraisal) component as main driver of all other components; 2) a *neurophysiological* component; 3) a *motivational* component; 4) a *motor expression* component; and 5) a *subjective feeling* component [88]. In the appraisal process, events and their consequences are evaluated with respect to

[1] Feelings are the most transient experiences of the affective process and are concerned with a specific object. Moods typically last longer than feelings and are more diffuse and global. Attitudes are relatively stable beliefs [50].

their compatibility with the important needs, desires, or goals of the appraiser [43,89,90,120]. In chronic pain, Trost et al. suggested that the cognitive appraisal component of anger includes goal frustration, attribution for negative outcomes (e.g., blame), and perceived injustice [113]. By surveying anger-eliciting events in patients with pain, Fernandez and Turk identified the following ten common entities [42]: 1) causal agent of injury or illness; 2) medical and 3) mental health care providers; 4) attorneys and legal professionals; 5) reimbursement system; 6) employer; 7) significant others; 8) god; 9) self; and 10) the whole world.

Anger requires precise delineation from related terms such as passive-aggressiveness, frustration, and impulsivity [5,55]. Readers need to be aware that these terms are not part of this study yet deserve to be assessed in their own right. Therefore, we refer to other review articles on the constructs of ***hostility*** [2,33,37,95], ***aggression*** [37,79,86], ***passive-aggressiveness, frustration, impulsivity*** [37,52,79,82], ***irritability*** [111], and ***hate*** [32].

Patients with chronic pain report more frequent and more intense anger compared to healthy individuals [42,74,85,109]. Anger arousal is bidirectionally associated with pain, function, and treatment outcomes [20,42,47-49,121]. It may adversely affect relationships with friends, family, and health care providers [21,44,48,49]. Lagged analyses confirmed that anger predicts negative social interactions [20]. Findings from questionnaire [22], laboratory-based, experimental [10,24,81], and studies utilizing momentary pain assessment [14,19,117] suggest that anger intensity and regulation may have detrimental effects on pain and function. In spite of available modern neuroscientific techniques (such as e.g. functional neuroimaging) for generating and testing novel theories, psychometrics in the clinic setting still relies on questionnaires. The history of self-report anger instruments dates back to the early 1970s, when three anger measures appeared in the psychological literature: The *Reaction Inventory* (RI; [36]), the *Anger Inventory* (AI; [68]), and the *Anger Self-Report* (ASR; [122]). Their construct validity was fragmentary and limited because of insufficient differentiation between anger, hostility, and aggression [5,55]. A further

problem with these instruments was seen in the confusion of the experience and expression of anger with situational determinants of angry reactions [105]. This led Spielberger, who pioneered modern anger science, to conclude that a coherent theoretical framework that considered a **state-trait** model was required. This allowed the construction and validation of new psychometric measures of anger [99,103,105]. ***State anger*** is defined as a biopsychosocial, subjective experience of a transitory emotional episode embedded in a specific situational context, assuming that it would fluctuate in function dependent on the appraisal of the situation [43]. ***Trait anger*** pertains to a relatively stable pattern of personality attributes akin to hostility [7,54,56,82]. In the later clinical discourse, a further dichotomy relating to **anger-in vs. anger-out** was established; ***anger-in*** commonly refers to the suppression or internalization of angry feelings whereas ***anger-out*** denotes physically or verbally expressive behavior (anger externalization) [105,106]. Finally, a focus on conscious anger management led to the concept of anger ***control***, which quantitatively explores an individual's preference to control the intensity of angry feelings and anger expression [7,106].

The importance of monitoring different dimensions of anger in people suffering from chronic pain [32,88] motivated us to identify validated anger questionnaires in the literature on anger by

(1) surveying, in the context of chronic pain, the application (and omission) of validated anger questionnaires published between 2005 and 2019;

(2) identifying a possible instrument preference as well as its dependence on chronic pain characteristics; and

(3) offer recommendations for the future use of such instruments.

Methods

For identifying anger questionnaires and assessing their use in studies focusing on associations between anger and pain aspects in persons experiencing chronic pain, 5 systematic, general and specific literature searches were employed (Table 1). Due to personal reasons of the first author, these searches were updated twice, first in July 2017 and again in March 2019.

Systematic general literature search

Information sources, search queries, and keywords

Search #1 screened the database Primo Central Index (PCI/NEBIS)[2] for textbooks containing comprehensive reviews on anger assessment instruments. A search query combining the search terms "anger," "diagnosis," "measure*," "assessment*," and "pain" for books published between 1965 and 2019 was applied(for the search query, see supplementary Table 1a).

Eligibility criteria and critical appraisal

Search #1 was restricted to relevant medical and psychological books, book chapters, or review articles addressing the psychometric validity of questionnaires assessing anger (Table 1). These had to match the following *inclusion criteria*: they had to be designed for adults; had to focus on anger intensity and/or anger management in unspecific situations (e.g. not in driving situations) and/or on targets of anger or anger-eliciting situations, as perceived by patients with pain; and had to be sufficiently validated (according to the authors of the literature cited above). Combined instruments that also measured hostility and/or aggression were excluded. The primary author (IS) performed the critical appraisal and eligibility at all times.

[2] The Primo Central Index (PCI) is a multidisciplinary index of scientific materials with more than 500 million electronic resources accessible via NEBIS recherche. NEBIS is the acronym for "Network of Libraries and Information Centers in Switzerland." The NEBIS catalog contains more than 10.5 million title records (books, serials, journals, and non-book materials) with more than 15 million items. Literature searches are performed in Scopus (Elsevier), SAGE Journals, ERIC (U.S. Dept. of Education), Science Citation Index Expanded (Web of Science), MEDLINE/PubMed (NLM), and Social Sciences Citation Index (Web of Science).

Systematic specific search on instrument prevalence in recent clinical studies

Search #2 was performed in PubMed to determine the utilization of instruments found in search #1 among clinical studies published between 2005 to 2019 (see supplementary Table 1b for search queries). Only those questionnaires identified by this query were retained for further examination.

Systematic specific search on literature focusing on associations between anger and pain

Information sources, search queries, and keywords

Search #3 aimed at finding studies focusing on anger in patients with chronic pain. It was performed in 4 databases (Web of Science, PubMed, Embase, and PCI/NEBIS) to identify pain publications from 2005 to 2019 that included a self-report measure for anger that addressed anger intensity, anger expression or control, anger targets, or reasons for anger. The MeSH term[3] "anger" served to exclude related terms such as aggression or hostility. The broad MESH term "pain" was selected to include all types and localizations of pain problems. Subsequently, search #4 focused on the use of the instruments identified in search #1. The aim of this search was to find anger measures in publications that did not use the MeSH terms 'anger' and/or 'pain' in their titles. Finally, in search #5 (hand search), additional relevant articles were identified by screening the reference lists of the articles resulting from searches #3 and #4 (Table 1 and Fig. 1). These searches were very broad to ensure that all relevant papers were identified. The detailed search queries are listed in supplementary Table 2.

Eligibility criteria and eligibility assessments

Only reviews or clinical trials (i.e., original quantitative research) with a major focus on populations with chronic pain written in English were included. The subsequent selection was based on the following criteria: adult (18+) patients with chronic pain; article, clinical trial, or review including a self-report tool assessing anger; full-text publication in English available in PDF format, and publication not older than 2005. Finally, only articles using an instrument measuring anger were included. Additionally, in search

[3] MESH (Medical Subject Headings) is the NLM-controlled vocabulary thesaurus used for indexing articles in PUBMED.

#4, the search term (name of the measure) had to match with a psychometric self-report instrument measuring anger, that is, false positive hits were excluded. Also excluded were papers using only interviews, visual analogue scales, or numerical rating scales for the assessment of anger. Papers focusing on hostility, aggressiveness, or other anger-related emotions were further excluded. For screening and eligibility assessment, all abstracts and methods chapters of potentially eligible records (PERs) were read. Full-text papers (FPs) were selected for further reading only if 1) their abstracts showed a major focus on direct associations between anger and pain and 2) if the methods chapters contained any information related to explicit measurements of anger constructs in patients with chronic pain (Fig. 1 and supplementary Table 3).

Updates

Searches #3 to #5 were repeated in July 2017 (from May 2005 to July 2017) through PCI/NEBIS, because – as shown in supplementary Table 3 – PCI/NEBIS provided all full-text papers also found in other databases (Fig. 1). In March 2019 all searches (#1 to #5) were updated again.

Results

Test-retest reliability

Testing the reliability of the screening and eligibility assessment was an important prerequisite for the quality of this review that included two search updates. The March 2019 update on textbooks or reviews detected no new items (search #1). Searches #3 to #5 repeated in July 2017 redetected all papers included in 2015 plus 17 additional records (Table 2). Of these, 10 records were excluded. Specifically, the analysis of exclusions showed that in 2017 (compared to 2015) 1.7% less duplicates, 0.1% more exclusions after screening, and 0.6% less exclusions were identified after eligibility assessment. Test-retest reliability, simply calculated as the ratio of the percentages of exclusions (2015 vs 2017) was excellent; values ranged from .96 to .99. The update performed in March 2019 provided 60 new records.

Of these 25.6%, less duplicates were calculated, as well as 39.8% more exclusions after screening and 8.5% less exclusions after eligibility assessment (compared to 2017). Thus, the 2017 update provided poor test-retest-reliability-coefficients for the different types of exclusion (.28, .44, .58), yet an excellent value of .94 concerning the total amount of exclusions (Table 2).

Anger questionnaires used in recent clinical studies

Search #1 identified 3 textbooks [37,56,86], 1 review article [33], and 1 chapter in a textbook [40]. Of these, 14 questionnaires matching the eligibility criteria mentioned above were retained (Table 3). Although all these instruments possess sufficient psychometric validity (eg, the Novaco Anger Scale [NAS]; [69]), the results of search #2 revealed that only eight had been used in recent publications (2005-2019) and were thus retained for this study (Table 3).

Anger questionnaires in recent studies focusing on chronic pain

Results of the inclusion and exclusion processes

Searches #3 and #4 identified 342 PERs (Fig. 1 and supplementary Table 3). 192 were duplicates and150 PERs were retained. The screening process excluded 71 PERs. The remaining 74 FPs were systematically evaluated against the inclusion/exclusion criteria, resulting in 27 FPs being retained.6 FPs were additionally found by hand search (search #5), of which only 1 FP fully matched the inclusion criteria. Thus, 28 FPs were finally included in the present study (Table 4).

Excluded instruments

2 FPs were excluded in the eligibility process because the authors used instruments that insufficiently differentiated anger from related constructs (Fig. 1). The first study, by Fishbain et al. [45] aimed at comparing the prevalence of different anger forms, namely anger, hostility, aggression, anger-in, anger-out, and chronic anger. To this purpose, the authors developed the Battery for Health Improvement Research (BHI-R), a version derived from the Battery for Health Improvement-2 (BHI-2; [15]). The BHI-R is

not an inventory; it contains no scales and therefore has no associated reliability and validity data. Burns et al. combined the Cook Medley Hostility Scale [30] with the Anger Expression Scale (AX) for examining if anger-in, anger-out, and hostility predicted symptom-specific muscle tension reactivity during anger induction among patients with chronic low back pain.

Included instruments

Included questionnaires are listed in Table 4. The **State-Trait Anger Scale** (**STAS**; [99]) is based on working definitions of "state" and "trait" anger [106]. It is composed of the State Anger Scale (SAS) and the Trait Anger Scale (TAS; [33]) (see Table 5). The SAS and TAS have internal reliability coefficients that range from .84 to .93 [104]. Factor analyses of the SAS identified a single underlying factor for both genders, indicating that the SAS measures a unitary emotional state that varies in intensity; in contrast, factor analyses of the TAS yielded two weakly correlated (r2= 0.27) factors labeled 'Angry Temperament' (TAS-T) and 'Angry Reaction' (TAS-R), with alpha coefficients of .85 and .73 respectively [46]. During this review, some confusion about names and acronyms used was detected: Bruehl et al. also referred to it as the "Trait Anger Scale" (TRANG; Table 4).

The construction of the **Anger Expression Scale** (**AX**, [102-104]) was guided by working definitions of "anger-in" and "anger-out." The AX includes the AX/In and the AX/Out subscales (Table 5). Both subscales have internal consistency estimates ranging from .73 to .84 [46,100,106] and are empirically independent and factorially orthogonal [56,99], thereby assessing two independent dimensions of anger expression [106]. For the AX, confusion about terminology was observed: Burns et al. used the acronym "AES" or referred to it as the "Anger Expression Inventory" (AEI) (Table 4).

The **State-Trait Anger Expression Inventory** (**STAXI**; [100,106]) integrates all STAS subscales and the AX. Furthermore, it includes two new subscales, the Anger Control Scale and the Anger Expression Scale (AX/Con and AX/Ex, respectively; Table 5) [104]. The AX/Con measures the frequency of an individual's

attempts to contain the expression of anger and has good psychometric properties. The AX/Ex is a composite scale that provides a total score for anger expressed [1].

In 1999, the STAXI was upgraded to the **State Trait Anger Expression Inventory – 2nd Ed** (**STAXI-II;** [101]). The STAXI-II is the result of the revision of some STAXI scales and the expansion of the SAS, the latter being referred to by the new acronym "S-Ang". It consists of 57 items distributed across 6 scales, 5 subscales, and an anger expression index. Table 6 reveals that the STAXI-II expands the STAXI by 1) differentiating three subtypes of state anger by adding 5 items, and 2) differentiating between anger control-in and control-out. Factor analytic studies largely support this new structure (S-Ang/V) [32,104]. The STAXI-II is based on a solid conceptual model and has proven to be a reliable and valid instrument measuring the experience and management of anger across a wide variety of normative groups, thereby making it an excellent choice for researchers and clinicians [33,105]. The STAXI-II and its previous versions represent the most widely used anger measures in both clinical and research settings [33,58].

The **Patient-Reported Outcome Measurement Information System** (**PROMIS**; [29]) comprises self-reported intensity measures for the assessment of various health-related constructs (see www.nihpromis.org) [28,77]. Among others, PROMIS has developed and calibrated three item banks assessing depression, anxiety, and anger as forms of emotional distress. The **PROMIS anger scale** is described in detail in Pilkonis et al. [77]. Its 22 items are listed in Table 7. The reliability and validity of the PROMIS anger scale were demonstrated in various settings [3,107].

The **Positive and Negative Affect Scales (PANAS and PANAS-X)** provide a reliable estimate of positive and negative affect (PA and NA) (Table 8). The expanded form of the PANAS, the **PANAS-X** [119], is based on a hierarchical structure, which comprises two broad, higher-order dimensions (NA and PA) and 11 subscales grouped into 3 categories. Furthermore, each affective state is composed of an uneven number of adjectives. In summary, the PANAS-X scales are strongly correlated with commonly used

measures of state affect and current psychiatric symptomatology (Profile of Mood States, POMS; [61,62]), and are sensitive to changing endogenous and exogenous conditions [119].

Omitted instruments

None of the studies selected for this review used the Multidimensional Anger Inventory (MAI; [94]), Novaco Anger Scale (NAS; [70]), Provocation Inventory (PI; [68,69]), or Novaco Anger Scale and Provocation Inventory (NAS-PI; [69,71]), although these scales were used in other contexts as shown in Table 3.

The **MAI** was constructed to assess the following dimensions of anger: frequency, duration, magnitude, mode of expression, hostile outlook, and range of anger-eliciting situations. Evidence accumulates concerning its weak psychometric properties [33].

The **NAS-PI Part A** (formerly the NAS) measures the cognitive, arousal, and behavioral components of anger. The cognitive subscale assesses suspiciousness, attention toward anger cues, and hostile attitudes; the arousal subscale, the duration and intensity of angry feelings and feelings of tension or irritability; and the behavioral subscale, impulsive behavior, verbal and physical aggression, and general anger expression strategies. The **NAS-PI Part B** (former PI) provides an index of the degree of responsiveness to anger-eliciting situations, i.e. disrespectful treatment, unfairness/injustice, frustration/interruptions, annoying traits, and irritations. It appears to provide useful measures, but its construct validity remains in doubt [33,40].

Instrument choice is independent of pain type and localization

The numbers of articles using the retained measures are as follows: 3 STAS; 7 AX; 10 STAXI; 6 STAXI-II; 2 PANAS-X; 2 PROMIS anger scale (table 4). The chronic pain conditions investigated included: non-cancer and cancer pain; low back pain; fibromyalgia; neck pain and whiplash-associated disorder; daily tension type headache,; migraine; intractable neuropathic pain; pelvic pain; and healthy pain-free controls.

The STAXI-II and its precursors (including translated versions) were used randomly in all types and

localizations of pain (Fig. 2). Due to the limited number of studies, no preference could be identified for the PANAS-X and PROMIS scales. Some studies combined different types of questionnaires or focused on more than one pain type, which explains the broken numbers in the data row of Fig. 2. The 28 FPs provided 30 assessments of anger. The majority was performed in patients suffering from musculoskeletal pain (53.3%), with a clear predominance of low back pain (46.4%). Five studies included patients suffering from orofacial pain and headaches (16.7%), whereas in another 7 studies chronic pain locations were undefined (23.3%). Of the remaining 4 studies, two were performed in the context of cancer pain (6.7%), and one each in the context of pelvic and neuropathic pain (3.3%, respectively; Fig. 2).

Discussion

From the original 342 PERs resulted 28 FPs. From relevant textbooks, a review article and 2 FPs 16 instruments were identified, but only the STAS, AX, STAXI, STAXI-II, and the PROMIS and PANAS-X anger scales were used in the 28 FPs, although the MAI and the NAS-PI were used in recent (2005-2015) publications on anger (tables 3 and 4). The present review detected some confusion about names and acronyms. We could further demonstrate a strong preference for anger questionnaire use in chronic low back pain populations.

This study was initiated on the premise that anger is reliably measurable with self-report instruments [82]. In two publications on aggression, self-reports correlated moderately but significantly with other reports ($r = 0.55$ and 0.58, respectively), indicating a readiness for anger disclosure [73,83]. Thus, we postulated that the same applies to anger. The inclusion criteria served to select anger-specific instruments.

Preference for the STAXI instrument family

It became evident that most studies employed the STAXI family of instruments, preferentially one of the STAXI-II precursors (AX, STAS, STAXI). 8/26 of the identified articles were published by the two leading authors Burns and Bruehl. The unrevised version of the STAXI was found in 10 papers and its precursors, the AX and STAS, in 7 and 3 papers, respectively. Interestingly, the STAXI-II was used only in 6 papers (table 4). This is surprising considering it was developed in 1999, but did not yet replace its precursors. This finding may be explained by the decision of some authors to facilitate comparisons across time. For example, Bruehl et al., whose examinations of the association between anger and pain cover a period of at least 23 years, continued to use the STAS and the AX (1986-version) or its modified 1988 version for all of their studies. The PROMIS and PANAS-X include items on anger (tables 7 and 8) and appeared in recent chronic pain literature published between 2010 and 2018 (table 4).

The AX, STAS, STAXI, and STAXI-II all have good psychometric properties for either assessing anger-in/-out (AX), anger control and anger expression (AX, 1988 version), anger state/trait (STAS), or all the above (STAXI and STAXI-II) (Table 5). The STAXI-II differs from the STAXI in that three subtypes of state anger are differentiated in addition to distinguishing between anger control-in and control-out (Table 6) as validated by factor analysis [33,55,105]. From a clinical standpoint, it was shown that participants' endeavors to control anger arousal (high scores on anger control-in) indeed resulted in reduced anger intensity. On the other hand, a heightened effort to prevent the outward expression of anger (high scores on anger control-out) required frequent anger monitoring, which in turn may lead to dysfunctional passivity and withdrawal [58]. Thus, knowledge about an individual's anger control strategy may serve to optimize individual therapeutic interventions.

The scale construction methods of the PROMIS and PANAS-X differ from the STAXI instrument family. The PROMIS is based on item response theory [28]. It was developed for the assessment of a broad range of health-related constructs, such as emotional distress, pain, fatigue, sleep disturbance, physical

functioning, and social participation [77]. A 22-item anger scale is part of the item bank assessing emotional distress (Table 7). In contrast to the STAXI family, the PROMIS presumes that emotional distress cannot be dichotomized according to the traditional state-trait model. Rather, it assumes a continuum from mild symptoms reflecting transient states to disabling symptoms approximating traits or temperamental variables [77]. The brevity of the PROMIS compromises on aspects of anger management (expression and control according to Spielberger) and appraisal (according to Scherer).

The novel features of the PANAS were 1) its construction by means of principal components analysis and 2) its distinction between positive and negative affect (PA and NA) (Table 8: general dimension scales) [119]. Its expanded form, the PANAS-X, introduced a hierarchical structure with 11 subscales grouped into 3 categories, which were defined according to their intercorrelations and their loading values on two higher-order dimensions (NA and PA). In contrast to the PROMIS, the PANAS-X has no distinct anger subscale. Rather, the adjectives "angry" and “irritable” are part of the Hostility subscale (table 8)which correlates with the Symptom Checklist Hostility and the State Anger subscales of the STAS (r = 0.55 and 0.45, respectively), thus questioning its validity as a “pure” anger state measure [31].Middendorp et al. only used the two items “angry” and “irritable” from the PANAS-X Hostility subscale for measuring state anger intensity and daily anger [116,117].

Omitted in the chronic pain literature: MAI, NAS, PI and cognitive appraisal of anger stimuli

Although the MAI, NAS, PI, and NAS-PI were used e.g. in the context of suicidal ideation, obsessive-compulsive behavior, major depression, and somatization in healthy, psychiatric, and forensic populations, they were omitted in the context of chronic pain from 2005 to 2019. This finding may be explained by their questionable psychometric validity. Additionally, the AEI and AES were found to be synonymous terms for the AX (tables 3 and 4).

In Spielberger's framework, the appraisal of anger-eliciting situations receives little attention, whereas Scherer focuses on this aspect by claiming that in “an ideal world of science”, measurements of emotions

ought to consider all components of his model: 1) the dynamic processes of situational appraisal; 2) reactive patterns of the neuroendocrine, autonomic, and somatic nervous systems; 3) motivational changes, namely action tendencies; 4) patterns of facial, bodily, and vocal expression; and 5) nature of the conscious feeling state that reflects all of these component changes [88,89]. Wisely enough, he adds that "it is needless to say, such comprehensive measurement of emotion has never been performed and is unlikely to become standard procedure in the near future" [90].

One observation emerges from our results: None of the present studies included assessments of the subjective relevance of anger stimuli, although this component is perceived to be a prerequisite for any attempt at understanding human anger [42,74]. While the STAXI-II, STAXI, and AX provide subscales for the assessment of behavior that is contingent on appraisal (action tendencies and expression/communication of emotion), the STAS, PROMIS, and PANAS-X are based on models primarily focusing on the subjective feeling component [89]. This finding is in line with the results of a review presented by Trost et al. [113], who concluded that little attention was given to the cognitive dimension of anger.

Risk of biased information due to unspecific use of instruments

We found no instrument preference for specific pain types. Yet, patients experiencing chronic low back pain were disproportionately more frequently questioned about anger. As exemplified for chronic pelvic pain, the pain location may be indicative of specific underlying psychological factors, such as posttraumatic stress [84,98]. Consequently, the predominance of using anger assessments among patients with chronic low back pain may lead to biased information concerning the effects of anger on pain intensity, function, or treatment or vice-versa.

Limitations of search strategy

Searches were adapted to closely reflect the theoretical framework proposed by Spielberg postulating a clear delineation among anger, hostility, and aggression as distinct psychological constructs. Therefore,

the word "anger" was required to appear in the title of a questionnaire. In view thereof, some questionnaires containing anger subscales were not detected by search #1. Additional theories on anger were not considered due to the scope of the manuscript.

Conclusions and recommendations

The review period covers records from 2005 onwards. We expected that 1) an instrument proven to be useful before 2005 would still have been applied later, and that 2) validated new or revised questionnaires would have an impact in successive studies. We were curious if any instrument was preferentially applied for specific pain conditions. Finally, by discussing the identified anger measures in the context of Spielberg's anger framework and Scherer's component process model of emotion, we aimed at providing guidance for the future use of such instruments.

Efforts to establish clearly defined theoretical models of anger led to the availability of a limited selection of questionnaires recommendable in the pain context. None of the instruments identified perfectly match the theoretical frameworks. To this respect, the STAXI-II evolved as a result of considerable theoretical and psychometric refinements of its precursors, whereas other instruments were not as thoroughly assessed as shown by previous studies [33,97]. Notably, few reliable and valid questionnaires exist to assess the subjective feeling and motivational components of the anger experience among pain sufferers; this contributes to the difficulties in offering guidance for choosing the best instrument. Studies that continue to use the AX without the state-trait distinction or the STAS without the distinction between anger-in and anger-out may have reduced clinical benefits.

In light of Scherer's component process model of emotions [88,89], a key deficit of all questionnaires identified is that they insufficiently address the cognitive (appraisal) component [87], although goal frustration, perceived injustice, and attribution for negative outcomes (e.g., blame for wrongdoing) are frequently encountered cognitions in patients with chronic pain [39,113]. Identifying and examining the appraisal component of anger can assist in restructuring the negative cognition behind this negative

emotion [4]. Further, only the TRAPS [42] and its adapted version, named the Targets of Anger Scale (TAS) [74], were designed to assess the relevance of anger-eliciting situations for patients with chronic pain. However, as shown in table 3, they have not been used since 2005 and the literature discussing their psychometric properties is sparse. Interestingly, the instruments omitted in chronic pain studies (the MAI and NAS-PI) contain subscales for assessing the cognitive component of the anger emotion. Nevertheless, their use may not be recommended because of their lack of construct validity, e.g. their insufficient distinction between anger and related constructs [33,40]. Therefore, opportunities still exist to develop high-quality instruments specifically measuring the cognitive component of anger. In summary, because multiple theories, frameworks, and novel questionnaire construction techniques exist, it may be best not to rely on a single questionnaire for a comprehensive understanding of a person's anger, but rather to use a combination of different instruments [117].

Last but not least, it needs to be pointed out that human anger, hostility, aggression, and violence are interrelated concepts, all associated with verbal or physical actions that may *result from* pain [16,24,81, 112], or *may increase* pain [47,121]. However, delineating the exact boundaries for these constructs is difficult as it is hard to determine at which point anger turns into aggression and aggression into violence [86]. Little is known about the impact of chronic pain on the aggravation of anger, aggression, or violence in patients with chronic pain. Similarly, data is lacking on the consequences of this aggravation process on health care providers as targets. This may be another important topic for future investigations.

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Statement of Ethics

The authors have no ethical conflicts to disclose.

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Figure Legends

Fig. 1: Flowchart of paper selection procedure

Search #3: both MESH terms “anger“ and “pain“ in the publication title

Search #4: name and/or acronym of instruments resulting from search #1 in text and “pain” in publication title

Search #5: hand search

PERs potentially eligible records

FPs full text papers

Fig. 2: Use of questionnaires according to pain type and location

Quantitative illustration of the use of questionnaires according to pain type and/or location. The combined use of different questionnaires in some studies or the focus on more than one pain type explains the broken numbers. AX: Anger Expression Scale; STAS: State-Trait Anger Scale; STAXI: State-Trait Anger Expression Inventory; STAXI-II: State-Trait Anger Expression Inventory – revised version; PANAS-X: Positive and Negative Affect Schedule – expanded version

Table 1: Overview of the five literature searches

Table 2: Estimates of test-retest reliability: original database search 2015 vs. update 2017 vs. update 2019

Table 3: Results of search #1 and hits in PUBMED (search #2)

Table 4: Results of searches #3 to #5 and pain conditions examined in the selected studies.

Pain types: aLBP: acute, non-cancer, low back pain; ccP: chronic cancer pain; cDHtt: chronic daily headache, tension type; cLBP: chronic, non-cancer, low back pain; cNP/WAD: chronic neck pain and whiplash associated disorder after motor-vehicle traffic injury; cP: chronic non-cancer pain; cPP: chronic pelvic pain; FM: fibromyalgia; icNeuP: intractable chronic neuropathic pain; MG: migraine

Table 5: Item lists of the AX, STAS and STAXI

Table 6: Item lists of the STAXI-II

Table 7: Item lists of the PROMIS Anger - Item bank

Table 8: Item lists of the PANAS-X scales

Suppl. Table 1: a) Search queries for search strategy #1

* original search: and exact facet creation date 1965/01/01 to 2015/12/31; update 2017: and exact facet creation date 1965/01/01 to 2017/07/31; update 2019: and exact facet creation date 2017/07/31 to 2019/03/31

b) Search queries for search strategy #2– PUBMED search

* original search: Publication date from 2005/01/01 to 2015/12/31; update 2017: Publication date from 2005/01/01 to 2017/07/31; update 2019: Publication date from 2017/08/01 to 2019/03/31

Suppl. Table 2: Search queries for search strategies #3 and #4

Suppl. Table 3: Search strategies #3 and #4 - Number of potentially eligible records (PERs) and full text papers (FPs), by databases and questionnaires

Fig. 1: Searches #3 to #5 - Flowchart of paper selection procedure

Legend:
Search #3: both MESH terms “anger” and “pain“ in the publication title
Search #4: name and/or acronym of instruments resulting from search #1 in text and “pain” in publication title
Search #5: hand search
PERs potentially eligible records
FPs full text papers

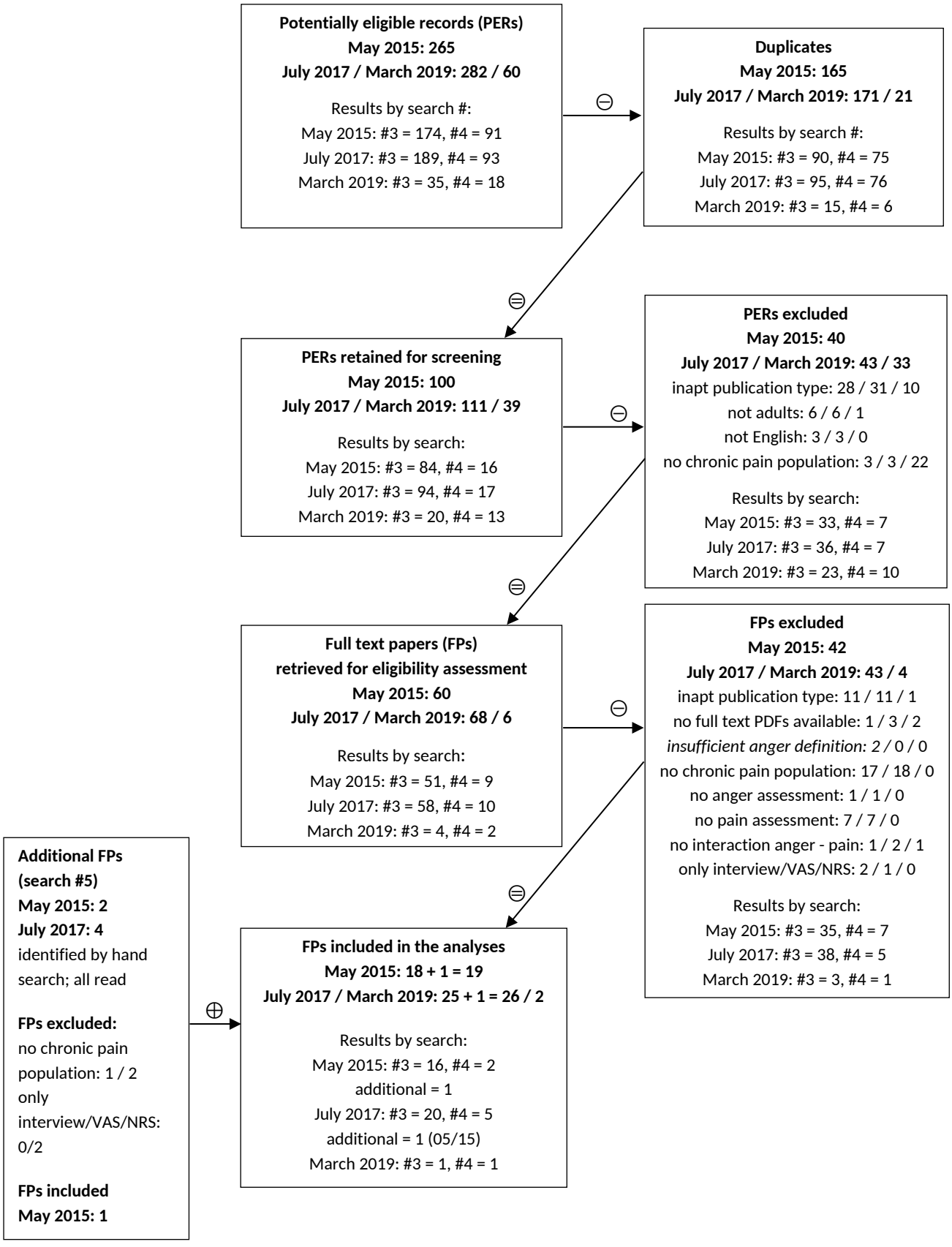

Fig. 2: Use of questionnaires according to pain type and location

Legend:
Quantitative illustration of the use of questionnaires according to pain type and/or location. The combined use of different questionnaires in some studies or the focus on more than one pain type explains the broken numbers. AX: Anger Expression Scale; STAS: State-Trait Anger Scale; STAXI: State-Trait Anger Expression Inventory; STAXI-II: State-Trait Anger Expression Inventory – revised version; PANAS-X: Positive and Negative Affect Schedule – expanded version

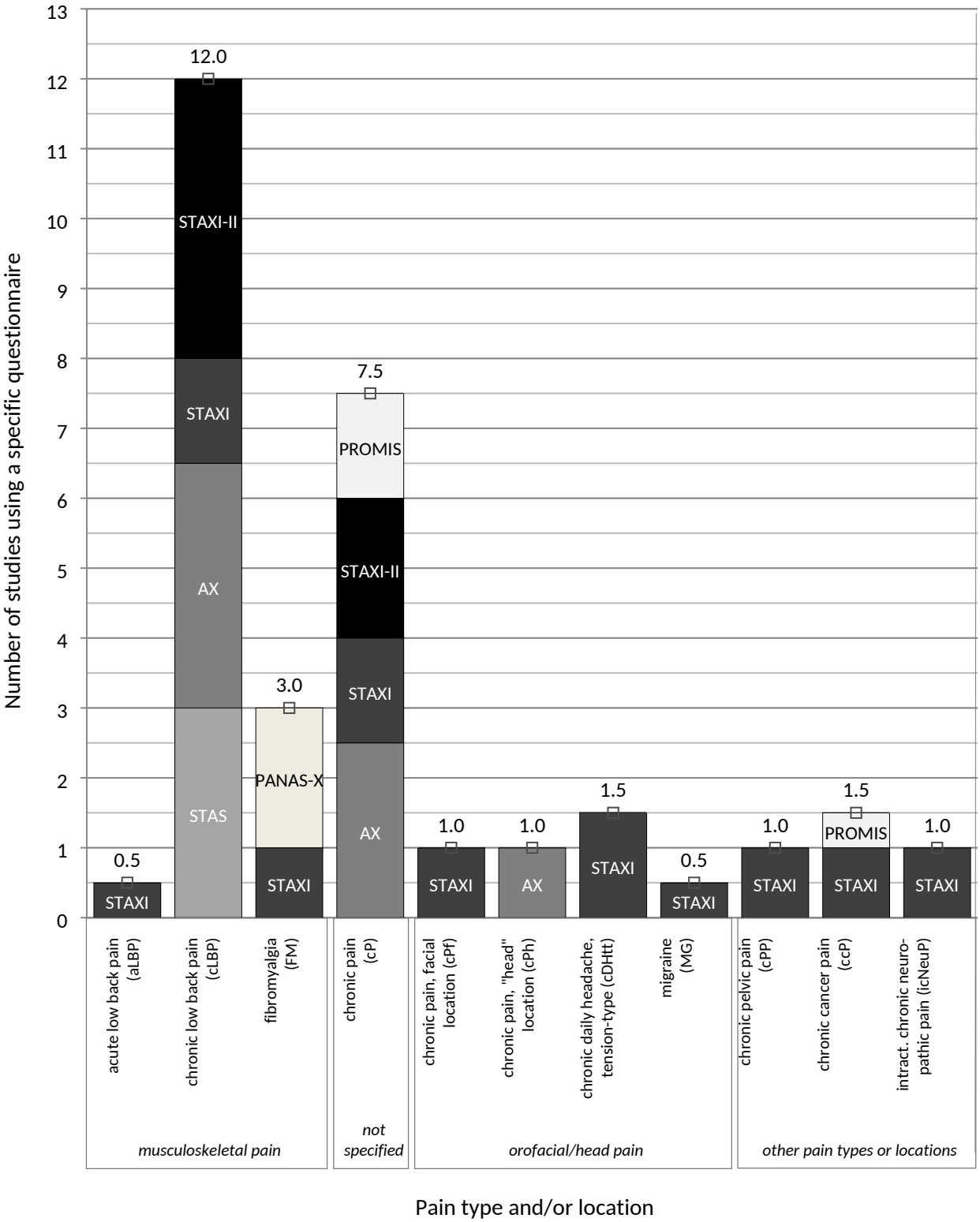

Table 1: Overview of the five literature searches

Search	Source/Database	Aim	Search terms	Inclusion criteria	Search queries
#1	Primo Central Index (PCI/NEBIS)[1]	Screening for comprehensive reviews of anger assessment instruments	"anger", "diagnosis", "measure*", "assessment*", "pain"	**Textbooks and review articles**; *Publication*: 1965-2019; *Language*: English	Appendix A1a
#2	PubMed	Determination of the relevance of instruments found through search strategy #1	Full names of the instruments identified through search #1	none	Appendix A1b
#3	Web of Science, PubMed, Embase, PCI/NEBIS	Screening for studies including a self-report measure of anger, declaration of study focus visible in title	MESH-terms[2] "anger" and "pain" in title	**Papers** (clinical trials or reviews); *Format*: PDF; *Publication*: 2005-2019; *Language*: English; *Population*: Adults (18+) chronic pain patients; *Questionnaire type*: anger (not hostility or aggression)	Appendix A2
#4	Web of Science, PubMed, Embase, PCI/NEBIS	Screening for studies including a self-report measure of anger, declaration of study focus not visible in title	Full names of the instruments identified through search #3	see search strategy #3	Appendix A2
#5	reference lists of results of searches #3 and #4	Identification of all relevant papers and questionnaires	Relevant citations in article text	see search strategy #3	Hand search

[1] The Primo Central Index (PCI) is a multidisciplinary index of scientific materials with more than 500 million electronic resources accessible via NEBIS recherche. NEBIS is the acronym for "Network of Libraries and Information Centers in Switzerland". The NEBIS catalog contains more than 10.5 million title records (books, serials, journals and non-book materials) with more than 15 million items. Literature searches are performed in Scopus (Elsevier), SAGE Journals, ERIC (U.S. Dept. of Education), Science Citation Index Expanded (Web of Science), MEDLINE/PubMed (NLM), and Social Sciences Citation Index (Web of Science).

[2] MESH (Medical Subject Headings) is the NLM controlled vocabulary thesaurus used for indexing articles in PUBMED.

Table 2: Estimates of test-retest reliability: original database search 2015 vs. update 2017 vs. update 2019

	Database searches	**Total of records**		**Differences**		**Test-Retest-Reliability**
		abs	**in %**	**abs**	**in %**	**R_{tt}**
Potentially eligible records (PERs)	original 2015 update 2017 update 2019	265 282 60		17		
Types of Exclusion						
Duplicates	original 2015 update 2017 update 2019	165 171 21	62.3 60.6 35.0	6	-1.7 -25.6	 R_{tt}=.97 R_{tt}=.58
Exclusions after screening	original 2015 update 2017 update 2019	40 43 33	15.1 15.2 55.0	3	+0.1 +39.8	 R_{tt}=.99 R_{tt}=.28
Exclusions after eligibility assessment	original 2015 update 2017 update 2019	42 43 4	15.8 15.2 6.7	1	-0.6 -8.5	 R_{tt}=.96 R_{tt}=.44
Total of exclusions	original 2015 update 2017 update 2019	**247** **257** **58**	**93.2** **91.1** **96.7**	**10**	**-2.1** **+5.6**	 **R_{tt}=.98** **R_{tt}=.94**

Table 3: Results of search #1 and hits in PUBMED (search #2)

Anger questionnaires (search #1)	**References (textbooks, reviews)**	**Hits in PUBMED (search #2)**
State-Trait Anger Scale (STAS) [98]	[33,56,86]	15, but confusion with STAXI
Anger Expression Scale (AX) [1] [101-103]	[33,56,86]	33, but confusion with STAXI
Anger Expression Inventory (AEI) [1][101-103] **Anger Expression Scale (AES)**[1] [101-103]	[86]	9, but 1 confusion with AX
State-Trait Anger Expression Inventory (STAXI) [99,105]	[33,37,56,86]	202, but confusion with STAXI-II
State-Trait Anger Expression Inventory – revised version (STAXI-II) [100]	[33,40,56,86]	66
Multidimensional Anger Inventory (MAI) [93]	[33,37,40,86]	8
Novaco Anger Scale (NAS) [69]	[33,37,40,86]	10, but confusion with NAS-PI [70]
Novaco Provocation Inventory (PI) [67,68]	[33,40,86]	5, but confusion with NAS-PI [70]
Minnesota Multiphasic Personality Inventory – 2 Anger Scale (MMPI-2-ANG) [5]	[33]	0
Anger Situation Questionnaire (ASQ) [114]	[86]	0
Clinical Anger Scale (CAS) [95]	[33,86]	0
Targets and Reasons for Anger in Pain Sufferers (TRAPS) [41] adapted version: Targets of Anger Scale (TAS) [73]	[37]	0
Anger Control Inventory (ACI) [52]	[40]	0
Anger Discomfort Scale (ADS) [92]	[40]	0

[1] In 1986 Spielberger, Johnson, et al. [6] developed the “Anger Expression Scale” and gave it the acronym “AX”. In later studies this scale was confusingly often called “Anger Expression Inventory” or “Anger Expression Scale”, leading to acronyms like “AEI” or “AES”. This confusion was considered using two separate search queries (see Appendix A1b).

Table 4: Results of searches #3 to #5 and pain conditions examined in the selected studies

Measure name and common acronyms	Counts of instrument use	References of selected studies	Pain conditions examined
State-Trait Anger Scale (**STAS**, 1983) [99] (also named TRANG)	3	[8] [11] [12]*	HC, cLBP HC, cLBP HC, cLBP
Anger Expression Scale (**AX**, 1986) [102-103] (also named, AES or Anger Expression Inventory, AEI)	7	[12]* [13] [14] [17] [18] [23]	cLBP HC, cLBP cP (incl. «head») cP HC, cLBP HC, cLBP
Anger Expression Scale (**AX**, 1988) [104]		[60]	cP
State-Trait Anger Expression Inventory (**STAXI**, 1995) [100,106]	10	[51] [59] [67] [72] [75][75] [76] [110]	cP cDHtt aLBP, cLBP cP (incl. facial pain) cDHtt, MG ccP cPP (women)
STAXI – german version (State-Trait Ärgerausdrucks-Inventar) [91]		[66] [78]	cLBP HC, icNeuP
Self-Expression and Control Scale, dutch (**SECS**) [34], based on the **STAXI**		[117]*	FM (women)
State-Trait Anger Expression Inventory – revised version (**STAXI-II**, 1999) [101]	6	[26] [27] [35] [114]	cLBP cLBP cP cLBP
STAXI-II - spanish version (Inventario De Expresión De Ira Estado-Rasgo) [64]		[65]	cLBP
STAXI-II – french version (Inventaire de colère trait et de colère état) [6]		[92]	cP
TOTAL STAXI-II and precursor versions	**26**	**25**	
Positive and Negative Affect Schedule – Expanded Form (**PANAS-X;** 1994) [119]	2	[116] [117]*	HC (women), FM (women) FM (women)
The Patient-Reported Outcomes Measurement Information System (**PROMIS®,** 2007): Anger scale [29]	2	[108] [25]	cP + ccP cP
TOTAL COUNTS	**4**	**3**	

HC: healthy pain-free controls
Types of pain sufferers: aLBP: acute, non-cancer, low back pain; ccP: chronic cancer pain; cDHtt: chronic daily headache, tension type; cLBP: chronic, non-cancer, low back pain; cNP/WAD: chronic neck pain and whiplash associated disorder after motor-vehicle traffic injury; cP: chronic non-cancer pain; cPP: chronic pelvic pain; FM: fibromyalgia; icNeuP: intractable chronic neuropathic pain; MG: migraine
*double citation

Table 5: Item lists of the AX, STAS and STAXI

State-Trait Anger Expression Inventory (STAXI) encompassing its precursor versions AX, STAS

Anger Expression Scale (AX)

Subscale: *AX/In (Anger-In)*

1. I keep things in
2. I pout or sulk
3. I withdraw from people
4. I boil inside, but don't show it
5. I tend to harbor grudges and don't tell anyone
6. I am secretly critical of others
7. I am angrier than I am willing to admit
8. I get more irritated than others are aware of

Subscale: *AX/Out (Anger-Out)*

1. I express my anger
2. If someone is annoying, I am apt to tell him or her
3. I lose my temper
4. I make sarcastic remarks to others
5. I do things like slamming doors
6. I argue with others
7. I strike out at whatever infuriates me
8. I say nasty things

Subscale: *AX/Con (Anger Control)*, *added 1988*

1. I control my temper
2. I am patient with others
3. I try to calm down as soon as possible
4. I keep cool
5. I control my behavior
6. I can stop myself from losing my temper
7. I try to be tolerant and understanding
8. I control my angry feelings

Rating (4-point scale): *1 "almost never", 2 "sometimes", 3 "often", 4 "almost always"*

State-Trait Anger Scale (STAS)

Subscale: *State Anger Scale (SAS)*

1. I am furious
2. I feel irritated
3. I feel angry
4. I feel like yelling at somebody
5. I feel like breaking things
6. I am mad
7. I feel like banging on the table
8. I feel like hitting someone
9. I feel like swearing
10. I am burned up

Rating (4-point scale):
1 "not at all", 2 "somewhat", 3 "moderately so", 4 "very much so"

Subscale: *Trait Anger Scale (TAS)*

> TAS-T (Angry Temperament)

1. I am quick tempered
2. I have a fiery temper
3. I am a hotheaded person
4. I fly off the handle
5. When I get mad, I say nasty things

> TAS-R (Angry Reactions)

6. I get angry when I am slowed down by others
7. I feel annoyed when I am not given recognition for doing good work
8. It makes me furious when I am criticized in front of others
9. I feel infuriated when I do a good job and get a poor evaluation
10. When I am frustrated I feel like hitting someone

new Subscale: *AX/Ex (Anger Expression Scale)*, *added 1988*

The AX/Ex is computed with the following formula: AX/EX = AX/Out + AX/In - AX/Con +16.
The addition of 16 at the end was designed to prevent negative scores

Table 6: Item lists of the STAXI-II

State-Trait Anger Expression Inventory (STAXI-II)

Subscale: *AX-I (Anger Expression-In)* = *AX/In*

Subscale: *AX-O (Anger Expression-Out)* = *AX/Out*

new Subscale: *AC-I (Anger-Control In)*

1. I take deep breaths and relax
2. I control urges to express angry feelings
3. I try to simmer down
4. I try to soothe angry feelings
5. I endeavor to become calm again
6. I reduce my anger as soon as possible
7. I do something relaxing to calm down
8. I try to relax

Subscale: *AC-O (Anger-Control out)* = *AX/Con*

new Subscale: *S-Ang (State Anger)* = *expanded SAS*

> S-Ang/F (feeling angry)

1. I am furious
2. I feel irritated
3. I feel angry
4. I am mad
5. I am burned up

> S-Ang/V (feel like expressing anger verbally)

1. I feel like yelling at somebody
2. I feel like swearing
3. I feel like cursing out loud
4. I feel like screaming
5. I feel like shouting out loud

> S-Ang/P (feel like expressing anger physically)

1. I feel like breaking things
2. I feel like banging on the table
3. I feel like hitting someone
4. I feel like kicking somebody
5. I feel like pounding on somebody

Rating (4-point scale):
1 "not at all", 2 "somewhat", 3 "moderately so", 4 "very much so"

Subscale: *T-Ang (Trait Anger)* = *TAS*

> T-Ang/T (Angry Temperament) = (TAS-T)

> T-Ang/R (Angry Reaction) = (TAS-R)

Rating (4-point scale): *1 "almost never", 2 "sometimes", 3 "often", 4 "almost always"*

Subscale: *AX/Ex (Anger Expression Scale)*, *added 1988*

The AX/Ex is computed with the following formula: AX/EX = AX/Out + AX/In – (AC-O + AC-I) + 48.
The addition of 48 at the end was designed to prevent negative scores.

Table 7: Item lists of the PROMIS Anger - Item bank

PROMIS – Item Bank v1.1 – Anger ©2008-2016 PROMIS Health Organization and PROMIS Cooperative Group, 25 April 2016	
EDANG01	when I was frustrated, I let it show
EDANG03	I was irritated more than people knew
EDANG04	I felt envious of others
EDANG05	I disagreed with people
EDANG09	I felt angry
EDANG10	when I was mad at someone, I gave them the silent treatment
EDANG11	I felt like breaking things
EDANG15	I felt like I was ready to explode
EDANG16	when I was angry, I sulked
EDANG17	I felt resentful when I didn't get my way
EDANG18	I felt guilty about my anger
EDANG21	I felt bitter about things
EDANG22	I felt that people were trying to anger me
EDANG26	I held grudges towards others
EDANG30	I was grouchy
EDANG31	I was stubborn with others
EDANG35	I felt annoyed
EDANG37	I had a bad temper
EDANG42	I had trouble controlling my temper
EDANG48	I felt like I needed help for my anger
EDANG55	I felt like yelling at someone
Instruction:	*In the past 7 days…*
Rating (5-point scale):	*1 "never", 2 "rarely", 3 "sometimes", 4 "often", 5 "always"*
EDANG56	just being around people irritated me
Instruction:	*In the past 7 days…*
Rating (5-point scale):	*1 "not", 2 "a little", 3 "somewhat", 4 "quite a bit", 5 "very much"*

Table 8: Item lists of the PANAS-X scales

Item Composition of the PANAS-X Scales	
General Dimension Scales	
Negative Affect (10)	afraid, scared, nervous, jittery, irritable, hostile, guilty, ashamed, upset, distressed
Positive Affect (10)	active, alert, attentive, determined, enthusiastic, excited, inspired, interested, proud, strong
Basic Negative Emotion Scales	
Fear (6)	afraid, scared, frightened, nervous, jittery, shaky
Hostility (6)	angry, hostile, irritable, scornful, disgusted, loathing
Guilt (6)	guilty, ashamed, blameworthy, angry at self, disgusted with self, dissatisfied with self
Sadness (5)	sad, blue, downhearted, alone, lonely
Basic Positive Emotion Scales	
Joviality (8)	happy, joyful, delighted, cheerful, excited, enthusiastic, lively, energetic
Self-Assurance (6)	proud, strong, confident, bold, daring, fearless
Attentiveness (4)	alert, attentive, concentrating, determined
Other Affective States	
Shyness (4)	shy, bashful, sheepish, timid
Fatigue (4)	sleepy, tired, sluggish, drowsy
Serenity (3)	calm, relaxed, at ease
Surprise (3)	amazed, surprised, astonished
Instruction:	*Indicate to what extent you have felt this way during the past few weeks*
Rating (5-point scale):	*1 "very slightly", 2 "a little", 3 "moderately", 4 "quite a bit", 5 "extremely"*

Note. The number of terms comprising each scale is shown in parentheses.

Supplementary Table 1a: Search queries for search strategy #1

Search Engine	Search query*
Primo Central Index	Title contains: anger and (diagnosis) OR (measure*) OR (assessment*) OR (pain) and exact facet creation date 1965/01/01 to 2019/03/31 and exact facet filter: books and exact facet lang:

* original search: and exact facet creation date 1965/01/01 to 2015/12/31; update 2017: and exact facet creation date 1965/01/01 to 2017/07/31; update 2019: and exact facet creation date 2017/07/31 to 2019/03/31

Supplementary Table 1b: Search queries for search strategy #2– PUBMED search

Search Engine	Instrument names and acronyms	Search queries*
Pubmed	**State-Trait Anger Scale (STAS)**	"State Trait Anger Scale"[Text Word] Filters: Publication date from 2005/01/01 to 2019/03/31
	Anger Expression Scale (AX)	"Anger Expression Scale"[Text Word] Filters: Publication date from 2005/01/01 to 2019/03/31
	Anger Expression Inventory (AEI)[1]/ Anger Expression Scale (AES)[1]	(("Anger Expression Inventory"[Text Word]) NOT State[Text Word]) NOT Trait[Text Word] Filters: Publication date from 2005/01/01 to 2019/03/31 (("Anger Expression Scale"[Text Word]) NOT State[Text Word]) NOT Trait[Text Word] Filters: Publication date from 2005/01/01 to 2019/03/31
	State-Trait Anger Expression Inventory (STAXI)	"State Trait Anger Expression Inventory"[Text Word] Filters: Publication date from 2005/01/01 to 2019/03/31
	State-Trait Anger Expression Inventory – revised version (STAXI-II)	"State Trait Anger Expression Inventory 2"[Text Word] Filters: Publication date from 2005/01/01 to 2019/03/31
	Multidimensional Anger Inventory (MAI)	"Multidimensional Anger Inventory"[Text Word] Filters: Publication date from 2005/01/01 to 2019/03/31
	Novaco Anger Scale (NAS)	"Novaco Anger Scale"[Text Word] Filters: Publication date from 2005/01/01 to 2019/03/31
	Novaco Provocation Inventory (PI)	Novaco "Provocation Inventory"[Text Word] Filters: Publication date from 2005/01/01 to 2019/03/31
	Minnesota Multiphasic PersonalityInventory – 2 Anger Scale (MMPI-2-ANG)	"MMPI Anger Scale"[Text Word] Filters: Publication date from 2005/01/01 to 2019/03/31
	Anger Situation Questionnaire (ASQ)	"Anger Situation Questionnaire"[Text Word] Filters: Publication date from 2005/01/01 to 2019/03/31
	Clinical Anger Scale (CAS)	"Clinial Anger Scale"[Text Word] Filters: Publication date from 2005/01/01 to 2019/03/31
	Targets and Reasons for Anger in Pain Sufferers (TRAPS)	"Targets and Reasons for Anger in Pain Sufferers"[Text Word] Filters: Publication date from 2005/01/01 to 2019/03/31
	Anger Control Inventory (ACI)	"Anger Control Inventory"[Text Word] Filters: Publication date from 2005/01/01 to 2019/03/31
	Anger Discomfort Scale (ADS)	"Anger Discomfort scale"[Text Word] Filters: Publication date from 2005/01/01 to 2019/03/31

* original search: Publication date from 2005/01/01 to 2015/12/31; update 2017: Publication date from 2005/01/01 to 2017/07/31; update 2019: Publication date from 2017/08/01 to 2019/03/31

[1] In 1986 Spielberger, Johnson, et al. [102] developed the “Anger Expression Scale” and gave it the acronym “AX”. In later studies this scale was confusingly often called “Anger Expression Inventory”. This resulted in acronyms like “AEI” or “AES”. This confusion was considered through use of two separate search queries (see Appendix A1b).

Supplementary Table 2: Search queries for search strategies #3 and #4

Short definition of search strategies

Search strategy #3: anger [in title] AND pain [in title]

Search strategy #4: <measure name> AND pain [in title]

Search Engine	Search queries (by strategy)
Web of Science	**Search strategy #3:** TI=(anger AND pain) Refined by: RESEARCH DOMAINS: (SOCIAL SCIENCES) AND DOCUMENT TYPES: (ARTICLE OR CLINICAL TRIAL OR REVIEW) [if possible] *Time span=2005-2019 (original search: Time span=2005-2015; update 2019: Time span=2017-2019)* *Search language=Auto*
	Search strategy #4: TS=("Anger Expression Scale") AND TI=(pain) TS=("Anger Expression Inventory") AND TI=(pain) TS=("State Trait Anger Scale") AND TI=(pain) TS=("STAS") AND TI=(pain) TS=("State Trait Anger Expression Inventory") AND TI=(pain) TS=("STAXI*") AND TI=(pain) TS=("Multidimensional Anger Inventory") AND TI=(pain) TS=("Novaco Anger Scale") AND TI=(pain) TS=(Novaco AND "Provocation Inventory") AND TI=(pain) Refined by: RESEARCH DOMAINS: (SOCIAL SCIENCES) AND DOCUMENT TYPES: (ARTICLE OR CLINICAL TRIAL OR REVIEW) [if possible] *Time span=2005-2019 (original search: Time span=2005-2015; update 2019: Time span=2017-2019)* *Search language=Auto*
Pubmed	**Search strategy #3:** (anger[Title]) AND pain[Title] AND ((Clinical Trial[ptyp] OR Review[ptyp]) AND ("2005/01/01"[PDat] : "2019/03/31"[PDat])* AND Humans[Mesh] AND English[lang] AND adult[MeSH])
	Search strategy #4: ("Anger Expression Scale") AND pain[Title] [1] ("Anger Expression Inventory") AND pain[Title] [1] ("State Trait Anger Scale") AND pain[Title] [1] ("State Trait Anger Expression Inventory") AND pain[Title] [1] ("STAXI*") AND pain[Title] [1] ("Multidimensional Anger Inventory") AND pain[Title] [1] ("Novaco Anger Scale") AND pain[Title] [1] ((Novaco) AND "Provocation Inventory") AND pain[Title] [1] [1]AND ((Clinical Trial[ptyp] OR Review[ptyp]) AND ("2005/01/01"[PDat] : "2019/03/31"[PDat])* AND Humans[Mesh] AND English[lang] AND adult[MeSH]) ** original search: ("2005/01/01"[PDat] : "2015/12/31"[PDat]); update 2019: ("2017/08/01"[PDat] : "2019/03/31"[PDat])*
Embase	**Search strategy #3:** 'anger':ti AND 'pain':ti AND ([article]/lim OR [article in press]/lim OR [review]/lim) AND [english]/lim AND ([adult]/lim OR [aged]/lim) AND [embase]/lim AND [2005-2019]*/py
	Search strategy #4: 'anger expression scale' AND 'pain':ti [2] 'anger expression inventory' AND 'pain':ti [2] 'state trait anger scale' AND 'pain':ti [2] 'state-trait anger expression inventory' AND 'pain':ti [2] 'staxi*' AND 'pain':ti [2] 'multidimensional anger inventory' AND 'pain':ti [2] 'novaco anger scale' AND 'pain':ti [2] novaco AND 'provocation inventory' AND 'pain':ti [2] [2]AND ([article]/lim OR [article in press]/lim OR [review]/lim) AND [english]/lim AND ([adult]/lim OR [aged]/lim) AND [embase]/lim AND [2005-2019]*/py ** original search: [embase]/lim AND [2005-2015]; update 2019: [embase]/lim AND [2017-2019]*

Supplementary Table 2: Search queries for search strategies #3 and #4, incl. update July 2017 (continued)

Search Engine	Search Strategies
Primo Central Index	**Search strategy #3:** contains Title: anger and contains Title pain and exact facet pfilter: articles and exact facet lang: and exact dr s:20050101 and exact dr e: 20190331*
	Search strategy #4: - Contains "anger expression scale" and contains Title: pain and exact facet pfilter: articles and exact facet lang: and exact dr s:20050101 and exact dr e: 20190331* - Contains "anger expression inventory" and contains Title: pain and exact facet pfilter: articles and exact facet lang: and exact dr s:20050101 and exact dr e: 20190331* - Contains "state trait anger scale" and contains Title: pain and exact facet pfilter: articles and exact facet lang: and exact dr s:20050101 and exact dr e: 20190331* - Contains "state trait anger expression inventory" and contains Title: pain and exact facet pfilter: articles and exact facet lang: and exact dr s:20050101 and exact dr e: 20190331* - Contains "multidimensional anger inventory" and contains Title: pain and exact facet pfilter: articles and exact facet lang: and exact dr s:20050101 and exact dr e: 20190331* - Contains "novaco anger scale" and contains Title: pain and exact facet pfilter: articles and exact facet lang: and exact dr s:20050101 and exact dr e: 20190331* - Contains novaco and contains "provocation inventory" and contains Title: pain and exact facet pfilter: articles and exact facet lang: and exact dr s:20050101 and exact dr e: 20190331* ** original search: (and exact dr s: 20050101 and exact dr e: 20151231); update 2017: (and exact dr s: 20050101 and exact dr e: 20170731); update 2019: (and exact dr s: 20170801 and exact dr e: 20190331)*

Supplementary Table 3: Search strategies #3 and #4 - Number of potentially eligible records (PERs) and full text papers (FPs), incl. updates 2017 and 2019

Databases	Search strategy #3 No. of articles	Search strategy #4 No. of articles	PERs	duplicates	Exclusions after screening	Total FPs
WoS	49	14	**63**	-59	-4	**0**
PM	11	4	**15**	-15	-0	**0**
EM	30	5	**35**	-35	-0	**0**
PCI/NEBIS	84	68	**152**	-56	-36	**60**
Total PERs 2005-2015	**174**	**91**	**265**			
Duplicates	-90	-75		**-165**		
Excl. after screening	-33	-7			**-40**	
Total FPs 2005-2015	**51**	***9***				**60**

Total PERs *2005-2017* *(PCI/NEBIS only)* *2017-2019* *(all databases)*	**231 *189* *42***	**111 *93* *18***	**342 *282* *60***			
Total Duplicates *2005-2017* *2017-2019*	-110 *-95* *-15*	-82 *-76* *- 6*		**-192 *-171* *-21***		
Total Excl. after screening *2005-2017* *2017-2019*	-59 *-36* *-23*	-17 *-7* *-10*			**-71 *-43* *-33***	
Total FPs *2005-2017* *2017-2019*	**62 *58* *4***	**12 *10* *2***				**74 *68* *6***

Short definition of search strategies

Search strategy #3: anger [in title] AND pain [in title]

Search strategy #4: <measure name> AND pain [in title]

Abbreviations

WoS	Web of Science	PCI/NEBIS	Primo Central Index
PM	Pubmed	EM	Embase
PERs		Potentially eligible records	
Total FPs		Total full text papers selected for assessment of eligibility	
2005-2017		Complete update performed in July 2017	
2017-2019		Additional update performed in March 2019	

Online Appendix: Books, Reviews and Articles identified

Books and book chapter

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Sincerely,

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