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REVIEW

Exploring Pain Empathy Among Doctors, Nurses and Patients: A Scoping Review

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Purpose: This review aims to systematically assess the existing body of research on pain empathy among healthcare workers and patients, with the goal of enhancing both understanding and clinical application.

Methods: Studies were retrieved from seven databases: PubMed, EBSCO, The Cochrane Library, Embase, CBM, CNKI, and Wanfang, with a search date limit from database inception to September 13, 2024. Inclusion and exclusion criteria were established based on the PCCs (Population, Concept, Context, Study design) principle. The research was independently screened and summarized by two researchers. A pre-designed data extraction form was used for information extraction from the included studies.

Results: A total of 4729 studies were initially identified, with 50 studies included after screening. The participants were categorized into six groups: pain patients, nurses, patients with neurological diseases, cancer patients, patients with psychiatric disorders, doctors, and medical students. The studies employed 75 distinct research tools, including the Empathy for Pain Scale (EPS), the Interpersonal Reactivity Index (IRI), pain empathy paradigms, and the Visual Analogue Scale (VAS), along with various detection technologies, such as functional magnetic resonance imaging (fMRI) and electroencephalography (EEG). Factors influencing pain empathy included psychological factors, individual traits, and social influences. Mechanistic studies explored the neural substrates of emotional empathy (anterior insula, anterior cingulate cortex, amygdala), cognitive empathy (precuneus and parietal-occipital junction), the relationship between emotional regulation and cognitive processing, and the synergistic interactions of multiple brain regions.

Conclusion: This review offers a comprehensive overview of research on pain empathy among healthcare workers and patients, emphasizing its multidisciplinary nature and complexity. It provides theoretical foundations and outlines potential directions for future research, which may include the adoption of unified research standards, interdisciplinary collaboration, the application of advanced technologies, and cross-cultural studies to further advance the field of pain empathy.

Keywords: pain empathy, healthcare worker, patient, scoping review

Introduction

Pain is a ubiquitous term in the healthcare field. The International Association for the Study of Pain (IASP) defines pain as "an unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage".[1] Statistics from the International Pain Society indicate that one in five people globally experiences chronic pain. A study by the Centers for Disease Control and Prevention (CDC) in the United States estimates that the prevalence of chronic pain is 20.4%.[2] In China, the prevalence of pain was 39.93% in women and 32.17% in men.[3] The "China Pain Medicine Development Report" indicates that over 300 million people in China suffer from chronic pain, with an annual increase of 10 to 20 million.[4] Pain has thus emerged as the third largest health issue after cardiovascular diseases and cancer. Rather than attributing the increasing burden of disease to rising pain prevalence, it is more accurate to state that pain is the primary reason people seek medical care and treatment. In the

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expansive domain of healthcare, pain management remains a multifaceted and complex challenge. Pain is not merely a physical discomfort but involves complex interactions across emotional, psychological, and social dimensions. As our understanding of pain deepens, the medical field increasingly acknowledges that the perception and experience of pain are significantly influenced by individual differences, cultural contexts, psychological states, and the healthcare environment.[5] In this context, pain empathy—the understanding and resonance of another person's pain experience—emerges as a crucial factor in enhancing the quality of pain care.

A century ago, Titchener introduced the term "empathy",[6] describing it as an intrinsic experience in which an individual can place themselves in another's situation and experience what the other person feels. Empathy is a crucial psychological process for understanding and sharing others' emotions. In 1983, Gladstein introduced the "dual-component theory" of empathy, categorizing it into two dimensions: affective empathy and cognitive empathy.[7,8] Scholars believe that empathy can not only help healthcare workers better understand patients, help patients relieve symptoms, but also help them build positive interpersonal relationships.[9,10]

Pain empathy, a prominent form of empathy, refers to the process by which an individual perceives, shares, understands, evaluates, and responds to the pain experiences of others, grounded in their own perception of pain and emotional experience.[11] For doctors and nurses, pain empathy is not simply an emotional response but a profound cognitive and behavioral ability that directly influences their capacity to understand and respond to the suffering of patients from their perspective. A strong sense of pain empathy can foster trust between healthcare providers and patients, improve patient satisfaction, enhance treatment adherence, and ultimately improve overall health outcomes.[12,13] Patients may also experience pain empathy towards other patients, which holds special significance in healthcare settings. When patients empathize with one another, a supportive environment is cultivated where they can emotionally understand and support each other. This shared empathy alleviates feelings of isolation and helplessness associated with their pain while enhancing psychological resilience in the face of illness and suffering. Moreover, this inter-patient pain empathy may influence their perceptions of their condition and treatment, thereby motivating their participation in the treatment process and promoting recovery.[14,15]

Despite the undeniable significance of pain empathy among healthcare practitioners and patients, current research in this field remains fragmented and dispersed. Existing studies span multiple disciplines, with numerous investigations examining the subject from diverse academic perspectives. While this multidisciplinary exploration has provided valuable insights, it has also resulted in the complexity and diversity of findings. The fragmented nature of the research makes it challenging to form a comprehensive and coherent understanding of pain empathy, hindering the seamless integration of knowledge across disciplines in clinical practice. Consequently, this limits the recognition, effective application and optimization of pain empathy in real-world settings.

This study aims to conduct a scoping review to systematically map the research in this field and identify existing knowledge gaps. The goal of this review is to assist healthcare practitioners in understanding the complexities of pain empathy more effectively, enabling them to apply relevant knowledge in clinical practice. This will, in turn, help optimize pain management strategies, enhance the quality of healthcare services, and ultimately improve patient care and treatment outcomes.

In his 1977 paper, "The Need for a New Medical Model: A Challenge to Biomedicine", published in Science, Engel systematically introduced the biopsychosocial framework.[16] This model emphasizes the importance of considering biological, psychological, and social factors comprehensively when addressing health and illness, offering a novel theoretical perspective and research framework for medicine and related fields. Research by Chen Jun et al[17] has shown that pain empathy provides a biopsychosocial-behavioral research paradigm for understanding brain function, highlighting that pain empathy itself is a complex phenomenon involving multiple factors. The adoption of the biopsychosocial framework facilitates a comprehensive and accurate approach to the various dimensions of pain empathy, including the biological foundation—such as the brain's response mechanisms to pain empathy—the psychological aspects, such as individual cognition and emotional influences on pain empathy, and social factors, including interpersonal relationships and socio-cultural contexts, all of which contribute to pain empathy. This approach helps gain a deeper understanding of the essence of pain empathy. Therefore, this study employs the biopsychosocial framework to systematically search for and screen research related to pain empathy from biological, psychological, and social perspectives (Table 1).

Table 1 The Biopsychosocial Framework

Level	Application
Biological Level	This level explores the neural mechanisms in the brain, such as the activation of brain regions associated with pain empathy. It also examines the regulatory role of neurotransmitters, such as dopamine and endorphins, in modulating pain empathy.
Psychological Level	This level analyzes the impact of cognitive, emotional, and personality factors on pain empathy, such as the patient's pain perception, coping strategies, emotional state, and other psychological aspects that influence their experience of pain empathy.
Social Level	This level examines the role of the healthcare environment, doctor-patient relationships, social support, and other societal factors in influencing pain empathy.

Methods

This study employs a scoping review methodology aimed at systematically mapping the research landscape of pain empathy among doctors, nurses and patients. The review adheres to the framework proposed by Arksey and O'Malley, with reference to the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) guidelines to ensure transparency and rigor in the methodology. The scoping review is conducted in five steps: (1) Defining the research question (2) Identifying relevant studies (3) Selecting studies (4) Data analysis (5) Organizing, summarizing, and reporting the results.

Defining the Research Question

This review aims to explore and synthesize the existing research evidence on pain empathy within the healthcare domain, focusing on its assessment tools, influencing factors, and potential implications for practice. The primary question addressed in this review is: How is research on pain empathy being conducted in current studies of doctors, nurses and patients?

Identification of Relevant Studies

A systematic search was performed across seven databases: PubMed, EBSCO, The Cochrane Library, Embase, CBM, CNKI, and Wanfang. The time frame for the search extended from the inception of these databases to September 13, 2024. Table 2 illustrates the search strategy using PubMed as an example, and the full search strategy can be found in Supplementary Table 1.

Table 2 Search Strategy (PubMed)

Database	PubMed	
Set #	**Search Terms**	**Number**
1	"pain"[MeSH Terms] OR "ache*"[Title/Abstract]	506,248
2	"empathy"[MeSH Terms] OR "empathy"[Title/Abstract] OR "empathetic"[Title/Abstract]	36,633
3	"delivery of health care"[MeSH Terms] OR "health"[MeSH Terms] OR "hospitals"[MeSH Terms] OR "hygiene"[MeSH Terms] OR "nurses, community health"[MeSH Terms] OR "nurses"[MeSH Terms] OR "physicians"[MeSH Terms] OR "patients"[MeSH Terms] OR "therapeutics"[MeSH Terms] OR "healthcare"[Title/Abstract] OR "health"[Title/Abstract] OR "medical"[Title/Abstract] OR "hospital*"[Title/Abstract] OR "clinic*"[Title/Abstract] OR "infirmary"[Title/Abstract] OR "hygiene"[Title/Abstract] OR "wellness"[Title/Abstract] OR "community"[Title/Abstract] OR "nurse*"[Title/Abstract] OR "physician*"[Title/Abstract] OR "doctor*"[Title/Abstract] OR "patient*"[Title/Abstract] OR "client*"[Title/Abstract] OR "ailing"[Title/Abstract] OR "intervention"[Title/Abstract] OR "treatment"[Title/Abstract] OR "treat"[Title/Abstract] OR "therapy"[Title/Abstract] OR "care"[Title/Abstract] OR "clinical"[Title/Abstract]	18,876,586
4	#1 and #2 and #3	763

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Selection and Screening of Studies

To ensure the systematic and scientific rigor of this review, the inclusion and exclusion criteria were based on the PCCs (Population, Concept, Context, Study design) framework.

Inclusion Criteria

①Population: Studies involving relevant populations in the healthcare environment, including but not limited to doctors, nurses, medical students, nursing students, and patients.②Concept: Studies clearly address the concept of "pain empathy" and its application in healthcare.③Context: Studies focused on healthcare settings, such as hospitals, clinics, long-term care institutions, and community health service centers.④Study Design: Quantitative studies, qualitative studies, and mixed-methods research.

Exclusion Criteria

①Animal or non-human studies.②Studies that do not provide original data, such as book chapters, reviews, and brief communications.③Studies published in languages other than English or Chinese.④Studies where the full text was not accessible.

Two researchers independently screened the studies. After deduplicating the retrieved studies using software, the researchers performed an initial screening by reviewing titles and abstracts. They selected studies based on the biological, psychological, and social dimensions of the biopsychosocial framework, excluding those that clearly did not meet the inclusion criteria. After the initial screening, the full texts of the selected studies were retrieved, reviewed, and further assessed for eligibility based on the inclusion and exclusion criteria. Throughout the initial screening and full-text evaluation, the two researchers cross-checked and discussed their results. Any disagreements were resolved through discussion, and if necessary, a third researcher was involved to make the final decision. The study selection process followed the PRISMA guidelines, and a flowchart (Figure 1) was created to illustrate the screening process.

Data Analysis

In this study, a pre-developed data extraction form was used to systematically standardize the extraction and recording of key information from each included study. The development of the data extraction form was based on the research objectives, the PCCs framework, and the research framework for the study review. Before formal data extraction, the form was discussed and trialed by the research team to ensure its applicability and consistency. The extracted information included the following: author(s), year, research design, sampling methods, study participants, study location, sample size, country, objectives, assessment indicators, assessment tools, main findings, and biological-psychosocial dimensions. The data extraction process was facilitated using NVivo software. All final studies included were imported into NVivo in PDF format, and each study was labeled and organized according to the information extracted from the data extraction form. The organized content was then entered into an Excel-based data extraction table.

Organizing, Summarizing, and Reporting the Results

Two researchers independently completed the data extraction and then compared and integrated the results to ensure consistency. The analysis results were presented using narrative synthesis, with the basic characteristics and key information of the studies organized into tables. Bar charts and pie charts were used to display the distribution and trends in the research.

Results

Basic Characteristics of Included Studies

A total of 4729 studies were retrieved from the selected databases. After deduplication with Endnote 20.0, 2593 studies remained. After an initial screening of titles and abstracts, 146 studies were identified. After obtaining and reviewing the full texts, 50 studies were ultimately included in the review. Figure 1 presents a detailed flowchart of the screening process. Supplementary Table 2 presents the details of the included studies. Table 3 presents the studies categorized according to the biopsychosocial framework.

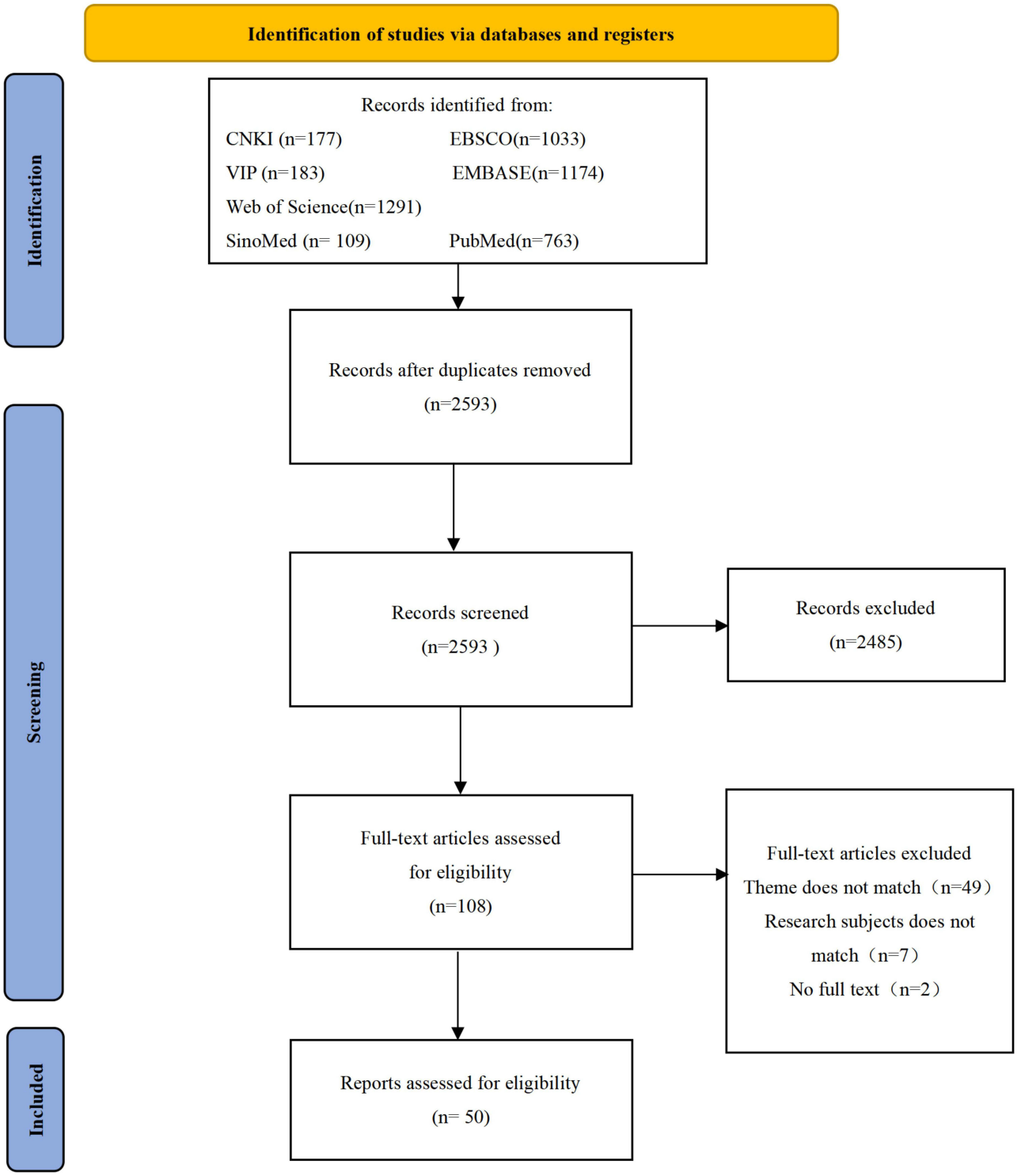

Figure 1 Flowchart of Screening Process.

Characteristics of Study Participants

Figure 2 illustrates the overall distribution of study participants, with pain patients and individuals with mental disorders being the two largest groups. The participants are divided into six main categories: pain patients (26%),[20–24,27,35,36,40,45,46,59,63] nurses (16%)/ doctors and medical students (10%),[28,32,42,48–50,54–57,60,66,67] patients

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Table 3 Study Stratification Based on the Biopsychosocial Framework

No	Framework	Study
Mechanisms Influencing Factors	Biological	[18–48]
	Psychological	[18–33,44,46–65]
	Social	[18–25,45,49–60,66,67]

with neurological disorders (10%),[25,26,31,41,64] cancer patients (8%),[18,19,34,61] patients with mental disorders (22%),[29,30,37–39,43,47,51–53,58] and other populations (8%).[31,33,44,65] A more detailed classification of the study participants reveals that clinical nurses (10%),[50,55,57,66,67] patients with primary dysmenorrhea (8%),[24,35,40,45] and patients with schizophrenia (8%)[29,30,38,51] have relatively higher representation in the research.

Research Tools for Pain Empathy

Table 4 presents 75 research tools mentioned across the 50 studies.[18–25,49–60,66] The methods used to assess pain empathy are varied, with 7 studies employing the Empathy for Pain Scale (EPS)[49,54,66] and its translated versions[50,55–57] to quantify an individual's level of pain empathy. The EPS is a psychometric tool specifically designed to evaluate an individual's empathy for others' pain, encompassing 2 dimensions: affective empathy and cognitive empathy. Research indicates that the EPS exhibits high internal consistency across different cultural contexts and reliably assesses pain empathy. It is widely used in psychology, clinical medicine, and neuroscience.

Fifteen studies also employed the Pain Empathy Paradigm[19,20,24,29,31,34,35,45,51–53,58,59,61,62] and 4 studies combined it with the Visual Analogue Scale (VAS)[23,40,44,45] for experimental measurement. The Pain Empathy Paradigm presents participants with stimuli depicting others in pain situations (such as images, videos, or textual descriptions), eliciting both emotional and cognitive responses to others' pain. Assessment methods include subjective reports, physiological indicators, and brain activity data. This paradigm provides essential tools for exploring the neural mechanisms of pain empathy.

Additionally, thirteen studies employed the Interpersonal Reactivity Index (IRI),[19,20,24,29,31,34,35,45,51–53,58,59,61,62] a multidimensional empathy assessment tool, which includes subscales for Perspective Taking, Fantasy, Empathic Concern, and Personal Distress. It offers a comprehensive reflection of an individual's emotional and cognitive empathy abilities in interpersonal contexts and is widely applied in social psychology, affective science, and research on interpersonal relationships.

In addition to these scales and paradigms, studies discuss a variety of tools related to empathy, pain, and cognition. For example, the Montreal Cognitive Assessment (MoCA)[31,43,44] for evaluating cognitive ability, the Pain Catastrophizing Scale (PCS)[22,44,65] for assessing pain perception, and the Hamilton Depression Rating Scale (HAMD)[20,31,43,59] for evaluating mental state. Studies also incorporated various detection techniques, such as functional magnetic resonance imaging (fMRI),[21,37,39,40,46] electroencephalography (EEG),[25,27,33,41] event-related potentials (ERP),[19,22,26,28,29,31,32,34,36,38,43,46–48,60] functional near-infrared spectroscopy (fNIRS),[42] eye tracking, and skin conductance responses (SCR),[41] to obtain a more comprehensive set of neural and physiological indicators related to pain empathy.

Factors Influencing Pain Empathy

Twenty-four studies[26,28,36,39,43–45,47–50,52–57,59,61–63,65–67] mentioned various factors influencing pain empathy. Pain-related factors include the type of pain and personal pain experiences. Psychological factors include negative emotions, psychological resilience, as well as individual traits and cultural backgrounds of patients. Social factors encompass professional background and healthcare provider characteristics, social support and therapeutic alliances, and situational and environmental factors. Table 5 shows all the details.

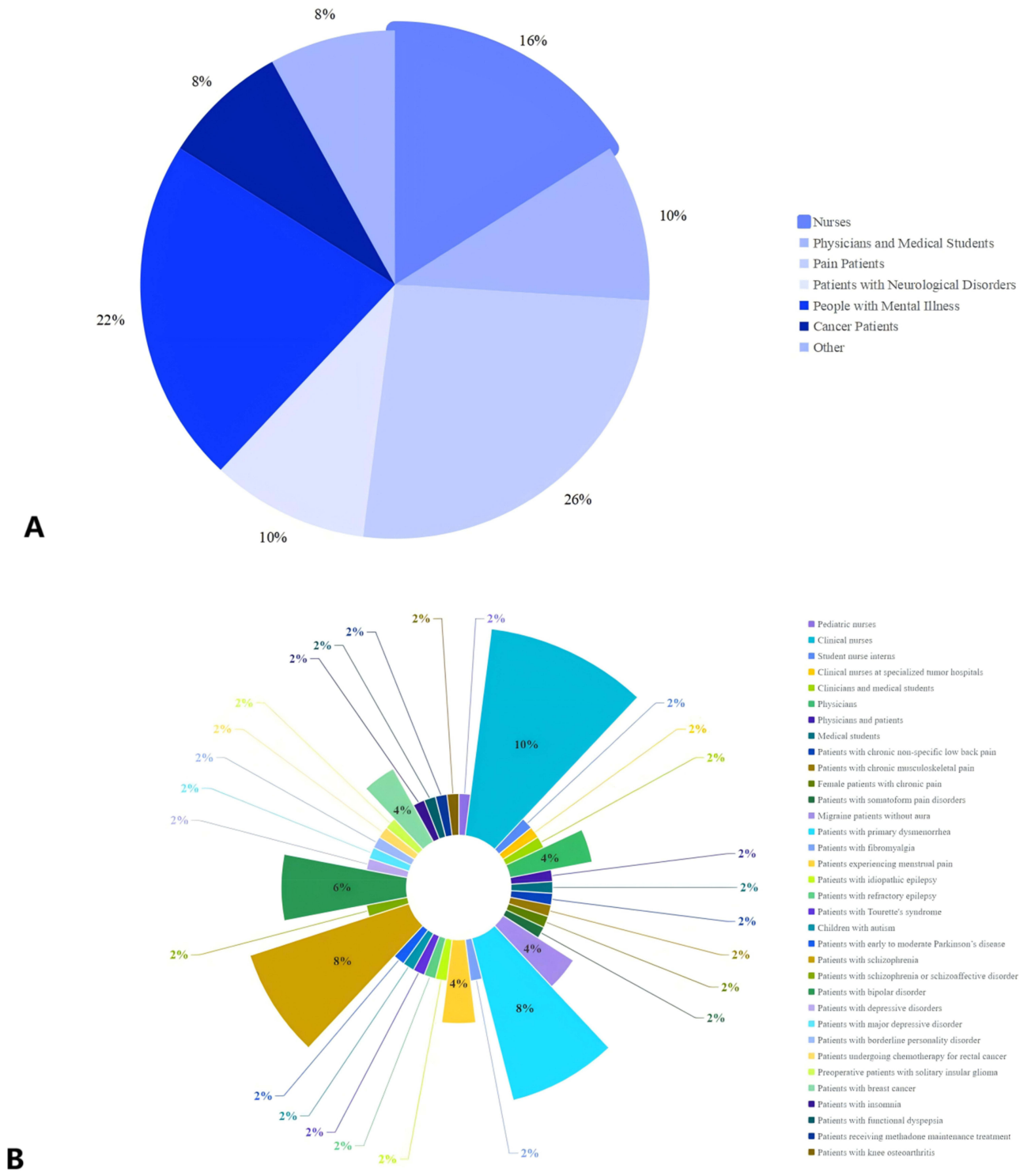

Figure 2 Characteristics of Study Participants. (**A**) study participants; (**B**) detailed study participants.

Mechanisms Related to Pain Empathy

The research on the mechanisms of pain empathy includes the neural basis of affective empathy (2 studies reported activation in the anterior insula and anterior cingulate cortex (ACC),[30,43] 2 studies reported involvement of the amygdala,[24,25] and 4 studies discussed adaptive brain changes related to chronic pain),[24,30,32,45] the neural basis of cognitive empathy (2 studies reported activation in the precuneus and temporoparietal junction (TPJ)),[21,37] the

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Table 4 Research Tools

Scale	Studies	Scale	Studies
Empathy-Related		**Emotional and Mental State Evaluation**	
The Empathy for Pain Scale (EPS)	[49,54,66]	Hamilton Depression Scale (HAMD)	[20,31,43,59]
The Chinese version of Empathy for Pain Scale (EPS-C)	[50,55–57]	Hamilton Rating Scale for Depression (HAMD-17)	[52,58]
Chinese version of Interpersonal Reactivity Index (IRI-C)	[19,25,26,32,34,42,43,48,50–53,57,58]	Hamilton Anxiety Scale (HAMA)	[20,26,31,37,59]
German Version of the Interpersonal Reactivity Index (IRI-G)	[29]	Self-Rating Depression Scale (SDS)	[21]
Interpersonal Reactivity Index (IRI)	[18,21,31,37,39–41,44,45,47,60,63,65]	Beck Depression Inventory (BDI)	[26,36]
Pain Empathy Paradigm	[26,35,62]	Short Form Beck Depression Inventory (BDI-SF)	[18]
Empathy for Others' Pain (EOP)	[18]	Self-Rating Anxiety Scale (SAS)	[21,22,33,40]
Chinese version of Jefferson Scale of Empathy (JSE-C)	[60]	State-Trait Anxiety Inventory (STAI)	[36]
Jefferson Scale of Physician Empathy - Health Professions (JSPE-HP)	[32]	Young Mania Rating Scale (YMRS)	[43,52]
Basic Empathy Scale (BES)	[22]	Positive and Negative Syndrome Scale (PANSS)	[39]
Consultation and Relational Empathy (CARE)	[46]	Brief Psychiatric Rating Scale (BPRS)	[30]
Social Interaction Empathy Task	[47]	Somatization Subscale of the SCL-90-R	[36]
Emotional Contagion Scale (ECS)	[37]	Negative Affect Scale (NAS)	[55]
Cognitive Ability-Related		Toronto Alexithymia Scale-20 (TAS-20)	[18,25,36]
Mini-Mental State Examination (MMSE)	[18–20,31,34,59]	Big Five Personality Analysis (NEO-FFI-30)	[18]
Beijing Version of Montreal Cognitive Assessment (MoCA-BJ)	[25,26]	Pittsburgh Sleep Quality Index (PSQI)	[33]
Montreal Cognitive Assessment (MoCA)	[31,43,44]	German Version of the Positive and Negative Affect Schedule (PANAS)	[29,33]
Digit Span Tests (DST)	[19,26,34,43]	Emotion Regulation Questionnaire (ERQ)	[37]
Verbal Fluency Test (VFT)	[19,20,26,34,59]	Saarbrücker Personality Questionnaire (SPF)	[29,47]
Wisconsin Card Sorting Test (WCST)	[39]	Geriatric Depression Scale - Short Form (GDS-S)	[65]
Mehrfachwahl-Wortschatz-Intelligenz-Test (MWT-A)	[47]	Geriatric Depression Scale - Short Form (GDS-S)	[65]
China-Wechsler Younger Children Scale of Intelligence (C-WYCSI)	[64]	**Other**	
Mini International Neuropsychiatric Interview (M.I.N.I).	[41]	Knowledge Sharing Behavior Scale (KSBS)	[66]
Pain-Related		Chinese Version of Nurses' Professional Quality of Life Scale (NProQOL-C)	[54]
Short Form McGill Pain Questionnaire (SF-MPQ)	[21,24,35,44]	Doctor-Patient Relationship Evaluation Scale (DPRES)	[60]
Fear of Pain Questionnaire (FPQ)	[22]	Scale of Social-Skills for Psychiatric Inpatients (SSPI)	[39]
Pain Sensitivity Questionnaire (PSQ)	[22]	Validation and Invalidation Behavioral Coding System (VIBCS)	[63]
Pain Catastrophizing Scale (PCS)	[22,44,65]	Dyadic Adjustment Scale (DAS)	[63]
Visual Analogue Scale (VAS)	[23,40,44,45]	Multidimensional Pain Inventory-Spouse Version (MPI-S)	[63]
Knowledge and Attitudes Survey Regarding Pain (KASRP)	[67]	Dyspepsia Symptom Score	[62]
Oswestry Disability Index (ODI)	[22]	Nepean Dyspepsia Life Quality Index (NDLQI)	[62]
Western Ontario and McMaster Universities Arthritis Index (WOMAC)	[65]	Reading the Mind in the Eyes Test (RMET)	[44]
Measurement Technologies		Adult Empathy Quotient (EQ60)	[44]
SEEG	[25]	Negative Life Event Scale (NLE)	[44]
Event-Related Brain Potential (ERP)	[19,22,26,28,29,31,32,34,36,38,43,46–48,60]	Yale Global Tic Severity Scale (YGTSS)	[41]
Functional Magnetic Resonance Imaging (fMRI)	[21,37,39,40,46]	Adult Tic Questionnaire (ATQ)	[41]
MRI	[23,30,45]	Premonitory Urge for Tics Scale (PUTS)	[41]
Eye Tracking Device	[64]	Diagnostic Confidence Index (DCI)	[41]
Functional Near-Infrared Spectroscopy (fNIRS)	[42]		
EEG	[25,27,33,41]		
Skin Conductance Response (SCR)	[41]		

Table 5 Factors Influencing Pain Empathy

No	Author	Influencing Factors	No	Author	Influencing Factors
1	Ren et al[66]	Age, title, highest level of education, participation in pain knowledge training, knowledge-sharing behavior	29	Yang et al[43]	Severity of manic symptoms, medications being used
2	Wei et al[52]	Staging of bipolar disorder, course of illness	30	Li et al[48]	Moral judgment triggered by news events
4	Sun et al[54]	Professional quality of life	31	Mu et al[45]	Chronic pain experience
7	Wu et al[55]	Major trauma or severe pain experience, chronic pain, negative emotions, perceived pain tolerance, participation in pain quality control management, awareness of empathy concept, work satisfaction, experience in oncology nursing, personality traits	36	Wu et al[67]	Pain knowledge and attitudes
8	Gao et al[50]	Time spent on pain assessment, whether a pain resource nurse, total working hours per week, emotional empathy	37	Vistoli et al[39]	Cognitive deficits
9	Li et al[56]	Gender, education, whether an only child, whether enjoys watching violent movies, parental upbringing style	38	Issner et al[63]	Marital satisfaction, care response, caregiving context
10	Yang et al[53]	Bipolar disorder	39	Hu et al[62]	Severity of functional dyspepsia symptoms and quality of life
11	Zhang et al[59]	BMI, frequent internal emotional experiences, physical labor, sleep quality	42	Zorani et al[44]	Catastrophic thinking, negative life events
15	Zhang et al[57]	Title, whether part of department pain management group, whether has children, emotional empathy ability	44	Zhao et al[65]	Depression, anxiety, and pain catastrophizing
17	Zu[61]	Type of pain stimuli and pain goals	46	Decety et al[28]	Doctors' emotional regulation
18	Dong et al[49]	Psychological resilience, gender, marital status, department, religious belief, exposure to pain empathy training, exposure to trauma-related pain	47	Peng et al[36]	Alexithymia
28	Flasbeck et al[47]	Childhood trauma	50	Zhu[26]	Attention

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relationship between emotional regulation and cognitive processing (3 studies),[22,60,64] and the unique mechanisms of multidimensional brain region coordination (2 studies reported social regulation and synchronization mechanisms,[46,48] 1 study discussed chronic pain and brain plasticity changes,[45] and 5 studies explored the impact of professional background and knowledge on neural mechanisms).[38,42,54,66,67] Detailed information is available in Supplementary Table 3.

Discussion

This study systematically screened and analyzed 50 relevant studies in the field of pain empathy, presenting the current state of research from multiple perspectives. The diversity of study participants, the range of research tools, the complexity of influencing factors, and the multi-faceted nature of research on related mechanisms collectively outline the intricate landscape of pain empathy research. This not only provides valuable material for the current understanding of pain empathy but also points to potential directions for future research.

Distribution and Implications of Study Participants

In the distribution of study participants, pain patients and individuals with mental disorders constitute a substantial proportion. For pain patients, their long-term experience with pain may result in differences in pain thresholds, sensitivity, and the way they perceive others' pain compared to healthy individuals.[68–70] Animal experiments demonstrate that chronic pain can induce structural changes in the cortical-limbic system. Chronic sympathetic pain not only increases the volume of the amygdala in rodents but also enhances neuronal activity and dendritic branching in the amygdala.[71] These changes influence emotional resonance in response to pain.[72,73] For patients with mental disorders, emotional and cognitive impairments are common due to the nature of their conditions, which can result in significant cognitive biases when interpreting others' emotions and pain signals.[74] As a key component of emotional cognition, pain empathy is inherently influenced by these biases.

However, the current distribution of study participants poses significant limitations. Some smaller, rarer groups, due to their low incidence, face challenges in sample collection and are often at the periphery of pain empathy research. This may result in a lack of personalized, pain empathy-driven guidance when providing comprehensive medical care to these patients. Additionally, there are considerable variations in inclusion criteria and research methodologies across studies involving the same population. For example, studies involving nurses might focus on nurses from general hospitals or specialized institutions, with differing research tools and evaluation metrics. Some studies assess nurses' pain empathy using questionnaires, while others observe real-life nursing scenarios, which makes it difficult to compare and integrate results. Future research should establish standardized criteria and expand the participant scope to include more marginalized groups, ensuring the generalizability and comparability of the findings.

The Diversity and Value of Research Tools

We summarized 75 research tools covering various aspects, including empathy, cognition, pain, emotional and mental state assessments, and diagnostic technologies. This comprehensive toolkit provides strong support for thorough and in-depth research on pain empathy. For instance, EPS is a widely used tool that accurately quantifies an individual's level of pain empathy and has been extensively applied in global pain empathy research.[75] It reliably measures pain empathy across different cultural contexts. Some studies also use IRI in conjunction with pain scales to measure pain empathy. The IRI has been translated and applied in several countries, demonstrating strong reliability and validity.[76] Additionally, the Pain Empathy Paradigm, combined with technologies like fMRI and EEG, has provided a bridge for exploring the neural mechanisms of pain empathy, enabling insights into brain activity patterns during the pain empathy process at a micro level.

The selection of research tools is closely aligned with the research goals and participants. The EPS scale is commonly used to measure an individual's pain empathy. Functional imaging technologies are indispensable for investigating the neurophysiological basis of pain empathy. However, when multiple tools are used in combination, integrating the differences in measurement results presents a considerable challenge. For example, different scales emphasize different aspects—some focus on emotional empathy, such as the Personal Distress subscale in the IRI, while others emphasize cognitive empathy, such as the Perspective Taking subscale in the IRI. The challenge lies in integrating these results from

different dimensions into a comprehensive understanding of pain empathy. Future research should develop an integrated assessment system that combines the strengths of various tools to achieve a more accurate evaluation of pain empathy.

The Role of Healthcare Professionals and Patient Factors in Pain Empathy

Our study presents multiple dimensions of the factors influencing pain empathy, aiming to provide a comprehensive understanding of this complex psychological phenomenon.

In this study, nurses play a crucial role in pain empathy. According to the included studies, nurses' professional backgrounds, emotional empathy abilities, and work experience significantly influence the expression of pain empathy. For instance, Wei et al[52] found that nurses' knowledge-sharing behaviors, emotional empathy capabilities, and experience in pain management directly affect patients' pain perception and nursing outcomes. Specifically, nurses with specialized training in pain management tend to exhibit higher levels of pain empathy, indicating that professional training significantly enhances nurses' abilities in this area. The data from the studies also suggest that nurses' emotional empathy is closely linked to patients' emotional regulation and pain relief.[56] Furthermore, Gao et al[50] noted that nurses' emotional regulation abilities also impact the neural mechanisms underlying their pain empathy, suggesting that in clinical practice, nurses' emotional empathy and emotional regulation skills are key factors influencing the effectiveness of pain empathy.

The role of doctors in pain empathy is reflected not only in clinical decision-making and treatment plan formulation but also in patients' emotional responses and treatment adherence. Dong Yong et al[49] indicated that doctors' emotional empathy abilities can alleviate patients' anxiety, foster trust, and enhance treatment adherence. Zu[61] further emphasized that doctors' professional background, pain management experience, and emotional regulation abilities all influence their performance in pain empathy. Among pain patients, doctors' emotional empathy can effectively improve patients' emotional states and reduce their pain perception.[57]

Patients' individual differences play an important role in pain empathy. According to research, patients' pain type, psychological state, and cultural background all influence their level of pain empathy. Wei et al[52] noted that chronic pain patients and those with mental disorders exhibit stronger emotional reactions and cognitive understanding during the pain empathy process, which may be attributed to their prolonged experience of physical or psychological pain. Zhang et al[57] also found that patients' emotional regulation abilities and psychological resilience significantly affect their expression of pain empathy. In particular, patients with poor emotional regulation are more likely to experience difficulty generating effective pain empathy, particularly among those with mental disorders. At the same time, patients' emotional regulation abilities and psychological resilience can also impact their neural responses, especially when facing chronic pain. Patients' neural plasticity and long-term pain adaptation may lead to changes in neural mechanisms, which in turn influence the expression of pain empathy.

The doctor-patient relationship plays a significant role in pain empathy. Research indicates that a strong doctor-patient relationship can enhance the effectiveness of pain empathy, particularly in patients' treatment adherence and outcomes. Zu[61] pointed out that the trust between doctors and patients directly affects the patient's pain experience and treatment outcomes. Zhang et al[57] showed that when doctors exhibit high levels of emotional empathy, patients tend to feel more understood and cared for, which enhances their trust and adherence to treatment.

The data suggest that in the "environment" of doctor-nurse-patient, pain empathy shows clear interaction, influence, and flow among individuals. In clinical nursing, based on these influencing factors, targeted measures can be implemented to improve the pain empathy abilities of healthcare professionals and patients.[77] Future research should further explore the interactions between these factors and their specific manifestations in different contexts, in order to reveal more comprehensively the complex mechanisms underlying pain empathy.

Mechanisms Related to Pain Empathy

Studies have confirmed that the anterior insula, ACC, and amygdala play essential roles in emotional empathy. Research on patients with primary dysmenorrhea has shown significant effects in the bilateral anterior insula during pain stimulus tasks, indicating that the anterior insula is essential in integrating pain sensation with emotions and generating emotional resonance. The anterior insula also coordinates pain empathy by forming functional networks with other brain regions.

Yang et al[43] studied patients with bipolar disorder and found that, when processing empathy-related information, decreased activity in the ACC correlated with the degree of impairment in pain empathy under different conditions. This suggests that the ACC is indispensable in the emotional experience of pain, as well as in the cognitive and emotional regulation of others' pain and that abnormal activity in this region may lead to empathy deficits. Zhang[25] used SEEG technology to study patients with refractory epilepsy and found that levels of alexithymia correlated with theta/alpha frequency band energy in the bilateral amygdala during pain empathy. This provides microscopic evidence for the amygdala's involvement in the neural mechanisms of pain empathy, suggesting that it influences the empathy experience through emotional information processing.

The impact of chronic pain on brain structure and function has been a central topic in pain empathy research. Zhang[24] proposed a fiber bundle analysis method based on seed point regions of interest and discovered that chronic pain could lead to structural abnormalities in the prefrontal cortex-amygdala-thalamus-occipital fiber bundle, particularly in the segment connecting the orbitofrontal cortex and amygdala. This structural abnormality was closely associated with pain and pain catastrophizing. This finding provides new insights into how chronic pain alters the brain's internal structure and profoundly impacts pain empathy. In a related study, Mu et al[45] provided a different perspective, showing that chronic pain leads to maladaptive structural changes in the brain, with areas of gray matter reduction mediating the relationship between pain intensity and pain empathy. This further emphasizes the importance of chronic pain in reshaping the brain's neural architecture, leading to systematic changes in the brain's neural processing of pain empathy. Over time, chronic pain leads to fundamental changes in how individuals perceive and react to others' pain, rather than merely causing localized or isolated changes.

The study of the neural basis of cognitive empathy has shown that TPJ play a central role in perspective-taking and inferring others' emotional states. The absence of activation in these areas serves as a key neurobiological basis for cognitive empathy deficits in patients.

In the relationship between emotional regulation and cognitive processing, Decety et al[28] used ERP to study doctors, finding that when confronted with visual pain stimuli, doctors initiated early emotional regulation, suppressing bottom-up processing of others' pain perception, reducing negative arousal, and freeing cognitive resources. This underscores the critical regulatory role of emotional regulation in the cognitive processing of pain empathy. Furthermore, Ellingsen et al[46] used fMRI hyperscans to study interactions between chronic pain patients and clinicians, discovering synchronized brain activity between the two. When patients interacted with supportive doctors, pain intensity decreased, and activation in the dorsolateral and ventrolateral prefrontal cortices, as well as primary and secondary somatosensory areas, increased. The synchronization of activity between the doctor's dlPFC and the patient's S2 was positively correlated with the therapeutic alliance, revealing the role of social regulation and synchronization mechanisms in pain empathy and providing new insights into the collaborative actions of multidimensional brain regions.

Despite these findings, current research on the mechanisms of pain empathy continues to have limitations. Most studies focus on specific brain regions or singular mechanisms, lacking a systematic integration of the overall mechanisms of pain empathy. Future research must leverage interdisciplinary approaches, integrating neuroscience, psychology, sociology, and other methods, to explore the interactions between different mechanisms. Additionally, longitudinal studies are required to track the dynamic changes in pain empathy mechanisms across different stages of development or disease progression, providing theoretical support for the development of precise intervention strategies.

Future Research Prospects

Future research on pain empathy has the potential to make breakthroughs in several areas. On one hand, large-scale, multi-center, and standardized studies should be conducted to unify research methods and evaluation criteria, minimizing errors caused by heterogeneity. Global research teams should be organized to collaboratively carry out large-scale projects focused on pain empathy, ensuring diversity and representativeness in research samples. On the other hand, advanced technologies, such as multimodal brain imaging techniques and genetic testing, should be used to explore the biological markers of pain empathy and enable precise diagnosis and intervention. For example, genetic testing could be employed to identify gene loci associated with pain empathy, providing a genetic basis for personalized treatment and intervention.

Furthermore, it is essential to examine the differences in pain empathy across various cultural and social backgrounds through cross-cultural studies. This would lead to more targeted strategies for global pain management and mental health services. For instance, research could explore how social norms and values surrounding pain in different cultures influence individuals' expressions of pain empathy, leading to the development of culturally tailored pain management strategies.

Conclusion and Limitations

This scoping review systematically examines research on pain empathy in the healthcare field, covering various aspects, including study participants, tools, influencing factors, and mechanisms. Pain patients and individuals with mental disorders constitute a significant proportion of the study participants, with the characteristics of these groups influencing their pain empathy. A variety of research tools support the assessment and investigation of pain empathy, though integrating these tools remains challenging. Pain empathy is influenced by multiple factors, including pain experiences, psychological factors, individual traits, and social factors, all of which intertwine to shape empathetic ability. Numerous studies have highlighted the key roles of various brain regions in emotional and cognitive empathy, as well as the impact of chronic pain and emotional regulation on pain empathy. These findings have deepened our understanding of pain empathy and provide a theoretical foundation for future research and clinical practice. In future research and management, large-scale, multi-center, and standardized studies should be conducted, with unified research methods and evaluation criteria. Advanced technologies should be employed to explore the biological markers of pain empathy, and cross-cultural studies should be conducted to investigate the differences in pain empathy across various cultural and social backgrounds.

However, this study has several limitations. First, it is based on existing research, relying heavily on available data, and may have overlooked potentially important findings that have not been sufficiently studied or reported. Second, the search for studies was limited to Chinese and English languages, which may affect the generalizability of the findings.

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