



Review Article

Pain and Psychology: Mechanisms, Interventions, and Future Perspectives from an Integrative Psychiatric View

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Abstract

Chronic pain is a highly prevalent and disabling condition, and the traditional biomedical model has limited explanatory and therapeutic value. Pain is increasingly understood as a biopsychosocial experience shaped by sensory, emotional, cognitive, and social factors. However, clinical assessment and treatment remain fragmented, and the role of psychiatry in integrated pain management is often underrecognized. This review aims to summarize the interaction mechanisms between pain and psychology, evaluate multimodal psychiatric and psychological interventions, and outline future directions for integrated pain care. To achieve this, relevant literature on pain mechanisms, psychotherapy, pharmacotherapy, neuromodulation, and digital health was reviewed and synthesized, with a focus on neuroimaging studies, clinical trials, and clinical guidelines. The findings indicate that neuroimaging studies have revealed shared brain networks and neuroplastic mechanisms between pain and emotion, providing a biological basis for psychological interventions. Major psychotherapeutic approaches—including cognitive behavioral therapy (CBT), acceptance and commitment therapy (ACT), emotion awareness and expression therapy (EAET), mindfulness-based stress reduction (MBSR), and hypnotherapy—target cognitive, emotional, and behavioral processes. Pharmacotherapy and neuromodulation further expand treatment options. Integrated psychiatric interventions can effectively alleviate chronic pain and comorbid mood symptoms, although challenges remain, including imperfect assessment, opioid-related risks, limited interdisciplinary collaboration, and individual heterogeneity. Future pain management should integrate neuroimaging, genetics, and digital health technologies to support individualized treatment, promote interdisciplinary collaboration, and shift from “treating pain” to “treating the person,” ultimately improving patients’ overall quality of life.

Keywords

Chronic Pain, Psychological Factors, Psychiatry, Neuroimaging, Multimodal Intervention, Psychotherapy

1. Introduction

Pain is a prevalent and complex experience. In 2020, the International Association for the Study of Pain (IASP) revised the definition of pain as “An unpleasant sensory and emotional experience associated with, or resembling that associated with,

actual or potential tissue damage” [1]. Affecting over 1.5 billion people, pain has emerged as a major public health issue, with a disproportionate impact on the elderly, women, and the working population. In explaining and managing chronic pain,

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the traditional biomedical model focused on physical injuries has significant limitations. With the medical model shifting toward the integrated biopsychosocial perspective, pain is now regarded as an active construction process integrating sensory, emotional, cognitive, and social factors. The new IASP definition formally establishes the core role of psychosocial factors in the pain experience. For example, pain catastrophizing has been consistently associated with pain intensity and functional impairment [2]. This paradigm shift has promoted the role of psychiatry in pain management, moving beyond the treatment of secondary emotional problems to active engagement in mechanism interpretation, risk assessment, and integrated treatment. Psychiatric intervention helps identify psychosocial risk factors—such as childhood trauma and abnormal illness behavior—that are often overlooked by traditional models, thereby revealing the underlying causes of refractory pain [3]. By integrating pharmacotherapy, psychotherapy, and physical therapy, psychiatry can simultaneously intervene in pain and its comorbid emotional and cognitive disorders. Among these, structured psychological interventions such as cognitive-behavioral therapy (CBT) constitute a key component of this integrative strategy.

This article systematically elaborates on the interaction mechanism between pain and psychology, multimodal intervention strategies, current challenges, and future directions from a psychiatric perspective, with the aim of providing a theoretical basis and practical references for the integrated diagnosis and treatment of chronic pain. This narrative review was based on a comprehensive search of PubMed, Web of Science, and relevant clinical guidelines, with a focus on studies published in recent decades.

2. The Relationship Between Pain and Psychology: Concepts, Psychological Impacts, and Neural Mechanisms

2.1. Definitions and Classifications of Pain

Based on the time dimension, pain is divided into acute pain and chronic pain with a 3-month cutoff. Chronic pain was first listed as an independent disease chapter (MG30) in International Classification of Diseases, 11th Revision (ICD-11). This classification framework officially promoted psychosocial factors from confounding variables to core elements [4]. Based on physiological mechanisms, the traditional dichotomy classifies pain into two types: nociceptive and neuropathic. However, this classification cannot cover all clinical situations, such as fibromyalgia and complex regional pain syndrome. Therefore, a third pain descriptor, named "nociplastic pain" (NP), has been adopted by the IASP [5]. As a mechanistic hypothesis, NP should not be equated with a diagnosis clinically to avoid overlooking potential organic causes due to excessive psychological attribution. In psychia-

try, psychogenic pain and neuropathic pain (NeP) conceptually overlap and have dynamic interactive effects. This requires psychiatrists to conduct meticulous assessments (including psychological evaluations, interviews, and necessary medical examinations) to understand how psychosocial factors drive the plastic changes in pain perception and to promote the development of targeted integrated treatment plans, rather than simply attributing it to pure psychological problems.

2.2. The Influence of Psychosocial Factors on Pain Perception

Pain and negative emotions are highly bidirectionally comorbid and persist throughout the entire life cycle. Anxiety, depression, and suppression are key emotional factors influencing pain perception [6]. Long-term negative emotions can lower the pain threshold, increase the intensity of pain, and prompt the transformation of acute pain into chronic pain [7]. Approximately one-third of adolescents with chronic pain meet the criteria for anxiety disorders, and one-eighth meet the criteria for depressive disorders [8]; among adult chronic pain patients, about 40.0% present with clinically significant depressive or anxiety symptoms [9]; in the elderly, the comorbidity rate of pain and depression is approximately 13.0% [10]. Therefore, screening and intervention of emotional states should be incorporated at all stages of pain development and management to better achieve systematic pain management. Moreover, Attention, expectation, and evaluation play regulatory roles in the pain experience. Attentional biases (e.g., excessive focus on pain-related signals) and interpretive biases (e.g., interpreting ambiguous bodily sensations as threats) can exacerbate poor pain outcomes, thus creating a vicious cycle [11]. According to the predictive coding theory, negative expectations of pain can amplify the perceived intensity of pain. Moreover, such negative expectations can be formed through conditioned learning and promote the chronicity of pain [12]. Pain catastrophizing (characterized by repeated rumination about pain, magnification of threat perception, and feelings of helplessness), as one of the most destructive cognitive patterns, is a powerful predictor of pain intensity, functional impairment, and levels of psychological distress [2]; it also constitutes an independent risk factor for suicidal ideation in patients with chronic pain [13].

Pain expression and coping strategies are profoundly shaped by sociocultural contexts. Emotional social support exerts an analgesic effect by fulfilling emotional needs; however, excessive attention to physical complaints and anxious states may reinforce observable disabling behaviors, such as limping, moaning, activity avoidance, and frequent healthcare-seeking [14]. Patients with pain often receive attention and social support owing to their suffering and vulnerable status, yet this process may paradoxically reinforce the sick role, increase dependency, and undermine self-confidence, thereby potentially

intensifying the pain experience. Furthermore, the meaning-making of pain varies according to individual cultural backgrounds and value systems. Consequently, pain management should integrate resources from family, community, healthcare services, and digital technologies to establish a social network that offers understanding, support, and facilitates functional recovery [15]. Such a network should encompass emotional support (e.g., sympathy, understanding, and encouragement), instrumental support (e.g., assistance with household tasks, transportation, and finances), informational support (e.g., treatment protocols and coping strategies), and companionship support. Concurrently, it is essential to enhance societal awareness of pain and strengthen patients' self-management capacities, in order to achieve bio-psycho-social multifaceted rehabilitation and improved quality of life.

2.3. Neurophysiological Mechanisms of Pain

The brain's processing of pain involves a complex interplay among sensory-discriminative, affective-motivational, and cognitive-evaluative networks. At the neurobiological level, pain perception entails coordinated activity across multiple central regions, spanning from the spinal cord, brainstem, and thalamus to the cerebral cortex. Nociceptive information is transmitted via ascending pathways to the brain, where it is processed by distributed neural networks, ultimately giving rise to an integrated experience encompassing sensory, affective, and cognitive dimensions. The application of techniques such as functional magnetic resonance imaging (fMRI) has greatly advanced the elucidation of this intricate process. Neuroimaging studies have provided critical biological evidence for the close comorbidity between pain and emotional disturbances, revealing shared brain networks and neuroplastic mechanisms underlying this relationship.

Structural Magnetic Resonance Imaging (MRI) meta-analyses have revealed similar reductions in cortical thickness in brain regions such as the right insula and left anterior cingulate cortex (ACC) across patients with chronic pain, depression, and anxiety disorders [16]. These regions constitute core hubs for pain–emotion interactions. Functionally, different cerebral areas subserve distinct roles in pain processing. The sensory-discriminative network (e.g., the primary and secondary somatosensory cortices S1/S2) is primarily responsible for spatial localization, intensity encoding, and qualitative discrimination of pain. The ACC, whose core functions include conflict monitoring and affective appraisal, is critically involved in the emotional and cognitive modulation of pain; moreover, its positive feedback loop with the ventral tegmental area (VTA) may contribute to the persistence of neuropathic pain [17, 18]. The insula, serving as a center for interoceptive awareness, is implicated in pain-related prediction error, expectation, and inhibition; its posterior portion is closely associated with both social pain—defined as the emotional distress arising from damage to social relationships or devaluation of

social worth—and physical pain perception [17, 19]. The default mode network (DMN), which is linked to self-referential thought, exhibits aberrant functional connectivity in chronic pain patients, and this abnormality is modulated by negative affect [20]. The limbic system and affective-motivational network represent key nodes for emotion–pain interactions: the amygdala processes pain-related fear and anxiety [17]; connectivity between the nucleus accumbens (NAc) and the periaqueductal gray (PAG) can predict the development of chronic pain [21]; and chronic pain states may suppress hippocampal neural activity. Prefrontal regions (e.g., the dorsolateral prefrontal cortex (dlPFC), orbitofrontal cortex (OFC), and medial prefrontal cortex (mPFC)) subserve top-down regulatory functions such as value appraisal, outcome prediction, and cognitive control over pain [17]. Finally, the descending pain modulatory system, comprising the PAG and rostral ventromedial medulla (RVM), constitutes a key node of the endogenous analgesic pathway [17].

3. Application of Psychiatric and Psychological Intervention in Pain Treatment

The management of chronic pain necessitates the integration of multimodal strategies to address its psychophysiological complexity; psychiatric interventions are directed not only at the pain sensation per se, but also at the comorbid emotional, cognitive, and behavioral disturbances.

3.1. Pharmacotherapy

Antidepressants have demonstrated notable efficacy in pain management. Tricyclic antidepressants (TCAs) and serotonin-norepinephrine reuptake inhibitors (SNRIs) exert clear analgesic effects on neuropathic pain and fibromyalgia by enhancing monoaminergic neurotransmission in descending inhibitory pathways, an effect that is independent of their antidepressant action [22]. For instance, duloxetine has been approved by the U.S. Food and Drug Administration (FDA) for the treatment of diabetic peripheral neuropathic pain. Anticonvulsants (e.g., gabapentin and pregabalin) reduce central sensitization through modulation of voltage-gated calcium channels and have also shown substantial efficacy, establishing them as first-line agents for neuropathic pain. In rigorously selected refractory cases, atypical antipsychotics (e.g., olanzapine and quetiapine) have been reported in small exploratory studies, although the level of evidence remains low, and their use requires caution due to risks of metabolic syndrome and sedation; they should be reserved as an adjunctive option of last resort. Certain psychedelics, such as psilocybin, may confer benefits for specific pain types or their associated symptoms [23]. Additionally, low-dose ketamine can be employed as one of the adjuvant analgesic strategies in chronic

pain management, particularly in patients with opioid tolerance [24]. Attention deficit hyperactivity disorder (ADHD) has been identified as a potential risk factor for chronic pain, with its characteristic impulsivity and hyperactivity potentially exacerbating pain perception [25]; therefore, pharmacotherapy for ADHD may offer some benefit to chronic pain patients, although its precise efficacy warrants further investigation. Moreover, sedative-hypnotics, such as benzodiazepines, may be helpful for anxiety-related pain, but their long-term use carries risks of dependence and tolerance.

3.2. Psychotherapy

Psychotherapy, through interventions targeting cognitive, emotional, and behavioral processes, breaks the vicious cycle and plays an irreplaceable role within the biopsychosocial framework.

Cognitive Behavioral Therapy (CBT) is the gold standard of psychological interventions for pain, with its core assumption grounded in the cognitive triad model, which posits that cognitions, emotions, and behaviors mutually influence one another, forming a self-perpetuating cycle [26]. CBT assists patients in identifying automatic negative thoughts, examining their evidence against reality, and restructuring them into more balanced cognitions; concurrently, it employs behavioral activation and graded exposure to disrupt the vicious cycle of "pain → fear → avoidance → functional decline → pain exacerbation." [27] Substantial evidence has demonstrated that CBT can significantly reduce pain intensity [28], improve functional outcomes and quality of life [29], and induce beneficial neuroplastic changes through modulation of prefrontal-cingulate functional connectivity [30].

Acceptance and Commitment Therapy (ACT) is centrally oriented toward enhancing psychological flexibility—that is, the capacity to embrace inner painful experiences while simultaneously engaging in actions aligned with one's personal values. Its core mechanisms operate at three interrelated levels. First, acceptance is not equivalent to resignation; it involves acknowledging the objective existence of pain and relinquishing futile counterefforts. Second, cognitive defusion entails separating thoughts from facts—for instance, refraining from interpreting one's pain as "I am a person destroyed by pain"—thereby preventing negative cognitions from amplifying suffering. Third, value-guided action directs attention toward genuinely important life goals rather than treating pain elimination as the sole objective [31, 32]. In practice, therapists cultivate acceptance skills through mindful breathing and body-scan exercises, supplemented by value clarification and commitment-based behavioral activation (e.g., developing value-oriented weekly action plans). Systematic reviews have demonstrated that ACT effectively improves functional disability and psychological flexibility in patients with chronic pain, with effects remaining stable at 12-month follow-up; it also exerts beneficial effects on depressive symptoms [33].

Emotion Awareness and Expression Therapy (EAET) is

grounded in emotion-centered theory, which posits that emotions drive behavior and that pain is not merely a physiological signal but may also represent a somatic expression of suppressed emotions—for example, unexpressed anger can exacerbate headache. EAET holds that through the awareness, exploration, and safe expression of these emotions, the vicious cycle of "pain → negative affect → pain exacerbation" can be interrupted [34]. The therapeutic procedures include: identifying and labeling specific emotions accompanying pain through body scanning; exploring the core psychological needs underlying these emotions, and facilitating the release of suppressed feelings in a safe environment via techniques such as expressive writing and role-playing; and ultimately connecting emotional experiences to life goals, while teaching self-soothing skills such as diaphragmatic breathing and progressive muscle relaxation. Randomized controlled trials have demonstrated that EAET yields clear efficacy in reducing chronic pain intensity and improving depression and anxiety [35, 36].

Mindfulness-Based Stress Reduction (MBSR) aims to reshape the individual's relationship with pain by cultivating non-judgmental awareness of the present moment [37]. Its core mechanisms operate as follows: by observing the physical sensations of pain—such as "stinging" or "aching"—with openness and acceptance, rather than succumbing to catastrophic narratives like "I cannot bear this," the reciprocal pain-anxiety amplification cycle is disrupted. Long-term mindfulness practice enhances top-down prefrontal and anterior cingulate cortical control over emotional regulation, while concurrently dampening hyperactivation in the amygdala and insula. Core techniques include mindful breathing (10–15 minutes daily), body scanning (systematically attending to bodily sensations without avoiding painful areas), mindful walking, and informal practices that integrate awareness into daily activities; for acute pain flares, the "three-step breathing space" can be employed as a rapid regulatory tool [38]. Neuroimaging evidence confirms that the analgesic effect of mindfulness is partially independent of placebo [39], operating by reducing the emotional reappraisal of pain—thereby alleviating pain-related discomfort [40]—and may serve as a non-pharmacological adjunct to reduce analgesic medication consumption [41].

Hypnotherapy modulates pain perception by inducing a distinctive state of focused attention and narrowed awareness, thereby heightening susceptibility to therapeutic suggestions [42]. Its analgesic mechanisms operate through three interrelated pathways: transiently suppressing the critical function of consciousness to facilitate the internalization of positive suggestions; modulating activity in brain regions associated with the endogenous opioid system—such as the anterior cingulate cortex and prefrontal cortex—thereby attenuating the transmission of nociceptive signals to cortical areas [43]; and promoting cognitive restructuring through suggestion, which alters catastrophic interpretations of pain signals. The standard procedural sequence comprises induction (via fixed-gaze or

progressive relaxation techniques), deepening techniques, delivery of therapeutic suggestions, and a smooth re-awakening phase, followed by instruction in self-hypnosis for daily application. Functional magnetic resonance imaging studies have demonstrated that hypnosis curbs excessive reactivity in the insula and amygdala while enhancing prefrontal regulatory

control over pain networks [44, 45]; clinical evidence further indicates that it effectively reduces pain intensity [46], alleviates anxiety, and decreases postoperative opioid consumption [47]. A summary comparison of these psychotherapeutic approaches is provided in Table 1.

Table 1. Comparison of major psychotherapeutic approaches for chronic pain.

Therapy	Core principle	Key techniques	Clinical efficacy
CBT	Cognitive triad model; maladaptive cognitions, emotions, and behaviors interact; learning theory	Cognitive restructuring, behavioral activation, graded exposure, relaxation training, relapse prevention	Reduces pain intensity; improves function and quality of life; enhances psychological resilience
ACT	Psychological flexibility: acceptance, cognitive defusion, value-guided action	Acceptance and defusion exercises, value clarification, committed action, present-moment awareness	Improves functional disability and psychological flexibility; reduces depressive symptoms; effects stable at 12-month follow-up
EAET	Emotion-centered theory: pain as a somatic expression of suppressed emotions; unmet emotional needs	Emotional awareness and labeling, emotional exploration and expression, value connection, self-soothing	Reduces pain intensity; improves depression and anxiety; decreases pain sensitivity
MBSR	Mind-body integration; non-judgmental awareness of the present moment	Mindful breathing, body scan, mindful walking, three-step breathing space	Reduces pain intensity (partially independent of placebo); decreases emotional amplification; improves function; reduces analgesic consumption
Hypnotherapy	Consciousness–subconscious interaction; focused attention and narrowed awareness; therapeutic suggestion	Induction and deepening, direct suggestion, cognitive restructuring, dissociation, imagery, self-hypnosis	Reduces pain intensity; alleviates anxiety and depression; decreases postoperative opioid use

CBT, cognitive behavioral therapy; ACT, acceptance and commitment therapy; EAET, emotion awareness and expression therapy; MBSR, mindfulness-based stress reduction.

3.3. Neuromodulation and Physical Therapy

Neuromodulatory therapies are grounded in the gate control theory of pain, proposed by Melzack and Wall in 1965, which posits that non-noxious sensory inputs can inhibit the transmission of nociceptive signals to the central nervous system [48]. Building upon this principle, modern neuromodulation techniques aim to achieve analgesia by targeted modulation of activity within specific neural networks. Based on their route of action and degree of invasiveness, these techniques can be broadly categorized into non-invasive and invasive modalities, acting on either the central or peripheral nervous system.

Non-invasive neuromodulation techniques primarily modulate brain activity by applying physical stimuli externally to the cranium. Among these, repetitive transcranial magnetic

stimulation (rTMS) is a widely used non-invasive brain stimulation technique [49]. Evidence indicates that rTMS applied to the dorsolateral prefrontal cortex or the primary motor cortex can effectively alleviate neuropathic pain, with its analgesic mechanism likely involving modulation of the endogenous opioid system and enhancement of descending inhibitory pathway function [50]. Animal studies have further revealed that rTMS attenuates pain in a sciatic nerve injury model by inhibiting the NLR family pyrin domain containing 3 (NLRP3) inflammasome pathway in the amygdala [49]. Transcranial direct current stimulation (tDCS) is another non-invasive technique that modulates cortical neuronal excitability by delivering a weak direct current via electrodes placed on the scalp. tDCS applied to the motor cortex can produce analgesic effects and may be used synergistically with other neuromodulatory modalities [51]. Additionally, transcutaneous electrical

nerve stimulation (TENS) delivers electrical current through skin electrodes to stimulate peripheral nerves; its analgesic mechanisms involve activation of gamma-aminobutyric acid (GABA) ergic, endogenous opioid, endocannabinoid, and adrenergic systems [52]. Despite decades of use, the precise clinical efficacy of TENS remains subject to some uncertainty.

Invasive neuromodulation techniques directly stimulate the nervous system via implanted devices. Spinal cord stimulation (SCS) is a well-established invasive modality that modulates neural function through electrodes implanted in the epidural space of the spinal cord, and has been successfully employed in the treatment of various refractory pain conditions, including failed back surgery syndrome, complex regional pain syndrome, and phantom limb pain [53]. In recent years, high-frequency SCS (e.g., 10-kHz SCS) has shown promising efficacy in managing intractable pain [54]. Peripheral nerve stimulation (PNS), which targets peripheral nerves, has been used for conditions such as chronic craniofacial pain and thoracoabdominal pain; however, its mechanisms of action are predominantly open-loop in nature and remain incompletely understood [55]. Dorsal root ganglion stimulation (DRG-S), as an emerging target, acts at a pivotal site of sensory afferent transmission and thus demonstrates unique potential in the treatment of chronic refractory neuropathic pain [56]. Other invasive techniques include vagus nerve stimulation (VNS) and motor cortex stimulation (MCS). VNS may simultaneously alleviate pain and improve cognitive function by modulating neuroimmune and glial cell activity [57].

In addition to the aforementioned electrical- or magnetic-based stimulation techniques, virtual reality (VR) is also regarded as broadly conceived neuromodulatory approach that alleviate pain by modulating nervous system function, thereby offering multimodal options for pain management. VR technology creates immersive environments that help divert patients' attention away from painful stimuli, consequently reducing pain perception [58]. Overall, neuromodulation intervenes in pain-processing networks through diverse pathways and provides an important therapeutic complement for chronic pain patients who respond inadequately to pharmacological treatments [52].

4. Multi-target Integrated Intervention

Psychosocial interventions can exert therapeutic effects across multiple levels of targets. At the neural level, functional connectivity in brain regions such as the ACC, prefrontal cortex, and insula has been shown to improve following CBT and MBSR [59, 60]. At the cognitive level, the perceived threat of pain is reduced as negative cognitive biases are corrected—for instance, through cognitive restructuring, patients are assisted in identifying automatic negative thoughts (e.g., "I cannot tolerate this pain"), transforming irrational beliefs (e.g., "Pain is uncontrollable"), and establishing adaptive cognitions (e.g., "Pain is a signal from the body, not permanent damage"). At the molecular and physiological levels, these interventions

may improve pain and emotional states by modulating hypothalamic-pituitary-adrenal (HPA) axis function and reducing cortisol and pro-inflammatory cytokine levels [61].

Enhancing multidisciplinary collaboration and integrating psychiatric expertise into pain management enables comprehensive treatment of both physical and psychological symptoms, thereby offering patients more holistic and individualized therapeutic plans and improving their quality of life. For example, for a patient with fibromyalgia and major depression, the treatment plan could be integrated as follows: (1) at the neural level, use of an SNRI to modulate monoaminergic pathways; (2) at the cognitive-behavioral level, implementation of CBT to correct the catastrophic cognition that "pain equals incapability"; (3) at the physiological level, mindfulness practice to regulate the HPA axis and reduce stress levels. A multidisciplinary team jointly develops and monitors this integrated plan.

Although multi-target integrated intervention strategies hold considerable promise, they still face numerous systemic challenges in clinical practice.

5. Limitations, Dilemmas, and Future Directions: Toward a New Paradigm of Integrated Pain Management

At present, pain management faces an intertwined set of dilemmas and limitations at both clinical and research levels. These challenges not only reveal the inadequacies of existing models but also delineate key directions for future transformation.

5.1. Real-World Dilemmas and Research Limitations

The foremost challenge in pain management lies in its inherent complexity and the reductionist nature of current assessment practices. Pain experience is rooted in the continuous interplay of biological, psychological, and social factors; however, clinical evaluation remains overly dependent on pain intensity ratings, while psychosocial dimensions are severely marginalized. Moreover, structural factors such as socioeconomic status, which exert profound influences on pain experience and healthcare accessibility, are frequently overlooked [62]. Secondly, treatment strategies are caught in a therapeutic dilemma. Opioids, in particular, offer limited analgesic benefits while posing significant risks of dependence and misuse; even standardized interventions struggle to fully curb inappropriate early prescription continuation [63, 64]. Thirdly, systemic resource disparities and collaborative barriers are pervasive. High-quality pain research evidence is heavily concentrated in high-income countries [62], whereas in clinical practice, poor coordination among psychiatry, pain medicine, and rehabilitation departments leaves the biopsychosocial integrated care model largely at the conceptual stage. Finally, individual heterogeneity

poses a core challenge for precision medicine. Patient responses to treatment are strongly influenced by genetic background, early-life trauma, personality traits, and other factors, yet reliable biomarkers for guiding truly individualized regimen selection are lacking in clinical settings.

On the research front, limitations are equally prominent: sample representativeness is often inadequate, and methodological heterogeneity undermines the reliability and replicability of findings; longitudinal studies tracking the dynamic trajectories of pain chronification are scarce; and translational efficiency from basic animal models to clinical applications remains low [65]. Taken together, these dilemmas and limitations indicate that traditional, unimodal pain management models are no longer sufficient to meet clinical demands.

5.2. Core Directions for Future Development

To overcome the aforementioned bottlenecks and drive a paradigm shift in pain medicine, future efforts must focus on the following interrelated strategic directions.

5.2.1. Advancing Precision Pain Medicine to Address Individual Heterogeneity

By integrating genomics (for predicting drug metabolism and risk), multimodal neuroimaging (for assessing brain network characteristics and comorbidity substrates), and digital phenotyping (continuous physiological and behavioral data from wearable devices), and by leveraging artificial intelligence algorithms for analysis, the goal is to develop objective biomarker systems for pain subtyping, prognosis prediction, and treatment response forecasting [66]. This will enable a fundamental shift from empirical trial-and-error to prospective precision matching.

5.2.2. Integrating Digital Health and Artificial Intelligence for Dynamic Personalized Management

The combination of ecological momentary assessment (real-time symptom and mood data collected via smartphone apps) and wearable devices (monitoring heart rate variability, physical activity, sleep, etc.) enables continuous, dynamic monitoring of pain and its correlates [67]. Machine learning models can analyze these high-dimensional data to identify flare patterns and predict treatment responses, thereby providing real-time guidance for adjusting the timing of psychological interventions and optimizing medication regimens—forming a closed-loop management cycle of "monitoring-prediction-intervention."

5.2.3. Deepening Interdisciplinary Integration and Implementation Science to Bridge Collaborative Gaps

Through implementation science research, structural re-

forms in healthcare systems should be promoted. This includes establishing institutionalized multidisciplinary pain clinics (e.g., combined pain-psychiatry clinics), routinizing psychosocial assessment, and systematically disseminating and implementing validated integrated interventions (e.g., pain neuroscience education, cognitive behavioral therapy). Concurrently, modern disease classification frameworks such as ICD-11 should be fully utilized to provide a common language and operational foundation for interdisciplinary practice.

5.2.4. Exploring Cutting-Edge Intervention Technologies to Expand Therapeutic Boundaries

Ongoing attention and investment should be directed toward clinical research on novel neuromodulation technologies (e.g., more targeted deep brain stimulation), internet-based and VR-based digital therapeutics, and new pharmacological and non-pharmacological interventions targeting specific mechanisms (e.g., neuroinflammation, neuroplasticity). For instance, microglial polarization modulators aim to intervene in pain at the neuroimmune interface, while virtual reality-based exposure therapy offers an innovative tool for overcoming pain-related fear and avoidance behaviors in a safe environment.

6. Conclusion and Prospects: From Pain-Centered to Person-Centered Care-A Paradigm Shift

Pain is, in essence, a dynamically integrated mind-body life experience. Psychiatry, with its bio-psycho-social perspective and systematic therapeutic toolbox, should actively engage in this paradigm shift. The psychotherapeutic approaches detailed in this review—CBT, ACT, EAET, MBSR, and hypnotherapy—each offer unique mechanisms for targeting the cognitive, emotional, and behavioral dimensions of pain, providing a rich armamentarium for individualized treatment planning. These therapies have their respective emphases: CBT focuses on correcting maladaptive cognitions and behaviors; ACT and MBSR emphasize acceptance, defusion, and present-moment awareness; EAET focuses on emotional expression and transformation; and hypnotherapy utilizes altered states of consciousness to modulate pain perception.

Future pain management must transcend the mere suppression of isolated symptoms and instead commit itself to the care of the whole person. This endeavor should be advanced synergistically on three interrelated levels: at the mechanistic level, by elucidating the shared neural circuits underlying pain-emotion comorbidity, thereby laying the groundwork for novel targeted interventions; at the clinical level, by deeply integrating multidimensional data to achieve genuine personalization and dynamic optimization of treatment regimens;

and at the systemic level, by establishing and implementing routine multidisciplinary integrated care models.

The ultimate vision is to provide every patient with integrated care that is no longer limited to analgesia alone, but rather a comprehensive approach that helps restore function, rekindle meaning in life, and enhance overall quality of life. This signifies a fundamental transition from traditional "pain-centered" treatment to modern "person-centered" care—an essential and inevitable trajectory for the advancement of pain medicine.

Abbreviations

ACC	Anterior Cingulate Cortex
ACT	Acceptance and Commitment Therapy
ADHD	Attention Deficit Hyperactivity Disorder
CBT	Cognitive Behavioral Therapy
dlPFC	Dorsolateral Prefrontal Cortex
DMN	Default Mode Network
DRG-S	Dorsal Root Ganglion Stimulation
EAET	Emotion Awareness and Expression Therapy
FDA	U.S. Food and Drug Administration
fMRI	Functional Magnetic Resonance Imaging
GABA	Gamma-Aminobutyric Acid
HPA	Hypothalamic-Pituitary-Adrenal
IASP	International Association for the Study of Pain
ICD-11	International Classification of Diseases, 11th Revision
MBSR	Mindfulness-Based Stress Reduction
MCS	Motor Cortex Stimulation
MPfc	Medial Prefrontal Cortex
MRI	Magnetic Resonance Imaging
NAc	Nucleus Accumbens
NeP	Neuropathic Pain
NLRP3	NLR Family Pyrin Domain Containing 3
NP	Nociplastic Pain
OFC	Orbitofrontal Cortex
PAG	Periaqueductal Gray
PNS	Peripheral Nerve Stimulation
rTMS	Repetitive Transcranial Magnetic Stimulation
RVM	Rostral Ventromedial Medulla
S1	Primary Somatosensory Cortex
S2	Secondary Somatosensory Cortex
SCS	Spinal Cord Stimulation
SNRIs	Serotonin-Norepinephrine Reuptake Inhibitors
TCAs	Tricyclic Antidepressants
tDCS	Transcranial Direct Current Stimulation
TENS	Transcutaneous Electrical Nerve Stimulation
VNS	Vagus Nerve Stimulation
VR	Virtual Reality
VTA	Ventral Tegmental Area

Author Contributions

Ming Ai: Conceptualization, Formal Analysis, Funding acquisition, Methodology, Supervision, Visualization, Writing – original draft, Writing – review & editing

Han Gao: Conceptualization, Formal Analysis, Methodology, Visualization, Writing – original draft, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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