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Pain education research: Advances, innovations, and challenges

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Pain education research: Advances, innovations, and challenges

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Editorial: Pain education research: advances, innovations, and challenges

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Editorial on the Research Topic
Pain education research: advances, innovations, and challenges

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Introduction

Worldwide consensus has identified pain education for health care professionals as inadequate to meet the clinical need for pain assessment and management. In the past decade, several professional organizations and academic institutions have taken this challenge and formulated curricula and training (often interprofessional) informed by the neuroscience of education and learning. As the cumulative experience among pain educators worldwide grows and evolves, a body of work has developed that systematically assesses the efficacy and real-world effectiveness of diverse approaches to pain education as a crucial stage in the translation of basic and applied knowledge into clinical practice.

Challenges facing pain educators include deciding upon and conveying the content to be transmitted, how best to use competencies related to this content, and how to tailor general educational approaches to best meet the needs of health care professionals dealing with patients with pain. Other issues include engaging patients and the public, including policy makers, in shared efforts to reduce unnecessary pain and suffering and optimize clinical outcomes associated with the entire spectrum of painful experiences.

This Research Topic provides a collection of articles addressing previous and ongoing barriers to the education of health care professionals, including competencies, and evidence-based approaches to overcoming these barriers, complemented by concurrent advances in patient and public education. We invited contributions on, but not limited to, the following topics:

- Content of pain education for health care professionals and its refinement according to changes in scientific knowledge and clinical practice.

- Methodologies synthesizing and translating pain-related content to ensure application to clinical care of people with pain across the lifespan.
- Frameworks and approaches to overcome challenges encountered by educators trying to facilitate learning about contemporary topics.
- Gaps in post-graduate and continuing education for licensed health professionals.

Eleven articles were accepted for inclusion in the Research Topic.

Overview of contributions

Contributions to the Research Topic provide a systematic evaluation of pain education content and methods, and novel perspectives and future directions for both practice and research. The collection includes the development and evaluation of various frameworks and approaches to overcome challenges encountered by educators trying to facilitate learning about contemporary approaches to assess and manage complex pain presentations, within the broader context of health care system change.

In the first of two contributions, Mardian et al. draw attention to the need for transformation in pain education and culture to improve clinical practice, through a lens of “didactic dissonance”—a disconnect between what is taught in classroom settings and what learners observe in clinical settings. They propose a process based on transformative learning theory to assist learners in exploring factors that create and perpetuate the education-practice disconnect, opening avenues of exploration for transformation in both educational and clinical practice. The findings of a qualitative study by Thompson et al. support this viewpoint by providing evidence that stakeholders of physiotherapy education emphasise the importance of preparing graduates for the challenges faced when encountering “real” people from diverse sociocultural backgrounds. Thompson et al. suggest that pain education in health care can be improved through a curriculum of practically engaging pain scenario’s reflecting the challenges faced in clinical practice.

The contribution by Siaton et al. demonstrates the challenges faced by educators and practitioners in the management of complex presentations, particularly related to older people with pain comorbidities. Siaton et al. report the use of a mixed methods approach to develop and pilot a Pain in Aging, Educational Assessment of Need (PAEAN) instrument to inform pain, comorbidities, and clinical decision-making associated with the complexities of assessing and managing geriatric pain. Their findings suggest that several factors impact pain-related clinical decision-making and that it is feasible to survey healthcare practitioners about the influence of comorbidities on decisions in the care of older adults with pain. The contribution by Soenarto et al. provides evidence that mnemonics are a helpful tool to develop knowledge of and skills for assessing pain in clinical consultation during a simulation-based educational workshop. Soenarto et al. found that medical students’ knowledge and skills of assessing chronic pain was improved using the PQRST (P, provoke and palliate; Q, quality; R, region and radiation; S, severity; T, time) mnemonic, although the addition of an ACT-UP (A, activity; C, coping; T, think; U, upset; P, people) was no better than using PQSRT alone. Soenarto et al. conclude that mnemonics are useful and can be integrated into various learning contexts such as lectures, demonstrations, simulations, and interactions with patients.

The contribution by Shipton et al. provides a useful approach to the complex process of curriculum change and supports the need for more formalised procedures to design, develop and evaluate the pain medicine curriculum. Shipton et al. describe how they conceptualised and developed a purposeful method to facilitate structured integration of pain education into the medical curriculum. Their Pain Medicine Curriculum Framework comprises future healthcare practice needs, the competencies and capabilities required of graduates, the teaching, learning and assessment methods to use, and institutional parameters. The contribution of Cao and Van Deusen provides evidence for the integration of opioid use disorder and chronic pain content within medical curricula. Their topic review revealed a lack of emphasis on chronic pain education, biopsychosocial approaches, and interprofessional learning in current US medical school curricula; and their evaluation of twelve winning student-designed opioid use disorder curricula utilised more diverse learning activities and assessment methods than current US medical school curricula.

In their additional contribution, Mardian et al. describe the “hidden curriculum” as a vehicle by which students learn values, attitudes, beliefs, and related behaviors important to medicine, and that this “hidden curriculum” is entrenched in a biomedical model of practice. Mardian et al. explain how they employed the Implicit Bias Recognition and Management tool to “flip” this hidden biomedical curriculum towards a sociopsychobiological model of care. Similarly, the contribution by Ng et al. reports the application of the behavioural change wheel to guide the implementation of a biopsychosocial approach to musculoskeletal pain care; they propose a worked example on how to operationalise the framework. In their contribution, Darnall et al. argue a need to overcome system-level barriers associated with the biomedically-dominant culture that marginalises education about, and access to, high-quality, evidenced-based behavioural pain treatments for youth and adults. Darnall et al. review literature to reveal several innovative digital treatment formats, technologies, and clinician trainings and offer clinical recommendations and future directions for research. The examples of evidence-informed strategies to assess, identify and analyse biopsychosocial factors provided in these contributions can be used by healthcare professionals and educationalists to strengthen a whole-of-system adoption of a biopsychosocial approach to pain care.

Technological advances have driven a shift towards online learning, and the contribution by Dao and Cao provides evidence to support the utility of this educational medium. They found that improvements in physiological knowledge and ability to work together in interprofessional teams achieved during in-person training using the Supervised Student Inter-professional

Pain Clinic Program (SSIPCP) were maintained when the program had to be delivered online using Zoom due to the COVID-19 pandemic. However, students using Zoom expressed a preference for in-person activities. The contribution by Lalloo et al. describes how they integrated and evaluated pediatric-pain core competency education within the Extension for Community Healthcare Outcomes (ECHO®) for Pain model. The ECHO® model delivers online education to interprofessional healthcare providers through virtual clinics to cultivate a community of practice, and Lalloo et al. provide evidence that the Pediatric Project ECHO® for Pain improved knowledge and self-efficacy in learners and had high usability with clinically realistic cases.

Impact of contributions

Contributions to this Research Topic address advances, innovations, and challenges in pain education research and provide evidence of a need to safeguard adequate and appropriate coverage of pain education in health professional curricula. In doing so, educationists are tasked with designing learning situations that align with contemporary pain knowledge, including sociopsychological aspects of pain and its management within the biopsychosocial model of care. Through providing examples of frameworks that are being used and evaluated to assist curriculum development, this eBook offers perspectives on how the challenges of reconceptualising pain education can be overcome. In addition to the focus on students, approaches address education for the educator who is developing and implementing curriculum, in both uni- and/or interprofessional settings. Contributions discuss the need to formalise approaches to design, develop, and evaluate pain curricula, and to provide learning opportunities that progress knowledge and skills on psychosocial aspects of pain. These discussions can be used to inform future directions of research and practice. Of priority is the development and implementation of authentic patient scenarios across the lifespan, co-created with people living with pain, that reflect the complexities and cultural-diversity of real-life clinical practice.

Author contributions

MJ: Writing – review & editing, Writing – original draft. YB: Writing – review & editing. SF: Writing – review & editing. KT: Writing – review & editing. JW-W: Writing – review & editing.

Conflict of interest

There are no commercial or financial conflicts of interest directly related to this article. We declare the following interests that are outside of the scope of this article. In the previous 5 years, MJ's employer has received income for expert consultancy activities from GlaxoSmithKline, TENSCare, and LifeCare Ltd. that lie outside of the submitted work. MJ declares book royalties from Oxford University Press. SF discloses Grant/Research/Clinical Trial Support to the University of California. He also receives royalties for books from: Elsevier Publisher [Royalties—pain and pain management]; Oxford University Press [Royalties—pain and pain management]; Wolters Kluwer Publisher [Royalties—pain and pain management] as well as for editorial work for UpToDate/Wolters Kluwer Publisher [chronic pain].

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The Pain Medicine Curriculum Framework-structured integration of pain medicine education into the medical curriculum

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Medical practitioners play an essential role in preventing pain, conducting comprehensive pain assessments, as well as promoting evidence-based practices. There is a need for the development of innovative, interprofessional and integrated pain medicine curricula for medical students. The Pain Medicine Curriculum Framework (PMCF) was developed to conceptualise a purposeful approach to the complex process of curriculum change and to prioritise the actions needed to address the gaps in pain medicine education. The PMCF comprises four dimensions: (1) future healthcare practice needs; (2) competencies and capabilities required of graduates; (3) teaching, learning and assessment methods; and (4) institutional parameters. Curricula need to meet the requirements of registration and accreditation bodies, but also equip graduates to serve in their particular local health system while maintaining the fundamental standards and values of these institutions. The curriculum needs to connect knowledge with experience and practice to be responsive to the changing needs of the increasingly complex health system yet adaptable to patients with pain in the local context. Appropriate learning, teaching and assessment strategies are necessary to ensure that medical practitioners of the future develop the required knowledge, skills and attitudes to treat the diverse needs of patients' experiencing pain. The historical, political, social and organisational values of the educational institution will have a significant impact on curriculum design. A more formalised approach to the development and delivery of a comprehensive pain medicine curriculum is necessary to ensure that medical students are adequately prepared for their future workplace responsibilities.

KEYWORDS

pain, pain medicine education, curriculum, medical school, framework

1. Introduction

Every medical practitioner has a responsibility to provide care for patients with pain, because management of pain transcends the speciality and clinical setting (1). Medical practitioners play an essential role in preventing pain, conducting comprehensive pain assessments, and promoting evidence-based practices. Treatment of pain is complex and requires consideration of the type of pain, patient comorbidities, patient risk factors for side effects or addiction, and the psychosocial characteristics of the patient experiencing pain (2, 3). Evidence points to a major gap between the increasingly sophisticated knowledge of pain and the prevailing inadequacy of its treatment (4, 5). Obstacles associated with the implementation of evidence-based pain management strategies are complex, and medical curricula design issues have been highlighted as one of the greatest barriers to effective treatment of pain (6–9).

Research has shown that there is a wide variation in the delivery of pain medicine education at medical schools across Australia and New Zealand (10). In general, medical schools in these countries lack well documented and comprehensive pain curricula (10). Indeed, pain medicine content is lacking in medical curriculae internationally (11).

There have been repeated calls for the development of innovative, interprofessional and integrated pain medicine curricula, education and resources by internationally recognized experts in clinical pain medicine and pain education to ensure that medical practitioners entering the workforce are able to deliver safe and effective pain management (12–17). Seven studies have described the process of developing a pain curriculum at individual medical schools in Canada and the USA, and provided details of the teaching and learning activity associated with the course (18–24).

The enormous difficulties involved with introducing a new curriculum cannot be underestimated (25). Universities are under pressure to change in a variety of ways, for instance, curriculum reform has been implemented to address the disparity in health status between Indigenous and non-Indigenous people in Australia and New Zealand (26, 27). Medical schools are complex educational systems that face their own unique cultural and organizational challenges when it comes to transforming curricula. Change is difficult due to long-standing biases towards basic sciences and tertiary care, perceived need to maintain the status quo and territorial protection of power and status (28–31). The medical specialists who are planning the curriculum and teaching the students are often leaders in their field in the clinical healthcare system, and may not perceive a need for transformative change (32). The medical curriculum is under pressure in terms of appropriate content in general due to an ever-increasing body of medical knowledge to be covered in the curricula. Adding pain education to a full medical curriculum of fixed length may not be well received when this necessitates other content is dropped (18).

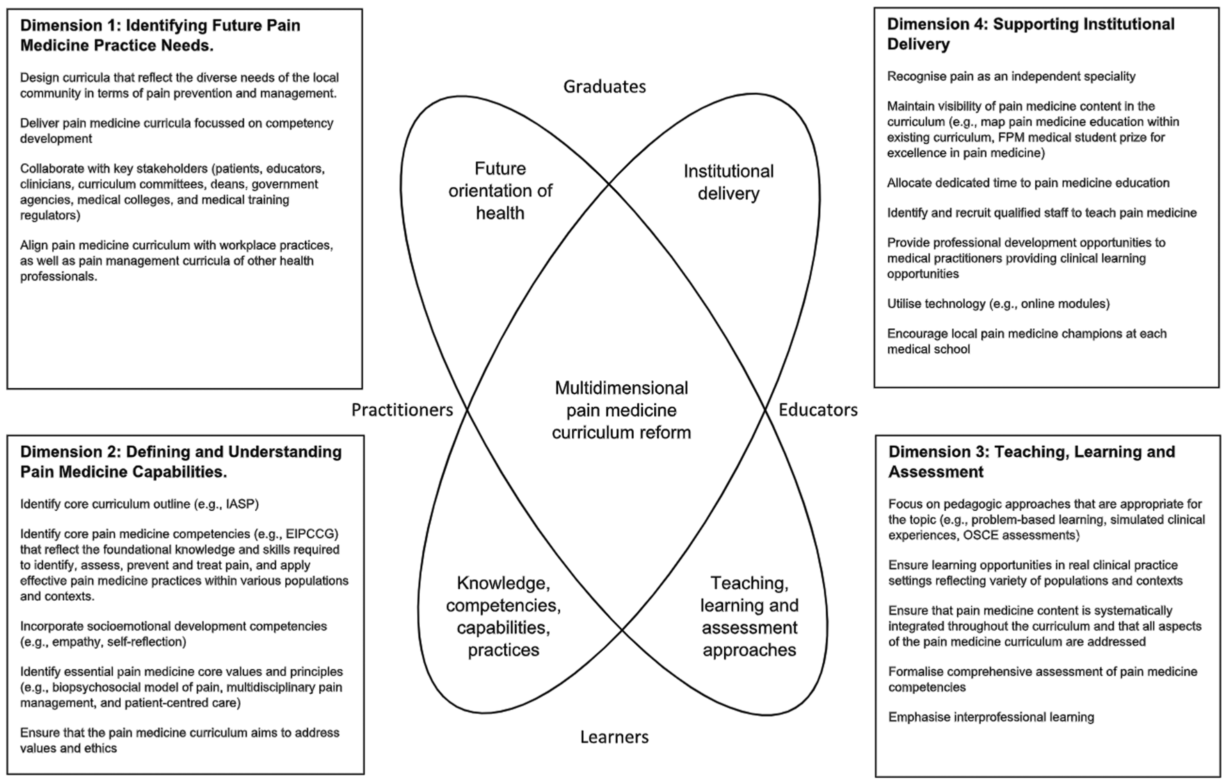
There is a need for the development of recommendations to enable effective integration of pain medicine education into medical curricula on an international scale (33). This review article will focus on essential components that need to be considered when considering new ways to include pain management in medical curricula, with particular reference to the Australian and New Zealand context.

Theoretical frameworks of curriculum structure and context are useful to assist in articulating and addressing the complexities of curriculum design and development (34). The Four-Dimensional Curriculum Development Framework (4DF) developed by Lee, Steketee, Rogers and Moran provides a template to comprehensively examine the complex and dynamic nature of the pain curricula for medical students (34). It is a useful tool for identifying curriculum priorities and “connecting content and activity with purpose and consequence” (34). It was designed in Australia to generate curriculum and pedagogical discussions crucial to supporting interprofessional education (IPE) as a core component of health professional education curricula (35). The 4DF has proved to be an effective tool used by individuals and institutions for review and development of interprofessional curricula and curriculum redesign (35, 36). The 4DF framework comprises four dimensions: (1) future healthcare practice needs; (2) competencies and capabilities required of graduates; (3) teaching, learning and assessment methods; and (4) institutional parameters.

The Pain Medicine Curriculum Framework was developed from the 4DF to conceptualise a purposeful approach to the complex process of curriculum change and to prioritise the actions needed to address the gaps in pain medicine education (see **Figure 1**). This Pain Medicine Curriculum Framework encompasses the four elements of the 4DF with particular reference to the design and delivery of pain medicine education at medical schools (34). PubMed, Medline, EMBASE, ERIC, and Google Scholar, and BEME data bases were searched for information relevant to the four dimensions. The team consisted of four members, two with a medical education lens and two with clinical pain medicine focus. One author, CS, was instrumental in the design of the 4DF and the subsequent application of the 4DF to specific curricula parameters. This was valuable when applying the 4DF to the unique demands of pain education for medical students. While this framework is particularly relevant to the Australian and New Zealand context, the framework is applicable to medical schools internationally with similar medical education systems, when locally contextualised.

2. Dimension 1: identifying future healthcare practice needs in pain medicine

The first dimension of this framework asks the questions “What is this curriculum for?” and “What is the professional landscape that it aims to prepare students for, now and in the future?” (35) Curricula need to meet the requirements of registration and accreditation bodies, but also equip graduates to serve in their particular local health system while maintaining the fundamental standards and values of these institutions (34). Curriculum design influences the education of future health professionals in terms of personal, professional, social, cultural, political and economic



Dimension 1: Identifying Future Pain Medicine Practice Needs.

Design curricula that reflect the diverse needs of the local community in terms of pain prevention and management.

Deliver pain medicine curricula focussed on competency development

Collaborate with key stakeholders (patients, educators, clinicians, curriculum committees, deans, government agencies, medical colleges, and medical training regulators)

Align pain medicine curriculum with workplace practices, as well as pain management curricula of other health professionals.

Dimension 2: Defining and Understanding Pain Medicine Capabilities.

Identify core curriculum outline (e.g., IASP)

Identify core pain medicine competencies (e.g., EIPCCG) that reflect the foundational knowledge and skills required to identify, assess, prevent and treat pain, and apply effective pain medicine practices within various populations and contexts.

Incorporate socioemotional development competencies (e.g., empathy, self-reflection)

Identify essential pain medicine core values and principles (e.g., biopsychosocial model of pain, multidisciplinary pain management, and patient-centred care)

Ensure that the pain medicine curriculum aims to address values and ethics

Dimension 4: Supporting Institutional Delivery

Recognise pain as an independent speciality

Maintain visibility of pain medicine content in the curriculum (e.g., map pain medicine education within existing curriculum, FPM medical student prize for excellence in pain medicine)

Allocate dedicated time to pain medicine education

Identify and recruit qualified staff to teach pain medicine

Provide professional development opportunities to medical practitioners providing clinical learning opportunities

Utilise technology (e.g., online modules)

Encourage local pain medicine champions at each medical school

Dimension 3: Teaching, Learning and Assessment

Focus on pedagogic approaches that are appropriate for the topic (e.g., problem-based learning, simulated clinical experiences, OSCE assessments)

Ensure learning opportunities in real clinical practice settings reflecting variety of populations and contexts

Ensure that pain medicine content is systematically integrated throughout the curriculum and that all aspects of the pain medicine curriculum are addressed

Formalise comprehensive assessment of pain medicine competencies

Emphasise interprofessional learning

FIGURE 1
The pain medicine curriculum framework.

development, by setting the pre-conditions for the development of specific knowledge, skills and attitudes (34).

2.1. Community need for pain medicine education

Why is it important that pain medicine is included in the medical curriculum? Acute pain is an almost universal experience and arises from trauma, burns, infection, emergency and elective surgery, childbirth and severe medical illness. There is a high prevalence of chronic pain in Australia and New Zealand; evidence from large-scale studies show that approximately one in five adults experience chronic pain (37–39). Half of all cancer patients experience chronic pain, and one third will describe their pain as moderate or severe (40). The Global Burden of Disease Study 2016 placed low back pain, migraine, other musculoskeletal pain (such as autoimmune, inflammatory, joint, ligament, tendon and muscle disorders) and neck pain in the top six causes of years lived with disability in Australia and New Zealand, alongside depression and anxiety (41, 42). In 2018, 3.24 million Australians were living with chronic pain, and it was estimated that in 2016–2017, about 770,000 adults in New Zealand experienced pain almost every day (43, 44). Chronic pain is common in children and adolescents, and in the elderly (45–47). In New Zealand, Māori have the highest rates of chronic pain compared with other population groups, and chronic pain is more prevalent in areas of high socio-economic deprivation (48, 49). Acute and chronic non-cancer pain rates in Australia and New Zealand are likely to continue to rise, related to the ageing population, lifestyle changes leading to obesity and inactivity, and the epidemiological shift from infectious diseases to non-communicable diseases (such as diabetes and arthritis) (43, 50–52). Advances in treatment of cancer have led to an increase of painful neuropathic conditions (53).

Medical practitioners need to recognise at-risk populations, and implement effective strategies for acute and chronic pain assessment and management so as to reduce the public health burden of pain (54).

2.2. Responsibility for developing and articulating pain medicine learning outcomes

2.2.1. The influence of the professional regulatory system on the inclusion of pain medicine in the medical curriculum

Professional accreditation bodies significantly influence curriculum design through the regulations and standards that they set (55). Accreditation is the process whereby organisations set standards to ensure that graduates are competent and safe to practice (56). The medical curriculum must meet the demands of the accrediting and professional bodies with respect to defined graduate outcomes. Influencing professional bodies to incorporate pain medicine competencies in entry-to-practice registration and maintenance of certification is likely to have a major impact on pain education and clinical practice (55, 57). It appears that regulatory bodies in Australia and New Zealand have not directed curricular requirements to integrate pain medicine into the curriculum. The Australian Medical Council (AMC) is responsible for developing standards, policies and procedures for the accreditation of medical programmes for Australia, and sets a framework around which medical education providers structure their individual programmes (58). The New Zealand Medical Council (NZMC) monitors the training of medical students in New Zealand (59). However, neither the AMC nor the NZMC has specifically defined in detail the outcomes that a student must demonstrate for graduation (58, 59). A defined pain medicine curriculum is therefore not a mandatory part of medical degrees in Australia and New Zealand.

Similarly, competencies in pain medicine have not been prioritised by regulatory bodies in Australia and New Zealand. Medical Deans Australia and New Zealand Inc, the eminent body representing entry-level medical education in Australia and New Zealand, endeavours to bring together stakeholders from all levels of medical education and training to prioritise future medical workforce planning (30, 60). In 2020, the Medical Deans' Medical Education Collaborative Committee identified a set of core competencies describing the foundational skills and knowledge required for final-year medical students to be ready for internship (61). No specific pain management core skills were identified apart from "prescribing analgesic medication (opioid and non-opioid)". The report specified that students should be able to demonstrate the knowledge of safe prescribing of high-risk medicines such as analgesics in a simulated experience or environment (such as an objective structured clinical examination), and at the time of graduation, be able to perform this competency under indirect supervision (61).

Likewise, entry-to-practice competencies that specifically identify pain-related knowledge, skills or attitudes are minimal or mostly absent in regulatory requirements for medical graduates in the United States of America (USA), Canada and the United Kingdom (UK) (57, 62). This is one of the major reasons that comprehensive pain management content is not mandatory in the medical curriculum in these countries (12–14, 63). Entry-to-practice competency requirements related to health science undergraduate training in Canada were examined in 2013 (55). While dentistry and nursing students were required to complete a number of pain-specific competencies, no regulatory requirements related to pain were found for medical students (55).

Core competencies for pain management have been accepted across a number of health professions and speciality professional organisations (such as the International Association for the Study of Pain [IASP], American Academy of Pain Medicine, American Society for Pain Management Nursing, American Council of Academic Physical Therapy, Royal College of Nursing and UK Physiotherapy Pain Association) (57, 64). Systematic change is likely to follow in terms of integration of pain education into the curriculum when accrediting bodies prioritise the need for medical students to display competencies in pain management (57).

2.2.2. Legal, ethical, and social issues related to pain medicine education

The consequences of not treating chronic pain can be severe, leading to significant deterioration in health-related quality of life and psychological wellbeing (65–68). The social consequences of persistent pain include breakdown of family and marital relationships, altered social role and social isolation (69, 70).

The economic cost of persistent pain on society is enormous. The total cost of chronic pain in 2018 in Australia was estimated at AUD$139.3 billion and 7% of total health system expenditure (cardiovascular disease accounted for 10% in a similar period), and up to $15 billion in New Zealand in 2016 (43, 71, 72). This cost included loss of productivity at work, burden of disease costs and healthcare costs, as well as welfare benefits and loss of taxation revenue (51, 71). Economic costs are attributable to the significant adverse effect on people who experience pain, but also on those caring for them, as well as friends and family, co-workers, employers, charities and governments. Pain negatively affects work productivity for both the patient and the carer. Loss of productive time can be explained by reduced performance at work, as well as by absence from work and premature retirement (73, 74).

There are also risks of harm associated with inappropriate treatment of chronic pain. While the value in using opioids for acute and cancer pain is accepted, opioids are increasingly being prescribed for chronic non-cancer pain despite an absence of evidence regarding the long-term efficacy or effectiveness (75). There are significant harms associated with the long-term use of opioids such as physical dependence, addiction, opioid-induced hyperalgesia and overdose (unintentional or intentional) (76). Medical practitioners face legal scrutiny in terms of opioid prescription, including over- or inappropriate prescription (77). There has been a substantial increase in prescription of opioid medications for chronic non-cancer pain in Australia and New Zealand in the past 20 years, with a parallel increase in opioid abuse, addiction and overdose deaths (76, 78, 79). Internationally, substantial practice and knowledge gaps of prescribing physicians have been identified, such as prescription of transdermal fentanyl in opioid-naive patients, or failure to discontinue opioids if ineffective for relieving pain (80). An inquest into the death of a patient in South Australia in 2015 found that the death was preventable and occurred as a result of prescribed opioid toxicity (81). Medical practitioners have recently been reprimanded in Australia over the inappropriate used of opioids and ketamine (an anaesthetic agent) (82–84).

Medical schools have a legal and ethical duty to teach pain management in a comprehensive manner in order to equip graduates with technical, cognitive, emotional and reflective skills to adequately manage people with pain needs (85).

2.2.3. Governmental support for developing pain medicine education

Pain has a low medico-political profile worldwide (9, 50, 68, 86). At present, the provision of pain care in Australia has been described as fragmented; in particular, chronic pain care is lacking a coordinated approach (87). Some changes are taking place in Australia, including the 2018 National Strategic Action Plan for Pain Management, supported by the Australian Government, which provides support for improved pain medicine education at medical schools in Australia (5). The Action Plan was developed by over 25 organisations, including those related to pain medicine, allied health, drug and addiction medicine, mental health, rural health, general practice and pharmacy as well as consumers and carers and is supported by the Australian Government (5). A key goal of the Action Plan (2018–2021) was to ensure that health practitioners are well-informed on the best practice evidence-based pain management and supported to deliver this care (5). The Action Plan aimed to achieve this goal by developing an overarching education strategy to promote evidence-based pain management education across health practitioner disciplines (5). This included standardisation of teaching curricula at universities and a focus on value-based health care (88).

No comprehensive population health-level strategy currently exists in New Zealand to tackle the magnitude of the problem of pain with coordinated strategies for pain prevention, treatment, education, reimbursement and research (43). It is critical that government agencies prioritise a coordinated national strategy and provide financial support for pain education to address the unnecessary burden of unrelieved pain (89, 90).

2.3. Expectations of pain medicine competencies in the workplace

What challenges are medical graduates likely to face when providing pain treatments in their local health system? There is no clinical specialty where the basics of pain management are not relevant because acute and chronic pain are features of each of these disciplines (7).

2.3.1. Hospital setting

It has been established that pain is common and often undertreated in both medical and surgical hospital inpatients in Australia (91–94). International studies report that acute pain is the main complaint of patients seeking treatment at an emergency department of a hospital, with approximately seven out of 10 patients attending because of severe pain (50, 95, 96). A prospective observational study of patients in Australia found that 47% of patients continued to experience moderate to severe pain one week after surgery (97). A further study in Australia showed that severe acute pain was reported by 56% of patients up to three days after orthopaedic surgery (98). Corresponding figures for acute pain prevalence in New Zealand have not been published.

Newly graduated medical practitioners in Australia and New Zealand (hereafter referred to as interns), are directly responsible for managing patients with pain presenting to hospital (99–101). A mixed methods study to better understand the clinical placement experience of prevocational doctors in Australia found that interns prescribed pain therapies and participated in discharge planning for most of their patients (100). For some of their patients, they implemented a management plan and prescribed the patients' medication throughout their stay (100). A survey of new interns in Australia found they frequently performed pain management tasks without direct supervision during the first year after graduation (99). A further study in Australia identified that levels of supervision decreased during night and weekend shifts and were dependent on service demands (102). In a survey undertaken in New South Wales, Australia, 70% of interns stated that they would be expected to initiate preliminary investigation, management or treatment for post-operative pain without supervision (103). Inadequate monitoring of interns' prescribing of analgesics has been described both in New Zealand and internationally (101, 104).

A study of opioid prescribing at a hospital in Australia showed that patients received inadequate analgesia because of medical practitioners' limited knowledge of pain assessment, opioid dose titration, available opioid preparations, lack of experience of multimodal analgesia and attitudes to opioids and pain relief (91). Patients are at risk of harm when interns lack of knowledge regarding analgesic medications. A study of junior doctors' opioid prescribing practices in New Zealand that found dose errors were common (54%) with 19% of these likely harmful and 4% potentially lethal (101). This appears to be a widespread problem among junior doctors internationally (105). In Australia, discharge prescribing is often delegated to junior doctors, and high doses of opioids in excess of patient are routinely prescribed (106).

There are similar reports of new graduates from medical schools in the USA with varying degrees of readiness to provide adequate pain management for their patients (107). Interns in the USA are generally poorly prepared to evaluate and treat acute pain, and find the complex problem of acute-on-chronic pain overwhelming (107). A survey of interns in the USA found that 78% reported a lack of training and competency in the prescription of opioids for chronic non-cancer pain (108).

2.3.2. Primary care

Specialist pain medicine resources are limited in Australia and New Zealand (43, 44, 109). It is therefore essential that patients with pain receive timely and appropriate care by non-pain specialists in the primary care setting (7).

Internationally, general practitioners have reported inadequate training regarding pain management, and have expressed difficulties with assessing and managing chronic pain, especially for their elderly patients and those requiring opioid treatment (110–113). Many patients feel that healthcare practitioners lack relevant knowledge regarding chronic pain and are dismissive of their individual pain needs (8, 114).

2.4. Need for collaboration

Proposals have been made both nationally and internationally to mobilise medical education stakeholders (patients, medical practitioners, allied health professionals and governmental bodies) to integrate a formal comprehensive pain medicine curriculum into medical school training (5, 33, 50, 62, 87, 115). An academic–clinical partnership is needed to develop effective collaborative approaches to improving pain medicine competencies of medical students.

An Australian study examining beliefs and clinical practice behaviours related to low back pain among multidisciplinary health professional students recommended more consistent alignment of evidence-based education regarding low back pain across disciplines (94). The problem of limited integration of pain content in pre-licensure health sciences curricula such as nursing, dentistry, occupational therapy, physiotherapy, pharmacy and social work has been identified in Canada, Europe and the USA (73, 81, 82, 91–93). The delivery of effective pain management can be complex and requires multidisciplinary team approaches (116). It is important that health professional students are provided with a common understanding of the basic principles of pain management in order to prepare them to work as part of an integrated multidisciplinary team (8, 117).

On a national scale, the Faculty of Pain Medicine of the Australian and New Zealand College of Anaesthetists (FPM ANZCA) has partnered with the Australian Government (through the Therapeutic Goods Administration) to support pain education for nurses and medical students. The Better Pain Prescribing initiative involves funding for nurses and medical students to access the Better Pain Management e-learning programme on the multidisciplinary, patient-centred approach to the assessment, diagnosis and management of people experiencing pain (88, 118, 119).

Medical schools need to collaborate with different stakeholders (academics, medical training regulators, professional medical colleges, and patient/consumer groups) to meet their responsibility for ensuring that pain medicine education is effectively integrated into the medical curriculum.

3. Dimension 2: defining and understanding pain medicine capabilities

The second dimension involves identifying sets of learning outcomes to specify the pain medicine knowledge, capabilities and attributes needed by health professionals to competently participate in high-quality, relevant and comprehensive health systems. The curriculum needs to connect knowledge with experience and practice to be responsive to the changing needs of the increasingly complex health system yet adaptable to patients with pain in the local context.

3.1. Currently available pain curricula

The original IASP curriculum was updated and entered its fourth edition in 2017 (120, 121). This IASP Curriculum Outline on Pain for Medicine is intended as a guideline for medical school curriculum planning, to draw attention to key pain concepts that should be taught during the medical training (121).

According to IASP, principles that should guide the pain curriculum for the entry-level physician are:

- Pain is multidimensional requiring comprehensive and ongoing assessment and effective management.
- Physicians play an essential role in the prevention, diagnosis and management of acute and persistent pain (121).

The specific objectives of this entry-level pain curriculum are:

(1) Recognize pain medicine as a necessary field in clinical practice for acute and persistent (chronic) pain conditions
(2) Understand the basic science of pain-processing components such as anatomy, physiology, and pharmacology
(3) Identify clinical presentation of acute and persistent pain syndromes or conditions
(4) Recognize the multidimensional aspects of the pain experience and its related management
(5) Understand pain management options appropriate for individual patients according to medical condition, medicine availability, risk-benefit balance, cost-effectiveness, culture, mental status, and evidence of efficacy
(6) Know the indications, contraindications, and risks of the primary elements of multimodal pain management
(7) Learn effective interaction with multi-professional teams involved in practicing pain medicine
(8) Practice pain medicine according to ethical principles (121).

The IASP Curriculum Outline on Pain for Medicine complements the European Pain Federation (EFIC) Pain Management Core Curriculum for Medical Students, which gives a more detailed breakdown of educational objectives, structure, content, number of teaching sessions and suggestions for delivery (122).

With the advances in the educational research and emphasis on competency-based education, pain management experts and educators became aware of the absence of pain management core competencies for entry-level health professional students (2, 123). It was felt that this deficiency was possibly one of the reasons for the lack of pain education in training programmes (2). In 2012, the Expert Interprofessional Pain Competencies Consensus Group (EIPCCG) comprising leaders from multiple professions with expertise in pain management, education science and development of evidence-based consensus came together to develop core competencies in pain assessment and management for entry-level health professional education (2). The recommended pain management competencies were categorised into four domains: multidimensional nature of pain, pain assessment and measurement, management of pain, and context of pain management (see **Figure 2**) (2). These domains address the fundamental concepts and complexity of pain; how pain is observed and assessed; collaborative approaches to treatment options; and application of competencies across the life span in the context of various settings, populations and care team models (2). These core competencies were based on the IASP interprofessional core curriculum (124).

3.2. Integrating pain medicine core competencies into medical curricula

The EFIC and IASP core curriculum have been recommended by expert pain researchers as a suitable structure for pain teaching in the undergraduate curriculum (14, 17, 18). The IASP Curriculum Outline on Pain for Medicine has been used as a reference to develop content of pain management courses in medical schools in Greece, the USA (Johns Hopkins University, Virginia Commonwealth University, New York University, University of Washington, State of Michigan medical schools), Finland, the UK and Canada (University of Toronto) (16–21, 23, 125–127).

In 2016, the EIPCCG pain management core competencies formed the basis of the document Strengthening Pain Content in Medical School Curricula, which was developed by an expert panel as a tool for integrating pain management content specifically into medical school curricula (128). Potential teaching methods and suggestions for education strategies and content were identified for each learning goal (128). The document also mapped the pain management core competencies with the Association of American Medical Colleges' Physician Competency Reference Set (128). The EIPCCG pain management core competencies have also been used as a framework for postgraduate continuing professional development for pain educators and clinicians (129).

A workgroup from the University of California was tasked to develop a set of core educational competencies to address pain, substance overuse disorder and safer opioid prescribing for adoption across the six medical schools in the academic health system (130). The final set of University of California pain and substance use disorder competencies was compiled in 2019 (130). Both medication management and nonpharmacological strategies to address pain and substance overuse disorder were included.

A curriculum audit of pain medicine education at medical schools in Australia and New Zealand showed that while 42% of medical schools had partially implemented the recommended IASP Curriculum Outline on Pain for Medicine, none had successfully achieved full integration of this comprehensive curriculum (121). Pain medicine curricula in Australia and New Zealand focused mainly on the neurophysiology, clinical assessment and biomedical treatment of pain, primarily using analgesics (131). A focused review of pain medicine education at medical schools internationally noted similar gaps in the breadth of core topics between the IASP-recommended pain medicine curricula and documented educational content (11–13, 15, 16, 131). These international surveys found that essential topics reflecting the biopsychosocial framework and multidisciplinary treatment of pain were underrepresented at most medical schools (132).

Medical students in Australia and New Zealand display gaps in proficiency in pain medicine knowledge, skills and attitudes, especially with regard to clinical pharmacology, understanding evidence-based pain management options for individual patients and concepts such as allodynia and central sensitisation (10, 133, 134). International studies have shown a similar lack of pain medicine competencies of medical students (135–138).

Pain medicine education needs to ensure that medical graduates are confident in their ability to respond to patients with pain, understand how the patient is experiencing pain, and recognise their own cultural and emotional response to pain (23, 139).

4. Dimension 3: teaching, learning and assessment

The third dimension of the curriculum framework considers the development of appropriate learning, teaching and assessment strategies that are necessary to ensure that medical practitioners of the future develop the required

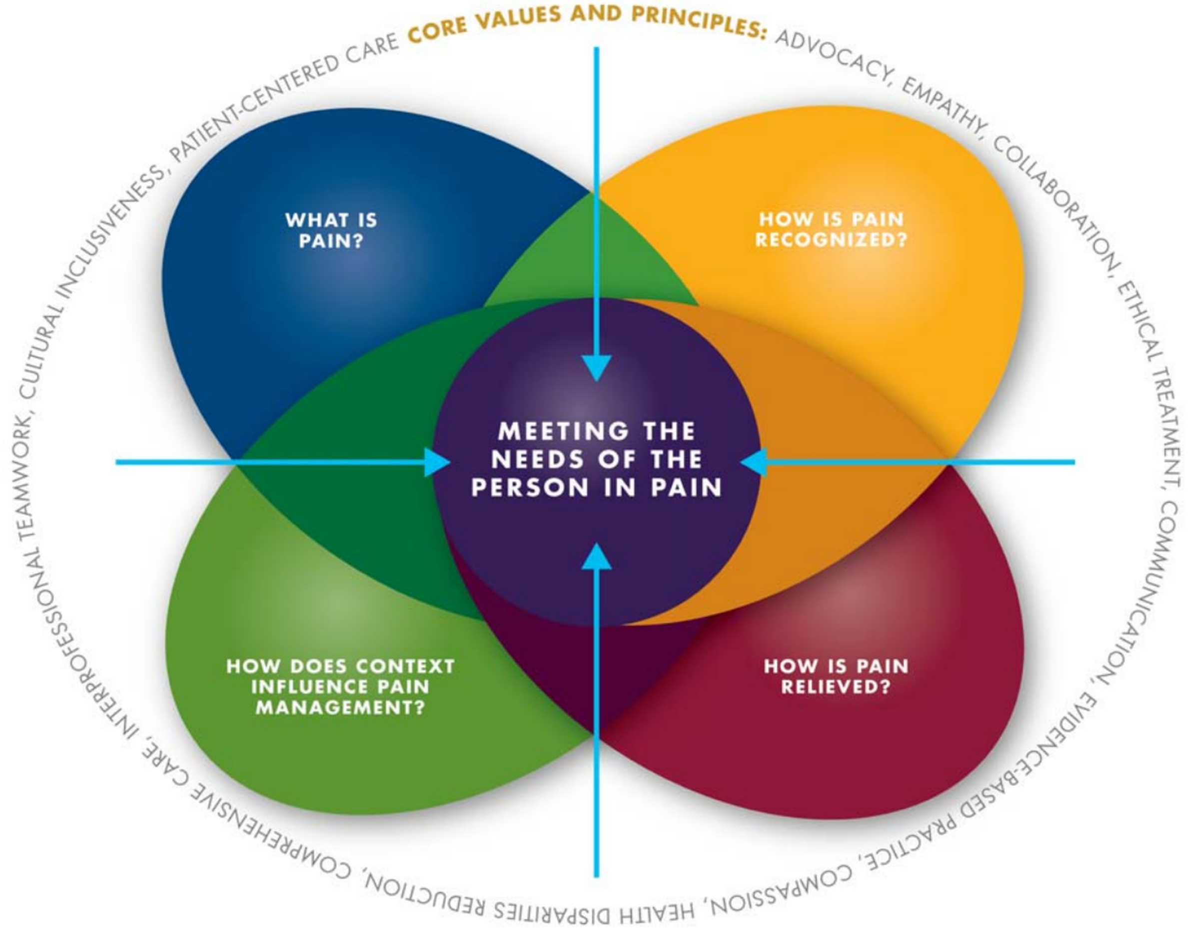


FIGURE 2
The core competencies for pain management (116). The core competencies are categorised within four domains. Core values and principles are embedded into all domains and competencies. Figure prepared by Ian Koebner, PhD, MS, and used with permission of Professor Scott Fishman, MD, Principal Investigator of the Expert Interprofessional Pain Competencies Consensus Group.

knowledge, skills and attitudes to treat the diverse needs of patients' experiencing pain.

4.1. The learning and teaching process

Pain management is complex and requires an understanding of the multidimensional aspects of the pain experience and its related management (121). Clearly defined objectives are important to connect learning activities and content with the pain medicine competencies doctors will require in clinical practice (29, 34, 132).

Traditional teaching methods such as lectures and seminars are commonly used for teaching the foundational concepts of pain management (basic sciences of pain processing and pharmacological therapy) to provide a well-structured base on which further knowledge is built (140, 141). More sophisticated strategies are likely to be required to provide opportunities for students to learn advanced competencies such as delivery of patient-centred pain management within the multiprofessional teams, empowerment of patients to self-manage their pain, explaining concepts such as central sensitisation to patients, and adapting pain assessment and management to the unique needs of special populations (2, 141). Formative OSCEs and structured clinical instruction modules have been used to improve pain medicine competencies of medical students (20, 142–146). Individual medical schools in the USA and Canada have developed dedicated pain modules using small-group discussions, expert-led sessions and patient interactions to improve students' clinical skills, attitudes and knowledge with regard to pain assessment and management (20, 23, 125). Case-based teaching and problem-based learning have also been used to develop the pain management skills necessary to apply knowledge in clinical situations (19–21, 125, 144, 145, 147–150). Expert pain medicine educators have stated that students are more likely to be engaged in pain education with student-centred learning and problem-based learning that includes the use of personal stories of pain (151).

The use of high- and low-fidelity simulation to provide students with a variety of real-life situational experiences (for example managing pain crises or challenging patient scenarios), and exposure to group interdisciplinary pain management planning can improve levels of critical thinking ability (125, 141, 152–156).

Pain provokes a strong negative response primarily on the person experiencing it directly, but can also impact primary caregivers and medical students (144, 157–160). Medical schools need to provide opportunities for students that will encourage positive emotional development and resilience relevant to pain care in conjunction with clinical pain medicine knowledge (161). Effective pain management requires medical practitioners demonstrate empathy, foster productive communication and nurture positive relationships (162). Role playing, motivational interviewing training, communication skills training and improved observational skills training are educational tools that have been recommended to help build empathy (163). Teaching methods such as writing a brief pain narrative, describing pain depicted in a fine-art image, and assessing personal responses to the experience of pain have improved students' awareness of the affective dimensions of pain while fostering their emotional development (161). Journaling, discussion groups and structured reflection have also been used by an individual medical school with positive outcomes on pain competencies (161).

Exposing students to different clinical learning opportunities, such as multidisciplinary pain clinics, general practice clinics, hospital and home visits, helps students understand pain management in the context of varied patient populations, settings and care teams (2, 18, 29, 141, 142). This exposure is important so that students see the continuum of pain care and the impact of pain on patients outside the hospital setting (29, 142).

However, careful selection of clinical placement is important as there is the potential for medical students to be taught by clinicians have not been adequately trained in pain medicine, and therefore providing suboptimal pain treatment and demonstrating negative attitudes towards their patients in pain (8, 164, 165). The challenge is to ensure that medical students are exposed to meaningful clinical learning opportunities in pain medicine.

Web-based pain medicine resources are being developed (19, 142, 147, 148, 166). These modules have been useful for improving medical students' pain competencies in acute, cancer, paediatric, chronic non-cancer and chronic low back pain. The e-learning resources were recommended because they provided resources to simulate authentic real-world contexts and had the potential to facilitate learning face to face or in remote settings (166). Increased use and sharing of online pain medicine education resources could potentially address the staff and learning resource deficit that has been identified (167–170). These e-resources need to be cost-effective and updated regularly.

There is no gold standard for delivering pain medicine education and each medical school would need to determine which model is most suitable for their local context. Pain education could be sequenced from more foundational concepts at the beginning of the medical course to more advanced curricula towards the final years of the course, with required competencies attained at different stages. "Flipping the pain curriculum" has been suggested, so instead of the standard approach of beginning with and emphasising pathophysiological pain processes, students would be initially exposed to the epidemiology of pain and disability, as well as the social and psychological aspects of pain in society, and then move to the more detailed biomedical aspects of pain management (171).

A flexible modular approach integrated over the entire medical curriculum may be the best way to structure the pain curricula for some universities, with pain medicine a common theme throughout the curriculum and different specialities plus a dedicated pain medicine rotation (12, 18, 154). Pain medicine education needs to be systematically integrated into all disciplines since pain is ubiquitous in clinical settings. A curriculum map might be useful to sequence pain curricula and improve cohesion of the pain medicine teaching throughout the medical training programme (172).

4.2. Assessment

Pain medicine competencies need to be assessed for formative and summative purposes to encourage learning, to enhance the importance of pain medicine education, to identify education gaps in the curriculum with respect to pain medicine and to ensure that new graduates are competent and safe to enter the workforce (173, 174).

The Pain Medicine Assessment Framework (PMAF) has been recommended to encourage a systematic approach to the task of assessing medical students' pain medicine competencies (121, 175). This framework emphasises the core pain medicine competencies recommended for pre-licensure health professionals by the EIPCCG (2) as well as the IASP Curriculum Outline on Pain for Medicine (121).

Assessments need to focus not only on pain medicine knowledge but also on clinical skills and attitudes. Written assessments such as multiple choice questions are reliable and practical to assess cognitive pain medicine knowledge and higher order thinking (such as applying knowledge to clinical situations) (173, 176–178). The OSCE assessment has been used effectively to assess medical students' pain competencies such as clinical knowledge, communication, empathy and attitude in a variety of contexts (acute, low back and cancer pain) (20, 145, 147, 179, 180). Progressive medical schools have developed alternative assessment methods (such as reflective journals, vignettes and portfolios) and multifaceted assessment processes to measure multiple domains of competence in clinical pain medicine practice (23, 125, 148, 173).

Internationally, pain medicine learning is likely to be assessed using written examinations, if undertaken at all (11, 173). OSCEs and practical assessments for pain medicine are used by very few medical schools internationally; and by less than 10% of medical schools in Europe (14, 16, 131, 181). There is no national licensing examination in Australian and New Zealand, so medical schools need to develop their own assessment processes to ensure that graduates possess the range of pain medicine competencies to meet the complex needs of people in pain (30, 131).

4.3. Interprofessional education (IPE)

Pain assessment and management provide an excellent model of interprofessional teaching and learning because of the multidimensional nature of pain (182). IPE is not fully integrated into the medical curriculum in Australia and New Zealand, and often exists as diverse discreet standalone programmes at individual universities (27, 183–186).

IPE has been shown to be effective for improving medical students' pain competencies in a variety of settings, including general pain management, paediatric pain and acute pain (125, 146, 187, 188). The interfaculty pain curriculum at the University of Toronto, Canada, includes interprofessional small-group sessions focused on developing assessment skills and management plans for patients using standardised patients (21). The e-learning Pain Education Interprofessional Resource also delivered at the University of Toronto has been shown to improve health professional students' pain knowledge and understanding of collaborative care (166). Medical schools need to build interprofessional teaching and learning opportunities into the medical curriculum to reinforce the importance of health professionals working together to effectively manage pain (187).

5. Dimension 4: supporting institutional delivery of pain medicine education

The last dimension of the curriculum framework is concerned with the influence of local university context on pain medicine education including the diverse strategic vision of medical schools, access to pain medicine resources and clinical teaching opportunities, and research funding. This involves the historical, political, social and organisational values of the educational institution, which will have a significant impact on curriculum design (34).

5.1. Value systems of individual education institutions: prioritising pain medicine

Pain medicine is a relatively new healthcare field, but is rapidly evolving (63). In particular, the understanding of transition from acute to chronic pain, and translation of promising scientific advances into effective diagnostic, preventative and therapeutic strategies for patients have dramatically improved in the past three decades (189, 190). Identification of peripheral and central nociceptive processes, discovery of endogenous neurochemicals and recognition of the role of the immune system in the maintenance of pain have furthered the understanding of pain mechanisms, diagnosis and treatment (132). Internationally, there is a continuing gap between what is known about pain medicine and the translation of this into clinical practice (62, 190). In general, despite robust evidence for a biopsychosocial model of pain, many medical practitioners continue to focus on a purely biomedical approach to pain (191). Pain is often seen as a symptom of a disease and therefore given a low priority by medical practitioners (9). Pain medicine education needs to be prioritised by medical schools to ensure that future medical practitioners are able to effectively and safely manage pain. This will require concerted collaborative effort and advocacy to ensure that greater time and resources are allocated to pain teaching.

Raising the value of pain medicine education necessitates increased profile of pain medicine in the curriculum and the recognition of pain medicine as an independent discipline rather than the domain of subspecialty training. The discipline of pain medicine was recognised in Australia as a medical specialty in its own right in 2005, and was accredited as a scope of practice in New Zealand in 2012 (192). Currently, the University of Notre Dame Australia has the Churack Chair of Chronic Pain Education and Research, and the University of Sydney has a chair in pain medicine. There is no chair in pain medicine in New Zealand.

To support the development of pain medicine curricula at medical schools in Australia and New Zealand, the FPM ANZCA offers an annual prize to the best medical student in pain medicine at each medical school. Most medical schools do not make use of this opportunity to raise the profile of pain medicine (193).

Each medical school has a set of norms and values that underpin its curriculum (194). Explicit values can be apparent in the formal curricula, such as course content, hours, requirements and evaluation. In Australia and New Zealand, there appears to be a lack of dedicated pain medicine modules, minimal learning time and little evaluation of pain medicine competencies as a requirement for graduation (131). The medical curriculum has been described as overcrowded with multiple competing priorities, so it may be difficult to find space for a new pain medicine programme in an already compacted course (195, 196).

Important learning also occurs *via* opportunistic teaching during clinical ward rounds (the informal curricula). Students learn by example from interactions with their teachers, also termed the hidden curriculum. This hidden curriculum pertains to what is tacitly acquired by example during training as opposed to the formally explicit teaching that the medical school intends to deliver (197). Lack of teaching or clinical exposure on a topic also portrays a value judgement (null curricula) (29). The null curriculum of pain medicine would be the absence of teaching regarding the management and assessment of patients experiencing pain from the formal curriculum (29). The imbalance of topics at medical schools has been attributed to a failure to recognise the prevalence of patients' experiencing pain in most primary care practices and indeed in most specialities (18).

Students continue to learn from senior medical practitioners who have not been adequately trained in evidence-based pain management (9). For example, medical professionals consistently tend to underestimate pain and the suffering of their patients, and this tendency is more pronounced when the patient reports severe pain and depression (198, 199). This has affected medical students' capacity to trust their patients' accounts of their pain (165). The hidden curriculum has been mentioned in the context of medical school pain education, where students stated that pain was viewed as a nuisance rather than an important symptom and disease in its own right (164). Medical students have also described a hidden curriculum that suggests that chronic pain patients lack educational value and are too difficult to treat (165). Students indicated that since their training primarily emphasised objective measurements, diagnosis and curative treatment, they were unprepared to deal with the "subjectivity" of pain and inability to cure chronic pain (165).

Culture is a powerful force in shaping beliefs and behaviours about pain (200). In New Zealand, one model for understanding Māori health is the concept of te whare tapa whā – the four cornerstones (or sides) of Hauora Māori. In a traditional Māori approach, the inclusion of wairua (the spiritual dimension), the role of the whānau (family) and the balance of hinengaro (mind) are as important as the physical manifestations of illness (taha tinana).

Medical students need to be made aware of their own biases and prejudices towards patients with pain (164). For instance, recent research in New Zealand has highlighted that Māori adults who experience chronic pain are not being offered holistic explanations about the causes of their pain, and are instead being prescribed analgesics at the expense of best practice treatments (201). It is imperative that medical schools address cross-cultural pain education to ensure issues such as conflicting perceptions regarding pain expression and disparities (in assessment, analgesic requirements and treatment) (200).

5.2. Staff resources

The literature supports the concept that pain medicine education is best provided by specialists (medical and allied) trained in pain medicine (62, 202). Lack of qualifications of teaching staff at medical schools to provide pain medicine education has been highlighted internationally (62, 203). There is a lack of qualified SPMPs in Australia and New Zealand, particularly in the rural setting (43, 44). Medical schools in Australia and New Zealand spread students over a number of training centres, including rural sites (204). A lack of allied health professionals and general practitioners with professional training in pain management in rural districts has also been identified (205, 206). For students to effectively work in partnership with other health professionals when treating people with complex pain presentations, they need to understand and value other health professionals' roles and expertise (116).

Medical schools need to commit to building a team of medical and allied health pain specialists who are equipped with the skills and teaching resources required to deliver comprehensive pain medicine curricula. It is also clear that continuing professional development for medical practitioners who oversee clinical learning opportunities would be useful to ensure that medical students are provided with consistent evidence-based pain medicine teaching throughout their medical training.

5.3. Locally adapted learning and teaching resources

Changes to the curriculum require much planning and financial investment, which may be prohibitive because of a lack of resources. Calls by specialist colleges (such as the FPM ANZCA) for changes to the curriculum to include more pain content may be ignored due to a lack of support and resources offered by these bodies (87, 154). The need for more research and development of pain education resources has been identified previously (89, 207). A systematic review of online pain resources for health professionals found that those available were helpful in improving learner knowledge and skills (207), however more support is needed for the development and distribution of pain medicine teaching resources to medical schools across Australia and New Zealand.

Curriculum designers will need to adapt these pain curricula to suit the needs of the local community they serve. For instance, in New Zealand, Māori have a pedagogical concept of "Ako" that acknowledges the way that new knowledge grows out of shared learning experiences; recognizing the knowledge that both teachers and learners bring to the learning environment (208). It affirms the value of building caring and inclusive learning communities. Studies have shown the need for culturally responsive pain management resources for people with persistent pain in New Zealand (201, 209). The pain medicine curriculum would need to be flexible in design for it to be incorporated into the diverse landscape of medical education in Australia and New Zealand.

5.4. Local networking

Pain specialists in the UK have advocated for local clinical and educational champions for pain education to build strong alliances with deans of medical schools and non-specialists in pain in their local schools to facilitate the incorporation of pain education into the curricula (7, 210). Medical schools would benefit from identifying a local pain champion to drive integration of pain medicine education into the medical curriculum.

6. Conclusion

Change is needed in the way pain medicine is taught at medical schools across Australia and New Zealand. It is crucial that a more formalised approach to the development and delivery of a comprehensive pain medicine curriculum is provided during pre-licensure training to ensure that graduates are adequately prepared for their future workplace responsibilities.

The Pain Medicine Curriculum Framework for improving pain medicine education presented in this paper will assist curriculum designers in Australia and New Zealand, and internationally, in the ongoing process of ensuring that medical graduates meet the professional and ethical challenges that arise in caring for those in pain.

Author contributions

These authors contributed equally to this work. All authors contributed to the article and approved the submitted version.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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A qualitative study to explore the acceptability and feasibility of implementing person-focused evidence-based pain education concepts in pre-registration physiotherapy training

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Objectives: The purpose of this study was to engage with physiotherapy clinicians, academics, physiotherapy students and patients to explore the acceptability, feasibility, and practical considerations of implementing person-focused evidence-based pain education concepts, identified from our previous research, in pre-registration physiotherapy training.

Design: This qualitative study took a person-focused approach to ground pain education in the perspectives and experiences of people who deliver and use it. Data was collected *via* focus groups and in-depth semi-structured interviews. Data was analysed using the seven stage Framework approach.

Setting: Focus groups and interviews were conducted either face to face, *via* video conferencing or *via* telephone. This depended on geographical location, participant preference, and towards the end of data collection the limitations on in-person contact due to the Covid-19 pandemic.

Participants: UK based physiotherapy clinicians, physiotherapy students, academics and patients living with pain were purposively sampled and invited to take part.

Results: Five focus groups and six semi-structured interviews were conducted with twenty-nine participants. Four key dimensions evolved from the dataset that encapsulate concepts underpinning the acceptability and feasibility of implementing pain education in pre-registration physiotherapy training. These are (1) make pain education authentic to reflect diverse, *real* patient scenarios, (2) demonstrate the value that pain education adds, (3) be creative by engaging students with content that requires active participation, (4) openly discuss the challenges and embrace scope of practice.

Conclusions: These key dimensions shift the focus of pain education towards practically engaging content that reflects people experiencing pain from diverse sociocultural backgrounds. This study highlights the need for creativity in curriculum design and the importance of preparing graduates for the challenges that they will face in clinical practice.

KEYWORDS

pain education, pain, physical therapy, physiotherapy, interprofessional and communication skills, person centered

Introduction

Chronic pain impacts negatively on the lives of individuals and causes a burden on health and social care systems globally. Estimates of the prevalence of chronic pain suggest that over 40% of adults experience pain on a daily basis and that over 10% of adults find this pain debilitating (1–3). Often, people experiencing pain seek support from physiotherapists who require an understanding of the multi-dimensional nature of pain and a broad skill set to manage the variety of pain conditions presenting in clinic. The foundation of knowledge and skill acquisition about pain is established in pre-registration training.

Pain education in pre-registration training is variable and, in some cases, inadequate (4–7). Historically, pain education has focused on biomedical concepts rather than practical skills (8), referred to by the International Association for the Study of Pain (IASP) as the "theory-practice gap" (9). Guidance documents for pain education of health care professionals have been published to address this theory-practice gap including core competencies (10), pain curricula (11), and practical guides for pain education (12), and these documents have been used to inform the design of pre-registration training. However, the complexities of implementing pain education in pre-registration training requires more investigation.

Previously, we evaluated pain education through a complex intervention lens by synthesising information about pain education contained in published research, policy, curricula, competencies, frameworks and the views of people experiencing pain (8, 13). Concepts emerged in relation to the context, content, delivery, and outcome of pain education as summarised in **Table 1**. The acceptability and feasibility of implementing pain education aligned to these concepts is unknown. Therefore, the purpose of the present study was to engage with key stakeholders (i.e., physiotherapy clinicians and academics, physiotherapy students and patients) to explore their views about the acceptability, feasibility, and practical considerations of implementing these concepts, identified by our previous research, in pre-registration physiotherapy training. It was decided that engaging stakeholders using qualitative methods would add personal and contextual experiences about the lived experience of pain, pain management, and pain education, that would inform the development of authentic educational strategies that reflected the clinical environment.

Materials and methods

Design

This qualitative study took a pragmatic person-focused approach to ground pain education in the perspectives and experiences of people who deliver and use it (14). Focus groups and semi-structured interviews were conducted using Framework analysis (15). The conduct of the study was guided by the COnsolidated criteria for REporting Qualitative research (COREQ) (16).

Sampling strategy

Physiotherapy clinicians, physiotherapy students, physiotherapy academics and patients living with pain were purposively sampled and invited to take part in a focus group discussion or an in-depth semi-structured interview.

A strategic and targeted approach was taken by inviting clinicians and academics active in the field of pain education.

TABLE 1 Person-focused evidence-based pain education concepts.

Context	Content
Concepts • Provide context by introducing students to patients' needs when experiencing pain • Map learning activities to patients needs **Example** Patients' needs are complex when experiencing pain. Patients' needs include: – "To feel listened to and believed" – "A reciprocal consultation" – "To understand the meaning of pain" – "To understand the mind-body link" – "Accessible and realistic pain management" – "Hope and direction from a professional"	**Concepts** • Develop pain management skills • Underpin with contemporary pain science • Learn to assess and challenge [own and others] attitudes and beliefs about pain **Example** – Develop active listening & communication skills – Practice explaining pain – Practice difficult conversations around the origins and meaning of pain – Learn to co-create goals, outcomes and management plans – Learn to teach, motivate, coach and give feedback – Embed IASP core curricula
Delivery	**Outcome**
Concepts • Include all stakeholders in pain education delivery • Move delivery away from theoretical towards practically engaging activities **Example** – Practice pain assessment and management with patients/actors – Use technology e.g., virtual reality to experience 'real' scenarios – Include current clinical expertise to provide case studies and scenarios – Engage final year students in first year education – Learn in multi-disciplinary groups	**Concepts** • Evaluate confidence and competence in pain assessment and pain management using a competency-based approach • Demonstrate & evaluate the impact of learning relative to patients needs **Example** – Introduce pain education competencies & outcomes (e.g., IASP endorsed competencies/PPA framework) to evaluate the impact of pain education – Include patients and clinicians in evaluating the outcome and impact of learning – Map learning outcomes to clinical placements including patient outcomes

IASP, International Assocition for the Study of Pain.

Patients were approached *via* gatekeepers of existing service user and carer groups, pain charities, pain support groups and social media. Physiotherapy students enrolled on a UK pre-registration physiotherapy programme and who had completed at least 3 clinical placements were approached *via* gatekeepers (course leaders/course directors) of their respective programmes of study (courses). The study was also advertised *via* professional networks, university networks social media and pain charities. A snowball effect occurred where the advert was forwarded and shared with those who may meet the eligibility criteria. Volunteers contacted the principal investigator (KT), were provided with a participant information sheet, and were invited to a study visit where informed consent to participate was gained.

Data collection

Focus groups and interviews were conducted by one author (KT) either face to face, *via* video conferencing or *via* telephone. This depended on geographical location, participant preference, and towards the end of data collection the limitations on in-person contact due to the Covid-19 pandemic. Focus groups and interviews were recorded and transcribed verbatim. Transcripts were uploaded and analysed in NVivo (17). Field notes were taken where possible e.g., tone of voice, gesturing, animated response to questions. In the focus groups and interviews, participants were presented with person-focused evidence-based pain education concepts identified by our previous research (8, 13). Participants were asked about

- their experiences, attitudes and beliefs about pain education
- their views and opinions about the acceptability (including appropriateness, suitability, likes and dislikes) of our person-focused evidence-based pain education concepts
- their views on the feasibility (including strengths, opportunities, barriers, challenges, and limitations) of implementing our person-focused evidence-based pain education concepts in preregistration physiotherapy training

The goal was to conduct 6–9 focus groups or equivalent interviews, or until there was evidence of data saturation.

Pilot

Concepts for pain education, identified by our previous research, were printed and presented in-person to a pilot group that included a physiotherapy clinician, physiotherapy academic, person with experience of pain and physiotherapy student prior to data collection. The purpose of this pilot group was to explore how best to present our person-focused evidence-based pain education concepts to study participants with diverse experiences and health literacy. KT facilitated discussions about the nature of the key concepts, potential questions and structure for the focus groups and interviews, and the format to present the key concepts. No major concerns were raised by participants during the pilot and only minor amendments were made to the language and content of documents and to the timing of the interview schedule to maximise discussion and debate.

The final format of delivery of the concepts used in the focus groups and interviews is provided in **Table 1**. **Supplementary File S1** provides the semi-structured interview guide.

Data analysis

Data was analysed using the seven stage Framework approach (15, 18) which included: transcription, familiarisation, labelling, indexing, sorting, charting data and abstracting key dimensions. Data was analysed using both inductive and deductive themes. Deductively, we specifically wanted to gather views about the acceptability of the concepts that participants were presented with, (including appropriateness, suitability, likes and dislikes) Data was labelled deductively as “likes” or “dislikes”. We also wanted to gather their views about the feasibility (practicalities) of implementing the concepts in preregistration pain education. Data was labelled deductively as “strengths and opportunities” and “barriers and limitations”. Data that did not fit into a pre-existing theme was labelled inductively. Data analysis was managed using NVivo (17).

To add rigour and to mitigate the perspective of one researcher dominating, two researchers (KT & JD) independently labelled three transcripts, one from each stakeholder group. The labels were discussed to construct an initial thematic framework (set of labels) which were subsequently applied to all remaining transcripts. Data that did not fit within one of the existing labels was given a new inductive label until all data was indexed and sorted into themes.

Once all data had been labelled, one author (KT) wrote a precis descriptive summary for each theme. Data analysis went beyond description to explore key dimensions that underpinned the acceptability and feasibility of implementing our person-focused evidence-based pain education concepts in pre-registration physiotherapy training (18).

Results

Description of participants

Five focus groups and six semi-structured interviews were conducted with twenty-nine participants (seventeen females and twelve males). Two focus groups were conducted with physiotherapy students (four females and four males) and three focus groups conducted with a mixture of physiotherapy clinicians and physiotherapy academics (seven females and eight males). In addition, one female physiotherapy clinical academic was interviewed separately as they were unable to attend a focus group. Five one-to-one interviews were undertaken with patients (five females). It was not possible to achieve the original target to conduct six to nine focus groups with equivalent numbers of participants for one-to-one semi-structured interviews because recruitment had to be closed due to restrictions imposed by the outbreak of Covid-19. Nevertheless, we exceeded minimal threshold for recruitment and data saturation was evident.

The purposeful approach to recruitment resulted in a sample of participants with diverse experiences ensuring "equal voice" across stakeholder groups. All patients had experienced physiotherapy for musculoskeletal pain. Pain duration ranged from 1 year to over 40 years. All physiotherapy students had completed at least three clinical placements with experience of assessing and supporting people living with pain. Clinicians and clinical academics had diverse experiences and included full time clinical NHS and private sector roles, mixed practitioner/educator roles, professional advisors, specialists in pain management, and academics working at different levels, including early career to senior academics.

Framework analysis

We interrogated the data transcripts within and across the different stakeholder groups. Four key themes emerged which are articulated as "key dimensions". This is in keeping with Framework methodology as the final output of the analysis of the whole dataset (18). In Framework methodology, the purpose of displaying the qualitative data in a matrix is to summarise, display and organise the data. A "key dimension" was interpreted to be "key" if it captured data about the acceptability and feasibility of implementing the pain education concepts across all stakeholder groups (18, 19). An example of data analysis is provided in **Supplementary File S2**. A description of each of the abstracted key dimensions are presented below.

DIMENSION 1: Make pain education authentic to reflect diverse, *real* patient scenarios

Participants frequently talked about the importance of pain education being "real" to ensure education incorporates patient scenarios that reflect diverse clinical practice. Encapsulating authenticity, it was important to participants that students engage in content that provides a window into the real lives of people who are experiencing pain.

> *[X] I think there's nothing like practice and there's nothing like having real people, in other words, real patients talking. [PARTICIPANT 27: PATIENT]*

> *[X] I really do think the value of getting people with lived experience of pain to talk about what's going on, I think that's what they would value, what the people with the lived experience have valued and would value. [PARTICIPANT 21: PHYSIOTHERAPIST]*

Reflecting on their own experiences, participants liked the fact that many of the concepts emphasised activities that were grounded in "real life", believing that this would facilitate the development of skills needed for clinical practice.

> *[X] I think it's important from an empathy perspective, to try and bring in the patient as much as possible. So I think if you can bring in patients or if you can have patient voice in videos etc., that definitely helps. [PARTICIPANT 26: PATIENT]*

This included using virtual or simulated patients as a tool for students to be immersed in clinical scenarios.

> *[X] I think there's lots of good things there and I'm just looking at simulated patients and practicing and real scenarios—those kind of things I think are really important. [PARTICIPANT 24: PATIENT]*

Participants offered suggestions of how pain education tools that reflect patients' lives could be developed and implemented to improve the skills of student physiotherapists. Participants wanted students to appreciate the wide-ranging impact that pain has on individuals' lives by learning to actively listen to a person's narrative and to actively seek a full understanding of a patient's experiences.

> *[X] I think that idea of 'patient's story' is really important, to adapt to it as well as just listening. I think the needs are there, I think they're all fine, but I think also about, the patient's actual full narrative that goes along with that. [PARTICIPANT 21: PHYSIOTHERAPIST]*

Participants believed that it was imperative to embed "real life" clinical scenarios early in pre-registration training to develop and practice conversational skills to support a *person* experiencing pain.

> *[X] I like the practical element of it. The more interactive work the better, the more time they [physiotherapy students] go away and engage with the materials themselves, actively, the better. [PARTICIPANT 17: PHYSIOTHERAPIST]*

> *[X] The other bits on the practice [are] difficult conversations and goal setting, I think are imperative. Practicing that difficult conversation has got to start early, definitely. [PARTICIPANT 16: PHYSIOTHERAPIST]*

> *[X] I think the more practice people [physiotherapy students] get of verbalising these very complex explanations, sometimes complex biology, complex psychology, complex sociology, that the easier it becomes for people, so that practical approach is very important. [PARTICIPANT 26: PATIENT]*

DIMENSION 2: Demonstrate the value that pain education adds

This dimension reflects data about the *value* that pain education adds to pre-registration training, that was not always necessarily explicit or overt. For instance, participants believed that embedding person-focused pain education has the potential to add value by facilitating and engaging students in wider conversations about individuals and society, to develop holistic health professionals who appreciate diverse sociocultural factors in health and wellbeing. In this respect, one participant described this approach to pain education as the perfect "starter topic" to physiotherapy training.

> *[X] I actually think that pain is sort of probably a really good vehicle to incorporate straight away. Hit them with it early as a real vehicle to see people as that, as thinking, feeling beings that exist in a real life world.. I think it's a really good springboard to the rest of their training [PARTICIPANT 14: PHYSIOTHERAPIST]*

Participants reflected on their own experiences of pain education discussing the added value that they perceived to have got from their training.

> *[X] We just used to meet for coffee first thing, we did nothing else, we just used to discuss where we'd seen aspects of pain in society and life in the papers, on the news, in all sorts of media and that used to generate fantastic discussion. [PARTICIPANT 12: PHYSIOTHERAPIST]*

> *[X] Chronic pain is associated with a whole host of other lifestyle and health and wellbeing factors, so part of a health and wellbeing module, where we talk about exercise and nutrition and other lifestyle factors. [PARTICIPANT 2: PHYSIOTHERAPY STUDENT]*

Participants reflected on the value of developing skills to be able to hold meaningful conversations with people, in considering differing levels of health literacy, language and conversation skills.

> *[X] I do think depending on the person that you deal with, some people are happy to have more information and to understand the processes and things of the pain, of why it operates and how it happens. I'm not saying that's right for everybody, but there will be that level of person that's important to understand why and how, which then gives them the sort of understanding to move forward with what they're trying to do. [PARTICIPANT 22: PATIENT]*

> *[X] Someone mentioned before about the context of society and culture, you know, it's completely embedded within that and embodies within the person and I think that, when you can get the student to appreciate that and some general principles and to understand themselves and to look after themselves and where they're coming from, their own biases, it is a start point [PARTICIPANT 11: PHYSIOTHERAPIST]*

DIMENSION 3: Be creative—engage students with content that requires active participation

This key dimension was abstracted from detected data about creating learning activities that students find interactive, engaging and memorable. Data analysis revealed significant coverage of discussions relating to the use of simulation in pain education. Physiotherapy students discussed that the use of simulation could create "safe spaces" to practice pain assessment and pain management prior to patient-facing clinical placements.

> *[X] I really like this bit.. using patients/actors, because in our neuro modules we had somebody come in and talking about their stroke experience and it was really nice to just listen to somebody, when you're not being assessed or you're not having to ask the questions but just listening to their story [PARTICIPANT 3: STUDENT]*

Participants reported that simulation gave them the opportunity to interact and experience some of the feelings that occur in real patient scenarios.

> *[X] But that whole situation when you're in there, it's quite, oh, like is this person actually, do I actually need to do stuff with them, because they are really good, they just put you in that mind frame [PARTICIPANT 2: STUDENT]*

Participants believed that the use of technology would be positive for pain education because it aligns with students' worlds and has the potential to make learning about pain more engaging and exciting.

> *[X] The support some of those other emerging technologies can give us in this sort of type of teaching and approach to people I think is really exciting. That's what they [students] interact with all the time, you know, electronic game sites being problem-based thinking when they're playing games. [PARTICIPANT 14: CLINICAL ACADEMIC]*

> *[X] I think [using technology] students will have a massive advantage going forwards, confidence wise, going forwards [PARTICIPANT 26: PATIENT]*

> *[X] I think if we can employ some of this technology, that sounds really exciting what you're talking about there. [PARTICIPANT 15: CLINICAL ACADEMIC]*

Participants reflected on their learning experiences, describing a dislike for the prospect of pain education being any more "theoretical" than they had experienced. Participants believed that theoretical understanding of pain science can be gained by independent directed learning and that a better use of face-to-face learning is to gain practical skills required to assess and support people in pain. Participants believed that curricula should foster active rather than passive learning, for instance, using approaches such as problem-based learning.

> *[X] Perhaps P.B.L. (problem based learning) was one of the best sort of vehicles, so very much that student engagement, course discipline learning, which actually really makes a massive impact [PARTICIPANT 14: CLINICAL ACADEMIC]*

> *[X] I think if we got more of a focus on those personable skills and those things in there that would help with how we communicate.. pain management has to come into it and just giving us the tools to be that all-rounded practitioner. [PARTICIPANT 2: STUDENT]*

There were mixed views on the prospect of actors or simulated patients to create authentic patient scenarios. Some participants believed that actors could never portray what it is like to really have chronic pain. Interestingly, participants reported that virtual patients could be viewed as more authentic than actors because virtual patients can be based upon and created from *real* patient scenarios and therefore would not be "acting".

> *[X] I just don't think that the responses you get from actors or simulated patients are anything like what you genuinely get. [PARTICIPANT 16: PHYSIOTHERAPIST]*

> *[X] I think I'd be a little reluctant to have actors and simulated patients, much more try and get video with patients and include that kind of assessment. [PARTICIPANT 18: CLINICAL EDUCATOR]*

> *[X] I think what you are doing looks to be some very good stuff. The only thing I'm not sure about is actors for the reasons I've already told you. Its acting—it's not what it's really like [PARTICIPANT 23: PATIENT]*

DIMENSION 4: Openly discuss the challenges and embrace scope of practice

This key dimension was abstracted from data about the challenges of implementing pain education in pre-registration physiotherapy training and in clinical practice. Participants identified barriers and threats to the delivery of pain education. Participants believed that some of the challenges include working alongside qualified physiotherapists who do not embrace contemporary pain management, lack of guidance from regulatory bodies and time constraints related to "business like" clinical models of care.

> *[X] I'm just conscious of the fact that they're (students) sort of plunged into departments with huge waiting lists and pressure to do everything in three appointments, and a lot of fairly mechanical, bio-medical outcome measures. You know what I mean? I'm just a bit concerned that, you know, you might end up with really rather unhappy people. [PARTICIPANT 21: PHYSIOTHERAPIST]*

There was a sense that for pre-registration pain education to succeed, some areas of clinical practice needed to be challenged. For example, when participants reflected on current physiotherapy services or physiotherapy attitudes that were perceived to negatively impact students' learning.

> *[X] I've been with some educators and qualified physios and they've not followed this kind of concept of pain management. They dismissed it and then obviously you [the student] is following, to a degree, this qualified physiotherapist's actions [PARTICIPANT 6: PHYSIOTHERAPY STUDENT]*

> *[X] I think it's a culture thing [physiotherapy profession culture]. If it's only becoming a thing now, then the people who are educating us [placement educators] wouldn't have had this education. [PARTICIPANT 7: PHYSIOTHERAPY STUDENT]*

Participants perceived a need to better prepare students for the challenges of modern clinical practice by raising awareness of professional culture and developing appropriate skills to cope with and challenge outdated views and clinical constraints.

> *[X] For me, the stumbling block is that it takes time for the things that are needed [for pain education]—to discuss things and to plan things and of course that's a great financial luxury, isn't it? [PARTICIPANT 24: PATIENT]*

> *[X] In MSK (musculoskeletal outpatients) we work in half hour appointments. It's not the best way of treating chronic pain patients, we need more time [with students] and resources [PARTICIPANT 8: PHYSIOTHERAPIST]*

Scope of practice was frequently mentioned by participants, often with contradictory views. Some participants believed that physiotherapists need to embrace their role in assessing and supporting people with psychological and social components of pain, whilst others felt this was beyond physiotherapists scope of practice and that physiotherapists should make better use of the multi-disciplinary team.

> *[X] It's much easier actually to put your hands on a patient and press it better or give them ten repetitions of X, Y or Z than it is to listen to somebody and the only other thing I would say is that I think the scope of practice comes in a bit. I mean I personally think that it is well within our scope of practice to do anything which is, talk about anything which is impacting the patients pain directly [PARTICIPANT 21: PHYSIOTHERAPIST]*

> *[X] I think you need to have quite clear pathways for additional support, particularly nowadays when people can start disclosing stuff which can be quite distressing and which obviously does take you then really outside of your scope of practice, particularly if you're a student or young clinician. We're not psychologists. [PARTICIPANT 21: PHYSIOTHERAPIST]*

Discussion

In this qualitative study we used Framework analysis to search for key dimensions that underpin the acceptability and feasibility of implementing our person focused pain education concepts in preregistration physiotherapy training. Four key dimensions emerged that encapsulate data across the stakeholder groups. We argue that to successfully embed person-focused evidence-based pain education in preregistration physiotherapy training, educators need to ensure that pain education:

(1) is *authentic* to reflect the diversity of real-life patient scenarios,
(2) explains the *value* that person-focused evidence-based pain education adds,
(3) is *creative* in design to engage students with content through active participation,
(4) *openly discusses* the challenges and embraces scope of practice.

Implementing these key dimensions within clinical and education settings will be discussed, relative to other literature, following an appraisal of the strengths and limitations of the study.

Strengths and limitations

This qualitative study had several strengths. The views and experiences of multiple stakeholders were sought giving equal voice to patients, physiotherapy students, clinicians and academics. Our recruitment strategy allowed participants to select their preferred method of data capture (i.e., focus group or one-to-one interview) and this promoted inclusivity so that the voice of people from diverse backgrounds and stakeholder groups was captured. Refinement of methodology following pilot focus groups ensured the robustness of interview technique and data collection and analysis. Transcripts were independently coded by two authors and agreement reached through discussions with the full authorship team.

The main limitation of the study was variations in data recording procedures. Field notes taken during in-person focus groups and interviews were more comprehensive and allowed observations of physical responses to questions than telephone interviews. Thus, there was more depth to the data collected from in-person sessions. All patient participants opted for a one-to-one interview over a focus group discussion. We do not know the reason for this, although we speculate that patients may have been reluctant to disclose personal thoughts and feelings in the presence of others. We did not directly invite health policy makers or health regulators and their inclusion may have added more breadth to the data analysis. Nevertheless, we did capture the views of participants who worked in advisory roles for national and international organisations such as the British Pain Society and the Health and Care Professions Council.

Implications for clinical and educational settings

In our key dimensions, we advocate implementing pain education that is authentic, that reflects diverse and real patient scenarios and that demonstrates its value. To successfully implement pain education that is guided by these key dimensions there is a requirement that educators recognise, include and respond to a range of dimensions of diversity that represent people from varied backgrounds with different experiences. For instance, ensuring that patient scenarios represent people with different experiences of healthcare, sociocultural values, socioeconomic determinants of health and belief systems about pain. This is important, to prepare graduates to work in health systems that are fit for purpose, particularly in the landscape of health inequalities in chronic pain (20). There is little published research to evaluate the impact and delivery of person-focussed pain education for pre-registration physiotherapy training. However, O'Shaughnessy and Tilki proposed a model for "cultural competence" for physiotherapists (21). The emphasis of the training was to enable staff to explore their own values, beliefs and ideas relative to cultural competence. There may be learning that can be applied to pain education in pre-registration training. Furthermore, information regarding wider socioeconomic determinants and disparities in chronic pain can be used to inform the development of authentic pain education materials that reflect diverse and real patient scenarios (20, 22, 23).

In our key dimensions we advocate engaging students with content that requires active participation. This requires consideration of operational logistics especially with known challenges such as limited time and space, and high demands to cover many topics in pre-registration curricula. Ensuring that students have had sufficient theoretical content to support the development of their practical skills is challenging. One solution could be the use of a "flipped classroom" which involves students engaging in preparatory theoretical content in advance of classroom-based learning. This prioritises classroom learning that focusses on skills development through authentic, valuable, creative, and interactive learning opportunities, such as patient scenarios, in which to apply theoretical concepts (24). There is a paucity of research to evaluate the use of a flipped classroom approach for pain education in pre-registration physiotherapy. However, Røe et al. (25) reported greater improvements in student outcomes following a flipped classroom approach for skills and knowledge of musculoskeletal physiotherapy compared with conventional teaching. Evaluations of flipped learning in medical education demonstrate increased motivation and engagement (26) and improvements in affective and soft skills (27). Limitations to flipped classrooms include not adequately preparing for in-classroom sessions, lack of access to tutors/ resources and students not working optimally in classroom activities (25, 28). These are important considerations when planning pain education content that requires active participation.

Finally, in our key dimensions we advocate openly discussing the challenges and embracing scope of physiotherapy practice in pre-registration pain education, to develop graduates who can positively influence and impact pain management, particularly in clinical services that may be practicing more biomedical approaches. However, we acknowledge that this is challenging, particularly for newly graduated physiotherapists, who would need the confidence and credibility to promote change. In the U.K., the Chartered Society of Physiotherapy have previously run a series of events and publications to raise the profile of leadership within the physiotherapy profession, arguing that leadership is as important for student and graduate physiotherapists as those in strategic and managerial positions (29). Incorporating and nurturing leadership skills early in physiotherapy training will help to equip students and graduates with the skills to discuss the challenges of pain management and physiotherapy scope of practice; and to advocate change towards more contemporary models of assessing, treating and caring for patients presenting with pain.

Future directions

There is a need to build an evidence base for pre-registration pain education, especially from the perspectives of people who experience pain. The four key dimensions emerging from our analysis of the views of stakeholders can be used to guide the design and implementation of person-focused evidence-based pain education curricula and materials. We recommend that any future pain educational materials aligned with these four key dimensions be shared with the wider pain education community so that their impact can be evaluated over several domains such as student learning, placement and patient outcomes. We advocate the use of qualitative, mixed methods or case study methodologies for such evaluations.

Conclusion

Our study engaged with various stakeholders, including patients, to explore the acceptability, feasibility and implementation of our person-focused evidence-based pain education concepts in pre-registration physiotherapy training. Emerging themes were to make pain education authentic and real-life, emphasising the value of the person not just the pain, and utilises creative and participatory learning opportunities that reveal the challenges and scope of clinical practice. In conclusion, we argue that the focus of pain education needs to shift towards the realities of clinical practice by creating content and learning opportunities that represent people experiencing various types of pain from diverse sociocultural backgrounds. This will involve creativity in curriculum design including, for example, use of flipped classroom contexts and simulated clinical scenarios using modern technologies. This will enable students to develop necessary skills and knowledge in safe learning environments so that they become confident and competent to embrace the challenges that they may face in clinical practice.

Data availability statement

The original contributions presented in the study are included in the article/**Supplementary Material**, further inquiries can be directed to the corresponding authors.

Ethics statement

The studies involving human participants were reviewed and approved by Leeds Beckett University Research Ethics Committee (Ref. no. 60811). The patients/participants provided their written informed consent to participate in this study.

Author contributions

KT, JM, MB and MJ made a substantial contribution to each stage of this qualitative study, from conception to completion. KT led the Framework data analysis with substantial input from JD, JM, MB and MJ. KT drafted the manuscript which JM, MB, JD and MJ subsequently contributed to, providing substantial input and approved the final version. All authors contributed to the article and approved the submitted version.

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Conflict of interest

In the previous 5 years, MIJ's employer has received income for expert consultancy activities from GSK, TENSCare, and LifeCare Ltd. that lie outside of the submitted work. MIJ declares book royalties from Oxford University Press. The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpain.2023.1162387/full#supplementary-material.

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Applying the behavioural change wheel to guide the implementation of a biopsychosocial approach to musculoskeletal pain care

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Achieving high value, biopsychosocial pain care can be complex, involving multiple stakeholders working synergistically to support the implementation of quality care. In order to empower healthcare professionals to assess, identify and analyse biopsychosocial factors contributing to musculoskeletal pain, and describe what changes are needed in the whole-of-system to navigate this complexity, we aimed to: (1) map established barriers and enablers influencing healthcare professionals' adoption of a biopsychosocial approach to musculoskeletal pain against behaviour change frameworks; and (2) identify behaviour change techniques to facilitate and support the adoption and improve pain education. A five-step process informed by the Behaviour Change Wheel (BCW) was undertaken: (i) from a recently published qualitative evidence synthesis, barriers and enablers were mapped onto the Capability Opportunity Motivation-Behaviour (COM-B) model and Theoretical Domains Framework (TDF) using "best fit" framework synthesis; (ii) relevant stakeholder groups involved in the whole-of-health were identified as audiences for potential interventions; (iii) possible intervention functions were considered based on the Affordability, Practicability, Effectiveness and Cost-effectiveness, Acceptability, Side-effects/safety, Equity criteria; (iv) a conceptual model was synthesised to understand the behavioural determinants underpinning biopsychosocial pain care; (v) behaviour change techniques (BCTs) to improve adoption were identified. Barriers and enablers mapped onto 5/6 components of the COM-B model and 12/15 domains on the TDF. Multi-stakeholder groups including healthcare professionals, educators, workplace managers, guideline developers and policymakers were identified as target audiences for behavioural interventions, specifically education, training, environmental restructuring, modelling and enablement. A framework was derived with six BCTs identified from the Behaviour Change Technique Taxonomy (version 1). Adoption of a biopsychosocial approach to musculoskeletal pain involves a complex set of behavioural determinants, relevant across multiple audiences, reflecting the

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Abbreviations

APEASE, affordability, practicability, effectiveness/cost-effectiveness, acceptability, side-effects/safety, equity; BCTs, behaviour change techniques; BCTTv1, behaviour change techniques taxonomy version 1; BCW, behavioural change wheel; BPS, biopsychosocial; COM-B, capability opportunity motivation-behaviour model; CPGs, clinical practice guidelines; DASS-21, depression, anxiety and stress scale; ePPOC, electronic persistent pain outcomes collaboration; GAPPA, global alliance of partners for pain advocacy; IASP, international association of the study of pain; ICF, international classification of functioning, disability and health; MBCTs, motivation and behaviour change techniques; ÖMPQ, örebro musculoskeletal pain questionnaire; SDH, social determinants of health; TaTT, theory and technique tool; TDF: theoretical domains framework.

importance of a whole-of-system approach to musculoskeletal health. We proposed a worked example on how to operationalise the framework and apply the BCTs. Evidence-informed strategies are recommended to empower healthcare professionals to assess, identify and analyse biopsychosocial factors, as well as targeted interventions relevant to various stakeholders. These strategies can help to strengthen a whole-of-system adoption of a biopsychosocial approach to pain care.

KEYWORDS

biopsychosocial, behaviour change techniques, behaviour change techniques taxonomy version 1, capability opportunity motivation-Behaviour, healthcare professionals, musculoskeletal pain, theoretical domains framework

Introduction

Engel's biopsychosocial model (1), has provided a blueprint for contemporary care of chronic pain disorders (2–10). However, there are significant challenges putting this model into clinical practice (11, 12). Pain is complex with multidimensional (biological, psychological and social) factors interacting to influence the lived experience (3, 13), often with multimorbidity (chronic lifestyle illnesses and mental health illnesses) (14). This complexity makes comprehending and caring for each individual's needs as a whole person challenging for healthcare professionals.

Against this background, we previously systematically reviewed evidence and generated insights on the barriers and enablers to the adoption of the biopsychosocial model in musculoskeletal pain, spanning the whole-of-health. Our recent qualitative review included 25 studies and the perspectives of 413 healthcare professionals (15). There are multiple factors influencing healthcare professionals' adoption of the biopsychosocial model. At the micro-level (clinical interface), healthcare professionals' knowledge and skills, personal factors, their misconceptions of clinical practice guidelines, perception of patients' factors, and time can influence adoption of a biopsychosocial approach. At the meso-level (health service provision), clinical practice guideline formulation, the availability and alignment of the clinical community, funding models, health service provision, resourcing, and workforce training issues may or may not adequately support the care. At the macro-level (health system), health policy, organizational, and social factors can significantly affect and shape how care for musculoskeletal disorders is delivered. Further evidence for challenges to adoption come from another review that included 12 qualitative studies and the views of 113 physiotherapists showing that despite the positive changes with education, physiotherapists lack confidence to implement biopsychosocial pain care (16). These findings are supported by the modest effect of educational meetings on changing clinical practice behaviours and clinical outcomes (17–21). Re-design of educational efforts to address the micro-level barriers might facilitate healthcare professionals in adopting the model in pain care, while also leveraging the meso- and macro-level enablers.

Using behavioural science frameworks to understand human behaviour may provide insights into *how* to drive translation efforts to support effective design of behavioural interventions that target relevant audiences involved in pain care (22). Inferring from Engel's original frame of reference of the Biopsychosocial Model (1), our specification of the target behaviour is: Healthcare professionals (who) assessing, identifying and analysing biopsychosocial factors contributing to musculoskeletal pain (what), using authentic communication upon patient interview within a strong therapeutic alliance and critical clinical reasoning (how, with whom), during consultation in clinical practice (when, where). We are also interested in what the critical stakeholder groups within healthcare services and systems (meso- and macro-level) can do, to assist healthcare professionals to achieve specified target behaviours.

The Behaviour Change Wheel (BCW) is derived from 19 frameworks of behaviour change, and is a systematic process used for designing behavioural interventions (23, 24). Broadly, the process covers understanding the behaviour, identifying intervention options, and identifying content and implementation options (23, 24). At the hub of the wheel is the Capability Opportunity Motivation-Behaviour (COM- B) model, surrounded by nine intervention functions and seven policy categories (24). The Theoretical Domains Framework (TDF) expands on the COM-B components and provides a more detailed understanding of the cognitive, affective, social and environmental influences on behaviour (25). The COM-B and TDF can be used to understand behaviour at the individual, community and organizational levels (23), i.e., allows us to analyse necessary conditions internal to individuals, and the social and physical environment to achieve a specified target behaviour (24). This is well-aligned to investigating what can empower healthcare professionals to assess, identify and analyse biopsychosocial factors at the clinical-level, what can support them at the health service and policy levels (across multi-levels) (26). It is also worth noting the COM-B model and TDF have been used in the implementation of evidence-based recommendations of musculoskeletal conditions (27–30). The hypothesized relationship between the COM-B model components and intervention functions in the BCW allows a precise analysis of how to make the selection of interventions and policies (24), after which can then be linked to specific behaviour change techniques (BCTs) (24, 31). The BCW offered a comprehensive and solid theoretical foundation for the synthesis.

Thus, the aims of this study are:

(i) to map established barriers and enablers influencing healthcare professionals' adoption of a biopsychosocial approach to musculoskeletal pain (15) using theoretical frameworks of behaviour change (23–25, 27, 31), and in the process, identify the behavioural determinants that can support the adoption,

(ii) formulate a novel conceptual model (using concepts from the COM-B model and TDF) to outline the behavioural determinants, as an overview to a whole-of-health perspective to healthcare professionals' adoption of the biopsychosocial model, and

(iii) derive a framework of BCTs that characterise how various stakeholder groups can help improve current pain education training efforts to support healthcare professionals' adoption of biopsychosocial musculoskeletal pain care.

Methods

We adopted a five-step process informed by the BCW (23, 24) (**Figure 1**) to synthesize the 46 subthemes and 14 main themes derived from our systematic review of the barriers and enablers influencing healthcare professionals' adoption of a biopsychosocial approach to musculoskeletal pain (15). These subthemes and main themes were therefore our data set used to apply the behavioural analysis. In each step, when discussion was necessary, iterative consensus was used to reach agreement within the research team (32). The characteristics and reflexivity of the research team members are described in **Table 1**. The team adopted our epistemological position as constructivist (33). Overall, the team has expertise that cuts across the micro-, meso- and macro-levels of healthcare, and proficiency with the biopsychosocial model, musculoskeletal pain, and the BCW process. Please note that all definitions and detailed description of terminologies related to the BCW are provided in the **Supplementary Tables S1–S4**.

We utilised a "best fit" framework synthesis (34–36) approach to analyse and develop new insights on the behavioural determinants to the adoption of biopsychosocial musculoskeletal pain care (hereafter, referred to as "adoption"). Framework synthesis offered a theory-based synthesis method, and utility and value have already been demonstrated in areas of healthcare with policy relevance (35). This approach allowed the application of a primarily deductive approach (34, 36) to the data, yet also permitted inductive revision and supplementation of the "a priori" theory (35). The components of the COM-B model, "capability", "opportunity", "motivation" and "behaviour", and the 14 domains of the TDF (23), formed the "a priori" framework for the synthesis. The approach enabled us to further interrogate from a behavioural perspective, previously established themes from our qualitative review and identify gaps in the knowledge. The definition of each COM-B component and TDF domain (**Supplementary Material**) were provided to research team members to facilitate consistent interpretation and mapping of the data to the framework. The following steps demonstrate our phased methodologic approach:

Step 1 Mapping previously derived subthemes to the COM-B model and TDF

Three team members (WN, DB, DG) were provided with a Microsoft Excel spreadsheet consisting of the 46 subthemes drawn from our previous qualitative synthesis (15). They independently mapped these subthemes against the COM-B model and TDF. Conflicts or discrepancy in the mapping results

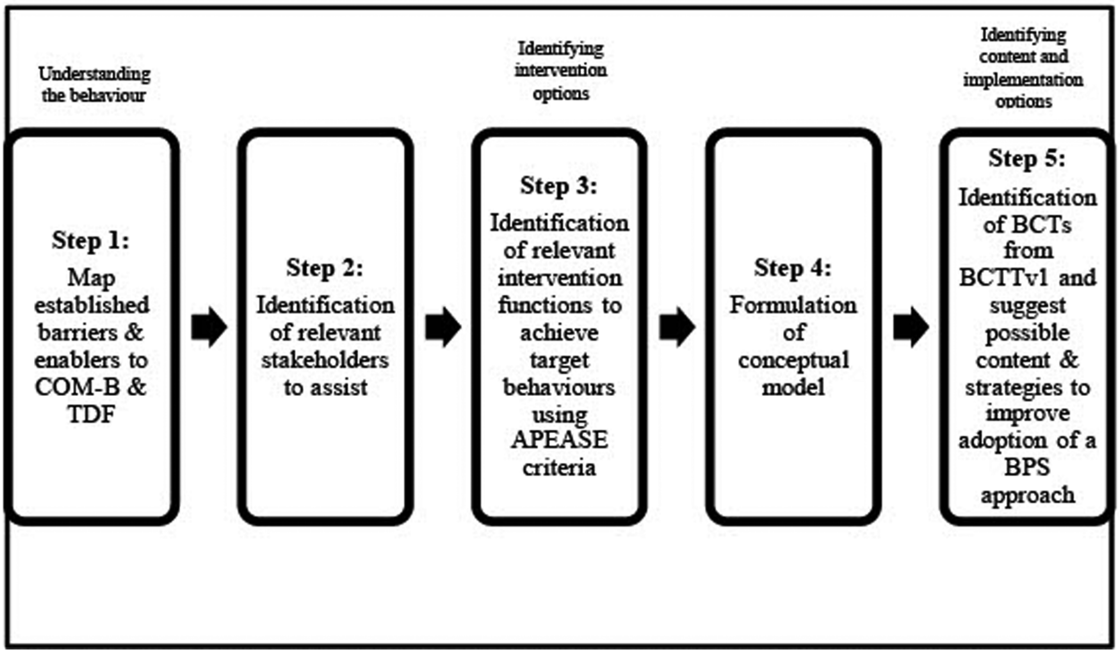

FIGURE 1
An Overview of the five-step process, informed by the behavioural change wheel (BCW). APEASE, affordability, practicability, effectiveness/cost-effectiveness, acceptability, side-effects/safety, equity; BCTs, behaviour change techniques; BCTTv1, behaviour change techniques taxonomy version 1; BPS, biopsychosocial; COM-B, capability opportunity motivation-behaviour model; TDF, theoretical domains framework.

TABLE 1 Characteristics & reflexivity of the research team.

Member	Background	Relevant experience	Years of research experience	Years of clinical experience	Years of teaching experience
WN	PhD candidate Clinician	Lead author of the qualitative systematic review preceding this study. Musculoskeletal physiotherapist, breadth of experience spans adult and paediatric musculoskeletal pain/disorders, with clinical focus on chronic and complex musculoskeletal pain using a biopsychosocial approach. Person with a lived experience of pain.	5[a]	15	–
DB	Clinician-Researcher	Practicing Specialist Musculoskeletal Physiotherapist (as awarded by the Australian College of Physiotherapists). Extensive clinical work including working in multidisciplinary teams to manage complex pain conditions and implementation of programs to enhance biopsychosocial patient care. Senior Research Fellow with broad research activities covering mechanistic understanding of clinical pain through to efforts to enhance the management of persistent pain and implementation of knowledge into practice. Educational experience with focus on the implantation of person-centered care that is biopsychosocial in nature, at the undergraduate and post-graduate levels. President of the Australian Physiotherapy Association for the last 4 years, with oversight of modernisation of the specialist training program around contemporary models of care.	22	30	22
DG	Psychological scientist	Educational training in psychology at both undergraduate [BSc (Hons)] and postgraduate (PhD) levels. Research portfolio sits at the interface of the psychological and behavioural sciences, and utilises basic and applied research paradigms to advance knowledge and practice on the complexities of human performance and health.	15	-	14
HS	Clinician Researcher	Roles involve intersection of clinical/teaching and research. Postgraduate Masters-level physiotherapy musculoskeletal teaching (including a pain unit). Extensive clinical practice across primary and tertiary care settings including in extended scope roles. Clinical research focused on musculoskeletal health and person-centred pain care; heath systems and services; models of care; systems strengthening; capacity building in health workforce to support improved pain care.	18	40	33

[a] 5 years into PhD training.

were resolved through discussion and consensus with the mapping team and an additional independent team member (HS).

Step 2 Identifying stakeholders who may potentially influence healthcare professionals′ adoption of a biopsychosocial model in musculoskeletal pain care

All team members studied the overall outcomes from Step 1. Based on the extracted data from the studies included in our previous review (15), the team derived a minimum list of stakeholders. This included stakeholders from across the whole-of-health from the micro-level (clinical interface), meso-level (health service provision and workforce training), and macro-level (health system).

In this step, a list of stakeholders and the previously derived 14 main themes were presented as a word document to the team. Members were tasked with independently answering the question "Is the theme critical for this stakeholder group to intervene on to improve biopsychosocial adoption?" We defined "intervene" as "to become intentionally involved in influencing and improving adoption". More than one stakeholder group could be selected to intervene for each theme, and team members could nominate any other relevant stakeholder group not otherwise mentioned but considered important potential contributors to adoption. Consensus on the most appropriate "proposed stakeholders" to potentially intervene on each of the 14 themes was achieved through a meeting.

Step 3 Deciding what intervention functions were important in supporting healthcare professionals′ adoption of a biopsychosocial model

To establish which category of interventions could potentially shift the behaviour of healthcare professionals to improve adoption, team members were asked to independently respond to this question "From the nine BCW intervention functions (education, persuasion, incentivisation, coercion, training, restriction, environmental restructuring, modelling, enablement), which function(s) meet the affordability, practicability, effectiveness/cost-effectiveness, acceptability, side-effects/safety, equity (APEASE) criteria to improving adoption?" (Definition of these intervention functions are shown later under results). We applied the APEASE criteria (23) to make strategic judgments on what might be the most appropriate intervention(s), with real world applicability. The description of the APEASE criteria can be found in **Supplementary Material**. Responses were collated and recorded on a Word document.

Step 4 Interpreting and conceptualising: Formulation of a conceptual model to understand the behavioural determinants and reach consensus on who may potentially influence healthcare professionals' adoption of the biopsychosocial model

A conceptual model, comprised of the pre-determined concepts (from the COM-B model and TDF) and newly-derived concepts integrated together, was developed to describe the behavioural determinants and explained how alignment of the various stakeholder groups could help achieve the goal of biopsychosocial musculoskeletal pain care.

The combination of the "a priori" concepts from the COM-B and TDF, and the research team members' newly-derived concepts from the interpretation of the data, highlighted the use of both deductive and inductive analyses in this step. The resultant synthesis of the conceptual model was built on the COM-B model and TDF, and was further enhanced with additional concepts from our qualitative review (15). This moved the description of the data used for the analysis to a higher level of abstraction and created an integrative conceptual framework. WN conceptualized and drew the conceptual model, the rest of the team commented on and refined the model to accurately reflect a visual representation of the behavioural determinants.

Step 5 Derivation of a pragmatic framework of behaviour change techniques to improve adoption

A behaviour change technique (BCT) is defined as "an active component of an intervention designed to change behaviour" (23). Here, we were interested to identify the observable, replicable, and irreducible components (i.e., active ingredients) of an intervention (31) that could facilitate behaviour change in healthcare professionals towards improved adoption. To approach this step, we gave thoughtful consideration to a principle used to achieve rigor in qualitative research analysis (37)—a hybrid approach of inductive and deductive analysis (38). Using both inductive and deductive analyses enabled us to collate a more comprehensive list of BCTs, grounded in the evidence-base, that would not have been achieved using either approach alone.

Figure 2 shows a graphic summary of the applied processes of deductive and inductive analyses.

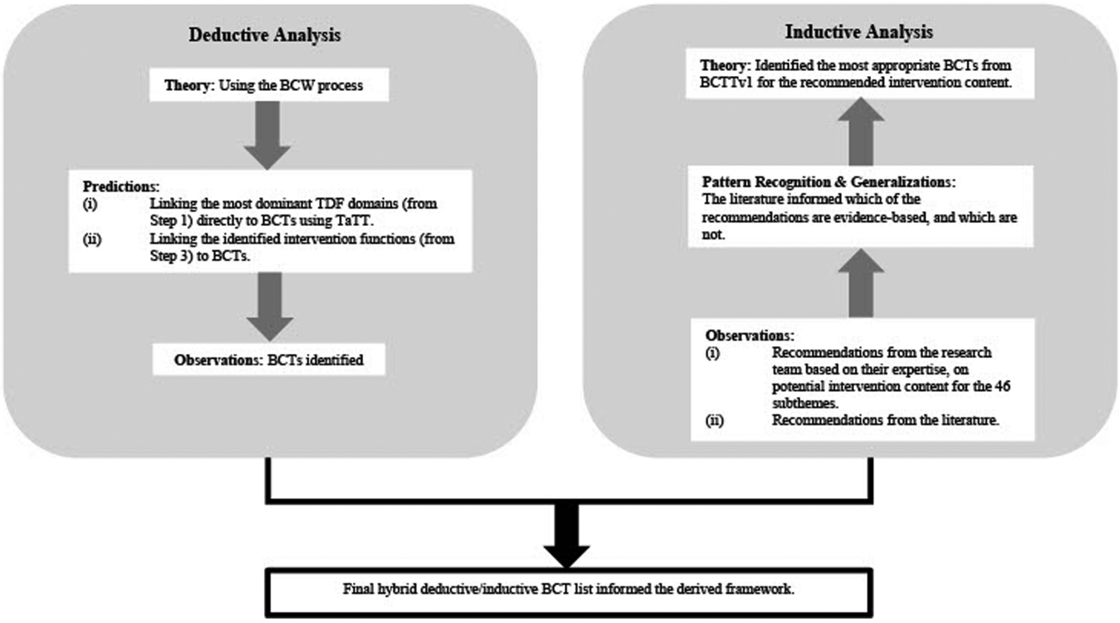

FIGURE 2
A graphic summary of the process of deductive and inductive analyses applied to derive a hybrid list of BCTs. Deductive analysis involves applying a theory (in this case, the Behaviour Change Wheel) to make predictions to our observed data. Inductive analysis involves observing our data thoroughly using researches' reflexivity and the evidence-base, to look for patterns, trends and generalizations in the data, to see if the data fits into a suggested theory (i.e., behavioural change techniques). BCTs, behaviour change techniques; BCTTv1, behaviour change techniques taxonomy version 1; BCW, behavioural change wheel; TDF, theoretical domains framework; TaTT, theory and technique tool.

Deductive analysis

(i) Linking TDF domains directly to BCTs using the Theory and Technique Tool (TaTT).

Based on the overall mapping results in Step 1, in order to identify priority areas for focusing intervention efforts to improve training and support for healthcare professionals' pain education, the most dominant TDF domains (as defined by count of the number of subthemes, at the micro-level, meso- and macro-level) populated by the mapping data were identified (WN). The most dominant TDF domains were linked directly to BCTs using the Theory and Technique Tool (TaTT) (39) via the Theory and Technique Tool website (40) through deductive inference. On the TaTT, the strength of a particular link between a mechanism of action/TDF domain and a BCT is denoted by four different coloured cells—white ("no evidence"), yellow ("inconclusive"), blue ("non-links") or green ("links") (39, 41, 42). For the purpose of this study, we wanted to identify the most effective BCTs to target on the most dominant TDF domains, hence only the green cells ("links") were considered.

(ii) Linking intervention functions to BCTs.

From Step 3, the identified intervention functions were then linked to the BCTs on Behavioural Change Techniques Taxonomy v1 (BCTTv1) (**Supplementary Material**) deductively by the BCW (23, 31). The links between intervention functions and BCTs had been established by expert consensus (23). To narrow down the list of BCTs for selection, for each intervention function, we only considered the most frequently used BCTs (43).

Using both deductive methods of linking, we were able to make predictions and identify which BCTs could potentially be adopted to target specific behavioural change. At this point, we assessed whether the BCTs selected would fit into proposed intervention(s) that also met the APEASE criteria i.e., were affordable, practical, cost-effective, acceptable, safe and equitable in the real world. One researcher (WN) collated, observed, and compared the two list of BCTs derived from both deductive methods of linking.

Inductive analysis

Based on their areas of expertise, the research team discussed their recommendations on how to address the target behaviour (**Table 2**) and suggested potential intervention content. These data were recorded in an Excel spreadsheet and interrogated against the 46 subthemes (the dataset) to ensure recommendations targeted specific areas relevant to healthcare professionals assessing, identifying and analysing biopsychosocial factors contributing to musculoskeletal pain. Recommendations from the team were collaboratively discussed and synthesized inductively and iteratively. The literature was then reviewed to examine if these recommendations were reflected in the evidence-base. The entire inductive analysis process was both iterative and reflexive. The most appropriate BCTs were identified by coding the intervention content to the most relevant grouping and definition of the BCT on the BCTTv1.

TABLE 2 Specifications of the target behaviour.

Target behaviour	Healthcare professionals' adoption of a biopsychosocial approach in musculoskeletal pain care.
Who	Healthcare professionals licensed to provide musculoskeletal pain care. Examples include (but not restricted to) anaesthetists, chiropractors, clinical psychologists, general practitioners, nurses, occupational therapists, osteopaths, pain physicians, physiotherapists and rheumatologists.
What	Assess, identify and analyse biopsychosocial factors contributing to each individual's musculoskeletal pain experience.
How	Using authentic communication and critical clinical reasoning, with strong therapeutic alliance.
Whom	In partnership with patients; people with lived pain experience; consumers.
When	During clinical consultation, first, ongoing or review appointments.
Where	In clinical practice settings.

Derivation of a final framework of BCTs

Based on what is in common between the BCTs derived from deductive linking, and the BCTs derived from inductive analysis of recommendations from the research team (that is also evidence-based), a hybrid list of BCTs (required at the bare minimal) to facilitate change towards improved adoption were identified.

The recommended strategies that could potentially empower healthcare professionals to assess, identify and analyse biopsychosocial factors contributing to musculoskeletal pain were collated and reported under "discussion". The research team also derived a worked example of how to use BCTs to improve healthcare professionals' adoption of a biopsychosocial approach across the whole-of-health.

Results

Step 1 Mapping previously derived subthemes to the COM-B model and TDF

Table 3 provides a detailed breakdown of how the subthemes from our previous qualitative evidence synthesis (15) mapped onto the COM-B model and TDF. A subtheme could be mapped onto more than one component on the COM-B and more than one domain on the TDF. An overview of the number of subthemes mapped to each COM-B component and TDF domain is provided in **Supplementary Table S5**. Overall, the 46 subthemes (barriers and enablers to the adoption of a biopsychosocial approach) mapped on 5/6 components on the COM-B model (with the exception of physical capability), and 12/15 domains on the TDF (with the exception of physical skills, optimism and goals), reflecting that the adoption of a biopsychosocial approach involved a complex set of behavioural determinants across multi-levels of healthcare.

TABLE 3 Healthcare professionals' barriers and enablers to the biopsychosocial approach mapped onto the COM-B model and TDF.

Themes	Subthemes	COM-B domains	TDF domains
Micro level			
1.1 Healthcare professional knowledge and skills Healthcare professional's knowledge of psychosocial factors, evidence-based practice and other healthcare disciplines, and their interpersonal and people skills.	1.1.1 Healthcare professionals are aware of the importance of psychosocial factors, but are vague about what those factors are.	Psychological capability	Knowledge
	1.1.2 Lack of knowledge of the levels of evidence & the concept of evidence-based practice.		Knowledge
	1.1.3 The knowledge (or the lack of knowledge) on how to identify psychosocial factors (including the use of questionnaires and instruments for screening); manage psychosocial factors or yellow flags; or the lack of ability to apply the biopsychosocial model.		Knowledge Skills
	1.1.4 Healthcare professionals' default approach of addressing "biomedical" or "red flags" first (or only), then "psychosocial" or "yellow flags" or "biopsychosocial".	Psychological capability Reflective motivation	Memory, attention and decision processes
	1.1.5 The ability (or inability) of the healthcare professionals to manage the clinician-patient alliance.	Psychological capability	Skills
	1.1.6 The ability (or inability) to use communication and interpersonal skills (e.g. counselling, explaining, instructing, listening, reassuring, motivating, promoting and selling a management approach).		Skills
	1.1.7 The knowledge (or the lack of knowledge) of what other healthcare professionals do, other treatment options, when and where to refer to.		Knowledge
	1.1.8 The skill (or the lack of skill) to manage and negotiate health beliefs and patients' expectations.		Skills
	1.1.9 The skill (or the lack of skill) to manage patients' emotions and reactions.		Skills
	1.1.10 The knowledge of individualized or personalized care.		Knowledge
	1.1.11 The knowledge that to treat chronic pain, it is not about curing it; rather, managing pain.		Knowledge
	1.1.12 The knowledge that the pain score is a means for the patient to communicate a more general suffering; & the skill to identify & modify pain, specific to patients' aggravating activity or affected behaviour.		Knowledge Skills
1.2 Healthcare professional personal factors Individual factors and arbitrary choices of healthcare professionals: their emotions associated with chronic pain management; beliefs; level of self-awareness with pre-existing clinical habits; desire to learn; the role and professional identity they assumed; qualifications and work experience associated with the use of a biopsychosocial approach in pain care.	1.2.1 Healthcare professionals' negative emotions associated with the management of chronic pain, psychosocial factors & the use of CPGs & questionnaires.	Automatic motivation	Emotion
	1.2.2 Healthcare professionals may have habits which they subconsciously continue with; or they may consciously not feel a desire to learn; or they may be self-aware, with an ability to reflect on evidence and clinical experience.	Automatic motivation Reflective motivation	Behavioural regulation Intentions Memory, attention and decision processes Reinforcement
	1.2.3 Healthcare professionals consider OR don't consider it their role (including the role to refer on) & scope of practice to use the BPS approach or follow BPS oriented guidelines.	Reflective motivation	Professional role and identity
	1.2.4 Healthcare professionals biomedical or biopsychosocial treatment orientation or professional identity.		
	1.2.5 Healthcare professionals helpful OR unhelpful beliefs (including misconceptions) towards the use of a BPS approach or the use of guidelines.		Beliefs about consequences
	1.2.6 Healthcare professionals additional qualifications & relevant work experience associated with the use of a BPS approach.	Psychological capability Reflective motivation	Knowledge Skills Professional role and identity
1.3 Healthcare professional misconceptions of clinical practice guidelines (CPGs) Healthcare professionals may misunderstand guidelines as being too generic, simplistic, prescriptive or lacking in flexibility to account for the necessary individualised management of musculoskeletal pain. The presentation of information on guidelines may be unappealing to learning quickly.	1.3.1 Guideline recommendation(s) perceived as uncertain OR unhelpful.	Reflective motivation	Beliefs about consequences
	1.3.2 Guidelines are perceived as generic OR simplistic OR too mechanistic, prescriptive OR rigid in the management of patients' musculoskeletal conditions.		
	1.3.3 Guidelines are perceived as not providing adequate clinical tools OR perceived as having too many psychosocial questionnaires to choose from.		

(*continued*)

TABLE 3 Continued

Themes	Subthemes	COM-B domains	TDF domains
	1.3.4 Healthcare professionals are generally not inclined to pay attention to CPGs, the presentation of CPGs is not appealing and may be incompatible with healthcare professionals' way of learning.		Memory, attention and decision processes
	1.3.5 Healthcare professionals are unclear of what "non-specific" means in the non-specific musculoskeletal pain diagnosis in CPGs.	Psychological capability	Knowledge
1.4 Healthcare professional perceptions about patient factors Healthcare professional perceptions and judgments about patient factors may overemphasize the psychological framing of the condition and the negative stereotype of the difficult patient.	1.4.1 Healthcare professionals' interpretation or judgment of patients' lack of motivation or ulterior motives.	Reflective motivation	Intentions
	1.4.2 Patients' biomedical focus or expectations, unhelpful beliefs and attitudes and poor health literacy can impact on their care and clinical management.	Social opportunity	Social influences
	1.4.3 Healthcare professionals' judgments about patients' circumstances, including the judgment of patients' social issues & involvement with a legal case, which may overemphasize the negative stereotype of chronic musculoskeletal pain.	Reflective motivation	Intentions Beliefs about consequences
	1.4.4 Patients' complexity of clinical presentation prompts the exploration of psychosocial factors or the use of recommendations from CPGs.	Psychological capability	Skills Memory, attention and decision processes
1.5 Healthcare professional perception of time Healthcare professionals perceived there is insufficient time to explore psychosocial factors within a clinical consultation, and the lack of time for learning.	1.5.1 Healthcare professionals perceived that there is insufficient time to explore psychosocial factors within a clinical consultation, and no time to reflect, or read and learn about CPGs.	Physical opportunity Reflective motivation	Environmental context and resources
Meso level			
2.1 CPG formulation Guideline development may be unable to account for different categories of patients, patients' expectations, healthcare professionals' former knowledge and training, contextual factors and real-world situations.	2.1.1 Guideline care may not be compatible with the concept of delivering individualized care.	Psychological capability Social opportunity	Knowledge Social influences
	2.1.2 Compatibility of guideline care to healthcare professionals' clinical practice, former knowledge, training, and real-world practice.	Reflective motivation Social opportunity	Beliefs about capabilities Social influences
	2.1.3 The existence of CPGs help to facilitate and coordinate teamwork among healthcare professionals, provided healthcare professionals are familiar with the content.	Social opportunity	Social influences
	2.1.4 Guidelines are a good source of information to patients and contribute to their understanding of evidence-based treatment options.		
	2.1.5 Guidelines provide up-to-date, useful information and decisional algorithms to help healthcare professionals in their clinical decision making and navigate clinical uncertainty.		
2.2 Clinical community factors Ready access and availability of an egalitarian interdisciplinary or multidisciplinary team to consult for challenging clinical cases, and whether or not the treatment orientation and communication among professionals within a team is aligned.	2.2.1 Access & availability (or lack thereof) of a clinical support system or network with an efficient communication channel.	Physical opportunity Social opportunity	Environmental context and resources Social influences
	2.2.2 Conflict or alignment between healthcare professionals in the interpretation about what care is required.	Social opportunity Reflective motivation	Social influences Beliefs about consequences
2.3 Funding models Financial barriers such as patients' lack of health insurance, the lack of funding to incentivise healthcare professionals for their time, effort and qualifications, as well as the funding required to construct models of care appropriate to deliver high value musculoskeletal pain care may impact the feasibility of using the biopsychosocial approach.	2.3.1 The funding model used (i.e. government group insurance, private healthcare insurance, workers' compensation board, individual out-of-pocket expenses) and the financial feasibility of the BPS approach can encourage or discourage the use of the approach.	Physical opportunity	Environmental context and resources Reinforcement
2.4 Health service provision Work processes such as needing to complete a large amount of administrative work, or performance indicators such as requiring to see many patients or the structure of group therapy sessions may not facilitate the use of a biopsychosocial approach to pain care.	2.4.1 The level of alignment of work processes within organizations to evidence-based methods, or a BPS approach.	Physical opportunity Social opportunity	Environmental context and resources Social influences

(*continued*)

TABLE 3 Continued

Themes	Subthemes	COM-B domains	TDF domains
2.5 Resourcing issues Lack of resources such as time, specialist services, appointment slots and clinic infrastructure to support the use of a biopsychosocial approach to pain care.	2.5.1 Insufficient time and frequency of consultation, and too much time on long waitlist for referrals to specialist services and investigations are resource-related time barriers to the use of a BPS approach.	Physical opportunity	Environmental context and resources
	2.5.2 The availability (or the lack of) of specialist services, appointment slots, clinic infrastructure and resources (such as educational content and tools) to support a BPS approach.		
2.6 Workforce training issues Workforce training issues such as a lack of explicit communication training, counselling and psychosocial competencies in undergraduate and postgraduate training programs.	2.6.1 Lack of counselling/psychosocial training to help healthcare professionals apply a BPS approach.	Physical opportunity	Environmental context and resources
Macro-level			
3.1 Health policy Health policy may not prioritise or align to best practice, evidence-based care of musculoskeletal conditions.	3.1.1 The level of political support or attention provided by governments, compensable bodies, professional associations and regulatory boards to provide evidence-based care.	Physical opportunity Social opportunity	Environmental context and resources Social influences
3.2 Organizational factors Organizational factors such as healthcare financing models and regulations within healthcare delivery may not align with high value, person-centred musculoskeletal pain care.	3.2.1 Criterion for the funding set by healthcare systems, insurers or organizations can be compatible or incompatible with the use of a BPS approach.	Physical opportunity Social opportunity	Environmental context and resources Social influences
	3.2.2 Regulations within healthcare systems or workplace culture may promote or obstruct the use of a BPS approach.		
3.3 Social factors Social factors such as the persistence and dominance of the biomedical paradigm in healthcare professions and systems, and stigma towards psychological services.	3.3.1 The persistence of a biomedical culture in healthcare professions & systems.	Social opportunity	Social influences
	3.3.2 Social stigma towards psychological services.		
	3.3.3 The pervasiveness of information spread via mass media may not be aligned to a BPS model of care.		

BPS, biopsychosocial; COM-B, Capability Opportunity Motivation-Behaviour; CPGs, Clinical Practice Guidelines; TDF, Theoretical Domains Framework.

Step 2 Identifying stakeholders who may potentially influence healthcare professionals' adoption of a biopsychosocial model in musculoskeletal pain care

Table 4 shows the tabulation of the identified key stakeholder groups. Healthcare professionals, educators, guideline developers, workplace managers, and policymakers were the stakeholder groups identified as target audiences for potential interventions. Researchers were considered as relevant to all five stakeholder groups. Researchers' roles may involve an investigation into healthcare professionals' behaviour, educators' behaviour, evaluation of clinical practice guideline implementation, workplace programs or policy implementation.

Step 3 Deciding what intervention functions were important in supporting healthcare professionals' adoption of a biopsychosocial model

Table 5 provides a list of targeted intervention functions that could help to address specific barriers to healthcare professionals' adoption of a biopsychosocial approach to musculoskeletal pain care. A supporting rationale is shown. This is based upon considering criteria such as affordability, practicability, effectiveness/cost-effectiveness, acceptability, side-effects/safety, and equity (APEASE). Team members discussed and reached consensus that the essential intervention functions important in supporting healthcare professionals' adoption of a biopsychosocial model were education, training, environmental restructuring, modelling and enablement.

It is important to note that in this step, applying the APEASE criteria to decide on the intervention functions is essentially a judgment call by the research team, based on our researchers' reflexivity and positionality (Table 1). Our assessment using the APEASE criteria may or may not accurately represent the views of stakeholder groups such as the workplace manager and policymaker, as there is no such representation within the research team. However, it is noteworthy that two of the team members (DB, HS) have relevant experience in collaborating with service providers, workplace managers and policymakers in their clinical and research scope of work. Whether the selected intervention functions will result in improved adoption of biopsychosocial musculoskeletal pain care remains to be tested.

Step 4 Interpreting and conceptualising: formulation of a conceptual model to understand the behavioural determinants, and reach consensus on who may potentially influence healthcare professionals' adoption of the biopsychosocial model

A conceptual model is shown to simplify the behavioural determinants of healthcare professionals adopting

TABLE 4 The key stakeholder groups to target behavioural interventions for the respective barriers and enablers to the adoption of the biopsychosocial approach.

Themes	Healthcare professionals[a] including researchers	Educators[b] including researchers	Guideline developers[c] including researchers	Workplace managers[d] including researchers	Policymakers[e] including researchers
Micro-level	√	√			
1.1 Healthcare professional knowledge and skills Healthcare professional's knowledge of psychosocial factors, evidence-based practice and other healthcare disciplines, and their interpersonal and people skills.					
1.2 Healthcare professional personal factors Individual factors and arbitrary choices of healthcare professionals: their emotions associated with chronic pain management; beliefs; level of self-awareness with pre-existing clinical habits; desire to learn; the role and professional identity they assumed; qualifications and work experience associated with the use of a biopsychosocial approach in pain care.	√	√			
1.3 Healthcare professional misconceptions of clinical practice guidelines (CPGs) Healthcare professionals may misunderstand guidelines as being too generic, simplistic, prescriptive or lacking in flexibility to account for the necessary individualised management of musculoskeletal pain. The presentation of information on guidelines may be unappealing to learning quickly.	√	√	√		
1.4 Healthcare professional perceptions about patient factors Healthcare professional perceptions and judgments about patient factors may overemphasize the psychological framing of the condition and the negative stereotype of the difficult patient.	√	√			
1.5 Healthcare professional perception of time Healthcare professionals perceived there is insufficient time to explore psychosocial factors within a clinical consultation, and the lack of time for learning.	√			√	
Meso-level			√		
2.1 CPG formulation Guideline development may be unable to account for different categories of patients, patients' expectations, healthcare professionals' former knowledge and training, contextual factors and real-world situations.					
2.2 Clinical community factors Ready access and availability of an egalitarian interdisciplinary or multidisciplinary team to consult for challenging clinical cases, and whether or not the treatment orientation and communication among professionals within a team is aligned.	√			√	
2.3 Funding models Financial barriers such as patients' lack of health insurance, the lack of funding to incentivise healthcare professionals for their time, effort and qualifications, as well as the funding required to construct models of care appropriate to deliver high value musculoskeletal pain care may impact the feasibility of using the biopsychosocial approach.				√	√
2.4 Health service provision Work processes such as needing to complete a large amount of administrative work, or performance indicators such as requiring to see many patients or the structure of group therapy sessions may not facilitate the use of a biopsychosocial approach to pain care.	√			√	√
2.5 Resourcing issues Lack of resources such as time, specialist services, appointment slots and clinic infrastructure to support the use of a biopsychosocial approach to pain care.				√	√
2.6 Workforce training issues Workforce training issues such as a lack of explicit		√		√	√

(*continued*)

TABLE 4 Continued

Themes	Healthcare professionals[a] including researchers	Educators[b] including researchers	Guideline developers[c] including researchers	Workplace managers[d] including researchers	Policymakers[e] including researchers
communication training, counselling and psychosocial competencies in undergraduate and postgraduate training programs.					
Macro-level					√
3.1 Health policy Health policy may not prioritise or align to best practice, evidence-based care of musculoskeletal conditions.					
3.2 Organizational factors Organizational factors such as healthcare financing models and regulations within healthcare delivery may not align with high value, person-centred musculoskeletal pain care.				√	√
3.3 Social factors Social factors such as the persistence and dominance of the biomedical paradigm in healthcare professions and systems, and stigma towards psychological services.	√	√		√	√

CPG, clinical practice guidelines; √, represents consensus has been achieved among research team members when asked the question "Is the theme critical for the stakeholder group to intervene on to improve biopsychosocial adoption?".

[a] Medical or allied health professionals licensed to provide musculoskeletal pain care and deliver health care services to patients. Examples include (but not restricted to) anaesthetists, chiropractors, clinical psychologists, general practitioners, nurses, occupational therapists, osteopaths, pain physicians, physiotherapists and rheumatologists.

[b] Teachers who provide education, instruction or clinical guidance in musculoskeletal sciences and/or pain curriculums, in the capacity as college/university educators, tutors, clinical educators and/or facilitators of continuing professional education.

[c] Researchers, professional organizations/associations, or department/ministry of health who develop clinical practice guidelines to grade evidence and develop recommendations based on best available evidence for musculoskeletal pain conditions.

[d] Clinic managers who oversee the day-to-day operation or management of healthcare facilities/musculoskeletal outpatient clinics, maintain responsibility for the administrative aspects of the clinical services, and liaise between healthcare professionals and patients.

[e] Members of professional organizations/associations, department/ministry of health or other government departments who are involved in legislation and healthcare funding rules, and are responsible for formulating healthcare policies and making policy decisions.

biopsychosocial pain care. The model aligns stakeholders towards enacting emergent, novel behaviours supporting biopsychosocial pain care. Figure 3 provides readers with a summary at one glance to understand the behavioural determinants and the major stakeholder groups that need to be involved, to help support healthcare professionals to achieve biopsychosocial pain care.

A new conceptual model differentiated from the original COM-B model (23) was developed (Figure 3) and demonstrates the relationship between "capability", "motivation", "behaviour", and "opportunity". Unlike the original COM-B model that does not give dominance to either factor "capability", "opportunity", or "motivation" influencing behaviour, this graphic proposes the environment (i.e., physical and social opportunity) in which healthcare professionals practise is crucial to adoption (illustrated as the big shaded circle, comprising of other stakeholder groups). Healthcare professionals (illustrated as the smaller circle) are surrounded by environmental context and social influences (physical and social opportunities) of the healthcare system, which will influence and shape how they behave. However, behaviours may sometimes be "out of context"- that is why the smaller circle representing the healthcare professional is drawn slightly out of the big circle representing the environmental context. Healthcare professionals' behaviours require psychological capability in decision-making in complex and varied clinical scenarios and may involve both reflective and automatic processes (or motivation) (48). Reflective processes refer to the cognitive ability, awareness and conscious deliberation to make complex clinical decisions before enacting behaviour; whereas automatic processes are learnt predispositions/proclivity to think or act in a given way or habits. These processes are cued by external factors (location, time, or people) or internal reactions and factors (mood or priorities) of the healthcare professional (48, 49).

A hypothetical patient cogwheel (illustrated as the circle with dotted line) is interacting with and influencing the behaviour of the healthcare professional, and vice versa. Every stakeholder, illustrated as interconnected individual circles, plays a role in the whole healthcare landscape (illustrated as the big shaded circle, i.e., representing the environmental context and social influences). The behaviour of a complex system emerges from the interaction of the six stakeholder groups (patients, healthcare professionals, educators, workplace managers, guideline developers and policymakers) (50), and will potentially influence and change the environmental and social context towards supporting the goal of biopsychosocial pain care, with the whole being greater than the sum of its parts. In other words, these emergent, novel behaviours extend beyond the clinician-patient system to the remainder of the healthcare system, encouraging communication and relationship-centered care among stakeholders across all levels of healthcare (51, 52). A circle coming in contact with another circle here represents the interdependency of the stakeholders to one another, though

TABLE 5 Selection of the intervention functions and rationale based on the APEASE criteria.

Intervention functions	Definition	Does the intervention function meet the APEASE criteria?
Education	Increasing knowledge or understanding.	Yes. Education is an essential tool that can be used to create the awareness, change knowledge, attitudes and beliefs of healthcare professionals. It is suggested the design of a pain curriculum be considered in the context of affordability, length of time it takes to upskill healthcare professionals and the cost-effectiveness of the program.
Persuasion	Using communication to induce positive or negative feelings or stimulate action.	As a standalone intervention, may be ineffective or minimally effective as there is evidence from our previous study (15) that healthcare professionals are aware of the biopsychosocial approach to musculoskeletal pain care, yet they lack the confidence and capability to apply it in clinical practice.
Incentivisation	Creating an expectation of reward.	Challenges acceptability, as adoption of a biopsychosocial approach to pain care is a best practice standard. Using social rewards or professional accolades to recognize individuals or clinics or organisations for implementing biopsychosocial pain care may be an appropriate incentive (versus monetary gains).
Coercion	Creating an expectation of punishment or cost.	Unacceptable and unethical to healthcare professionals.
Training	Imparting skills.	Yes, ongoing training can be embedded within the continuing professional development requirement to maintain recency of practice and reflect alignment with evidence and best practice standards.
Restriction	Using rules to reduce the opportunity to engage in the target behaviour (or to increase the target behaviour by reducing the opportunity to engage in competing behaviours).	Impractical, as there are no options to restrict in this context.
Environmental restructuring	Changing the physical or social context.	Yes. Use of virtual “community of practice” can mitigate against geographical barriers to help foster shared learning and useful discussion among healthcare professionals to support the adoption of biopsychosocial musculoskeletal pain care. Project ECHO (44) is an example of a collaborative model/virtual community that provides access to knowledge, mentorship and ongoing support for healthcare professionals.
Modelling	Providing an example for people to aspire to or imitate.	Yes. Support and leadership from opinion leaders, clinical champions, and patient advocates with lived experience, in the field of musculoskeletal pain, are helpful.
Enablement	Increasing means/reducing barriers to increase capability (beyond education and training) or opportunity (beyond environmental restructuring).	Yes. Data registries, such as the electronic Persistent Pain Outcomes Collaboration (ePPOC), facilitate the collection of data from pain management services. This helps to analyse healthcare utilization and outcomes and these data can be used for benchmarking practice and to promote research into important areas of pain management (45). Websites such as the Cochrane musculoskeletal group (46) and the International Association of the Study of Pain (IASP) (47) are helpful online platforms that collate the latest scientific evidence and enable sharing of these trustworthy information to healthcare professionals and patients to inform clinical decision making.
Suggested intervention functions	**Education** **Training** **Environmental restructuring** **Modelling** **Enablement**	

APEASE, affordability, practicability, effectiveness/cost-effectiveness, acceptability, side-effects/safety, and equity.

alignment of the stakeholders is not necessarily mutually exclusive (e.g., workplace managers may come directly in contact with policymakers). Arrows are used to denote the dynamicity of the system, i.e., moving one cogwheel can potentially influence and impact the adjacent aligning cogwheel. Subsequently, the interdependencies can set the whole cogwheel system in motion (synonymous to cooperation and collaboration between stakeholders). However, if one cogwheel moves in a direction that does not align with the rest of the cogwheels, it may potentially create a barrier or “logjam” in the system.

Step 5 Derivation of a pragmatic framework of behaviour change techniques to improve adoption

As shown in **Table 3** (and **Supplementary Table S5**), the majority of the micro-level subthemes mapped to the “knowledge” and “cognitive and interpersonal skills” domain on the TDF, whereas the majority of the meso-level and macro-level subthemes mapped to the “environmental context and resources” and “social influences” domain on the TDF.

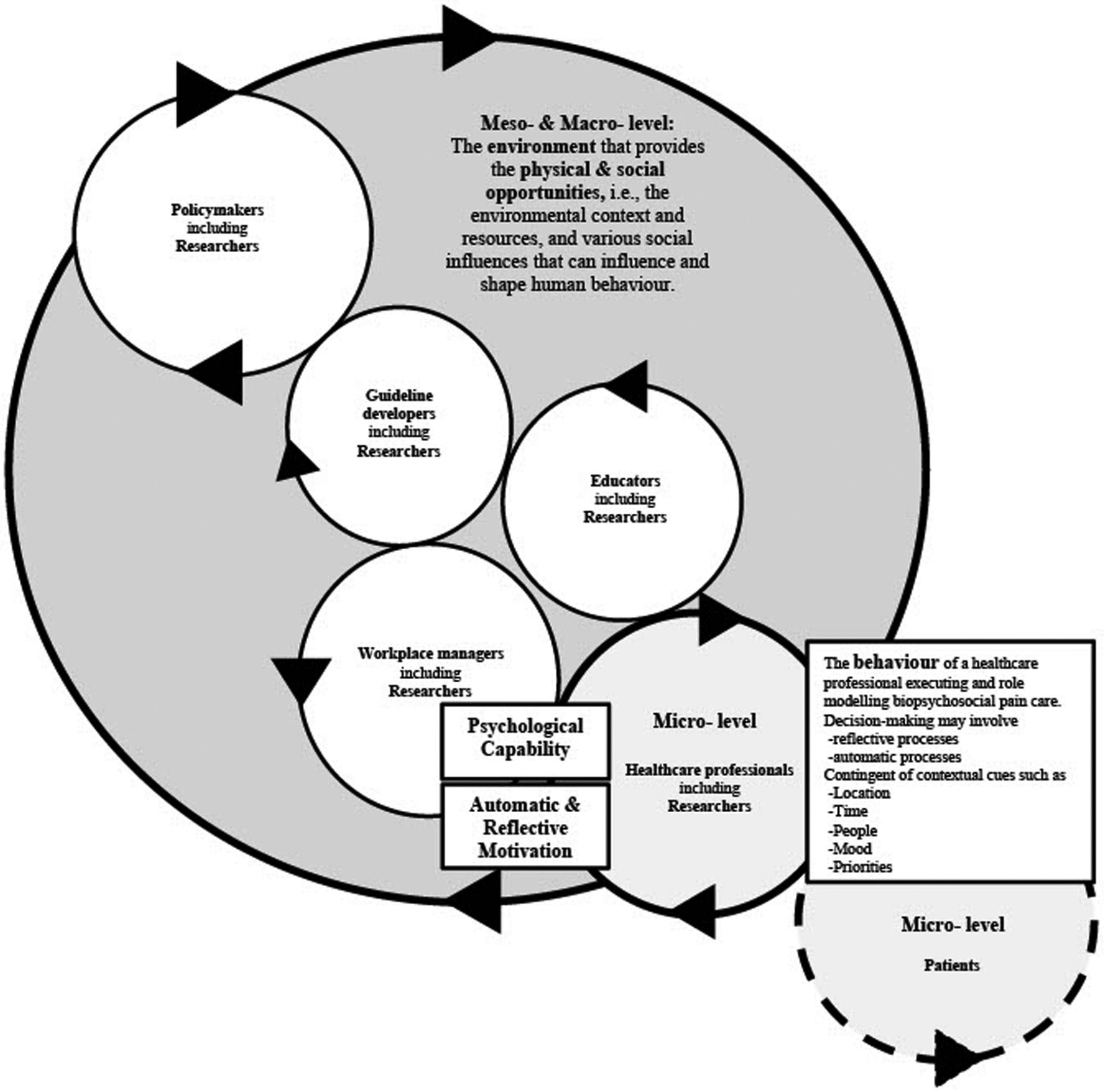

FIGURE 3
A conceptual cogwheel model outlinning the behavioural determinates of healthcare professionals adopting biopsychosocial pain care, and aligning stakeholders towards enacting emergent, novel behaviours supporting pain care. The terms "psychological capability", "automatic & reflective motivation", "behaviour", "physical & social opportunity" are concepts from the COM-B model. The terms "enviromental context and resources" "social influences" are concepts from the TDF. COM-B, capability opportunity motivation-behaviour model; TDF, theoretical domains framework.

Table 6 shows the list of BCTs identified via two deductive methods of linking, inductive analysis and the final hybrid list of BCTs identified by both deductive linking and inductive analysis. The full BCT taxonomy v1 and the definition of each BCT are provided in Supplementary Table S4.

Overall, six BCTs from BCTTv1 were identified as relevant and the minimum required to facilitate healthcare professionals' behaviour change towards improved adoption. At the micro-level, BCTs "4.1 instruction on how to perform a behaviour" and "8.1 behavioural practice/rehearsal" were relevant. At the meso- and macro-level, BCTs "3.1 social support (unspecified)", "3.2 social support (practical)", "7.1 prompts/cues", and "12.1 restructuring the physical environment" were relevant.

A template of our synthesized framework of BCTs, with the links between the dominant COM-B components and TDF domains, intervention functions and the selected BCTs as informed by the BCW process (23, 24, 31, 40–43) can be found in Supplementary Table S6.

Discussion

This study describes a novel systematic approach in which we leveraged principles from the BCW process to (i) identify behavioural determinants that can support the adoption of a biopsychosocial approach, (ii) formulate a novel conceptual model outlining these behavioural determinants, and (iii) derive a framework of BCTs that have the potential to facilitate and improve healthcare professionals' adoption of a biopsychosocial approach to musculoskeletal pain care. This approach provides a

TABLE 6 Identified behaviour change techniques derived from deductive linking, inductive analysis resulting in the final hybrid list.

	Deductive Linking/Analysis			
	(i) Dominant TDF domain	Links to BCTs identified on TaTT as "green" links	(ii) Identified intervention functions	Most frequently used BCTs (from BCTTv1) for specific intervention function
Micro-level	**Knowledge**	2.6 Biofeedback 4.1 Instruction on how to perform behaviour 4.2 Information about antecedents 5.1 Information about health consequences 5.3 Information about social and environmental consequences	**Education**	2.2 Feedback on behaviour 2.3 Self-monitoring of behaviour 2.7 Feedback on outcome(s) of behaviour 5.1 Information about health consequences 5.3 Information about social and environmental consequences 7.1 Prompts/cues
	Cognitive and interpersonal skills	4.1 Instruction on how to perform behaviour 8.1 Behavioural practice/rehearsal 8.7 Graded tasks	**Training**	2.2 Feedback on behaviour 2.3 Self-monitoring of behaviour 2.7 Feedback on outcome(s) of behaviour 4.1 Instruction on how to perform the behaviour 6.1 Demonstration of the behaviour 8.1 Behavioural practice/rehearsal
Meso- & Macro-level	**Environmental context and resources**	3.2 Social support (practical) 7.1 Prompts/cues 7.5 Remove aversive stimulus 12.1 Restructuring the physical environment 12.2 Restructuring the social environment 12.3 Avoidance/reducing exposure to cues for the behaviour 12.5 Adding objects to the environment	**Environmental restructuring**	7.1 Prompts/cues 12.1 Restructuring the physical environment 12.5 Adding objects to the environment
	Social influences	3.1 Social support (unspecified) 3.2 Social support (practical) 6.2 Social comparison 6.3 Information about others' approval 10.4 Social reward	**Modelling**	6.1 Demonstration of the behaviour
			Enablement	1.1 Goal setting (behaviour) 1.2 Problem solving 1.3 Goal setting (outcome) 1.4 Action planning 1.5 Review behaviour goal(s) 1.7 Review outcome goal(s) 2.3 Self-monitoring of behaviour 3.1 Social support (unspecified) 3.2 Social support (practical) 12.1 Restructuring the physical environment 12.5 Adding objects to the environment
Inductive Analysis (2 examples provided)				
Subtheme	**Example of intervention content**			**Identified BCT (from BCTTv1)**
1.1.4 Healthcare professionals' prioritizes addressing "biomedical" or "red flags" first (or only), then "psychosocial" or "yellow flags" or "biopsychosocial".	Introduce a checkbox on the initial assessment form to prompt for a psychosocial assessment with the use of questionnaires such as the Örebro Musculoskeletal Pain Questionnaire (ÖMPQ).			7.1 Prompts/cues
1.1.5 The ability (or inability) of the healthcare professionals to manage the clinician-patient alliance.	Training in the form of practice and empathetic reflective feedback from clinician to patient enhances overall communication style and patient-centred communication behaviours.			8.1 Behavioural practice/rehearsal
Final hybrid list of BCTs				
Based on both deductive and inductive analysis, the most relevant BCTs required at the bare minimum to facilitate change towards improved adoption of the biopsychosocial approach:				
Micro-level				
4.1 Instruction on how to perform a behaviour				

(*continued*)

TABLE 6 Continued

	Deductive Linking/Analysis			
	(i) Dominant TDF domain	Links to BCTs identified on TaTT as “green” links	(ii) Identified intervention functions	Most frequently used BCTs (from BCTTv1) for specific intervention function
8.1 Behavioural practice/rehearsal				
Meso- and Macro-level				
3.1 Social support (unspecified)				
3.2 Social support (practical)				
7.1 Prompts/cues				
12.1 Restructuring the physical environment				

BCTs, behaviour change techniques; BCTTv1, behaviour change techniques taxonomy version 1; TDF, theoretical domains framework; TaTT, theory and technique tool. BCTs underlined are in common, using the two deductive methods of linking.

blueprint to road test how target interventions can help improve healthcare professionals’ understanding of pain by addressing important target behaviours that underpin quality pain care.

In line with the aim of our work, a recent review (26) also investigated and mapped the barriers and facilitators to a biopsychosocial approach against the TDF and subsequently to the TaTT. These colleagues identified 10 TDF domains and 33 BCTs that could foster implementation. Consistent with our findings, the authors highlighted that implementation of a biopsychosocial approach is complex (26). That study also used deductive coding and analysis, and their results were specific to physiotherapy practice. In contrast, by taking a more in-depth and broader whole-of-system approach to driving adoption, our study value-adds to the evidence base by (i) amalgamating the determinants to derive a cogwheel model to enhance understanding of the subject matter from a behavioural perspective, (ii) identifying relevant stakeholder groups to intervene, (iii) suggesting targeted intervention functions and content, and (iv) identifying core BCTs to improve adoption.

The use of both deductive and inductive analysis in our study is a strength of this study as we combined the use of theory with clinical and research expertise. It is important to note the BCW process is not a panacea for behaviour change but a system of using best available evidence, informed judgment and resources to arrive at a strategy to address a specified behaviour (23). Hence, this discussion is structured to elucidate our reasoning processes. Stakeholders working within the health services and systems level may derive practical, useful and actionable insights from our findings.

Strengths

The conceptual model developed in our study capture a broad system overview on factors and key stakeholders who can potentially influence the adoption of a biopsychosocial approach to musculoskeletal pain care. This cogwheel model reflects a whole-of-system approach and highlight opportunities for behavioural intervention designers and policymakers to target specific initiatives to promote and support and strengthen a system-wide approach to biopsychosocial musculoskeletal pain care. Developing the model from existing evidence-based behaviour change theoretical foundations (23, 24, 27, 31) is also a strength. Our method of conceptual model development is explicit and transparent, allowing readers to see clearly how data from our previous review (15) mapped to the COM-B model and TDF, and how these data are then translated back to the COM-B model to derive the new conceptual model (53). Our constructivist epistemological position towards knowledge construction and the hybrid approach of using both deductive and inductive analysis demonstrate theoretical rigor by accounting for sound and logical reasoning in the analysis process. We incorporated team members’ subjective interpretation of the data from various experiential levels of the health system and ensured knowledge generated by this research is usable in real-world healthcare settings (37).

Limitations

The consensus reached in the team was driven by the knowledge and experience of a small group of clinicians and researchers working in musculoskeletal pain, the majority of whom are clinical and research physiotherapists (**Table 1**). Physiotherapists develop, maintain and restore maximum movement and functional ability in people and maximise their quality of life by looking at physical, psychological, emotional and social wellbeing, mainly using non-invasive, physical treatments or modalities such as exercises, manual therapy and education (54). High-value, biopsychosocial musculoskeletal pain care encompasses a mixture of conservative, non-invasive treatment methods, education, psychological therapies, pharmacological treatment and only in relevant cases, surgical treatment (55, 56). As such, the research team was unable to offer comprehensive representation of the views of all other healthcare professionals utilising assessment and treatment methods that were also evidence-based, when we came up with the recommendations to address the target behaviour during the inductive analysis at Step 5. The BCTs framework and worked example (see below) have been designed with the purpose of offering some proposed interventions with universal applicability across implementation contexts. However, the BCTs suggested are by no means exhaustive. This does not mean other BCTs are unimportant or ineffective, rather our selection of the BCTs is targeted at addressing the specified healthcare professionals' behaviours at the micro-level, and supporting these behaviours at the meso- and macro-level. We acknowledge the need to externally test and validate the conceptual model and synthesized framework of BCTs we have derived, to assess readiness to change, and to mindfully consider cultural factors influencing clinical community collaboration in different jurisdictions. We also speculate that the barriers to the adoption of a biopsychosocial approach may be "musculoskeletal pain"-agnostic, but since our search criterion for the initial review (15) is limited to musculoskeletal pain conditions, we could not generalise the findings beyond musculoskeletal pain.

Context is key in influencing healthcare professionals' behaviour towards improved adoption of a biopsychosocial approach to pain care

Data from our previous qualitative review (15) were found to support almost all the constructs in the COM-B model and TDF, with no data not fitting within the "a priori" framework. Consequently, no secondary thematic analysis was required in the "best fit" framework synthesis. It was worth highlighting that none of the coding undertaken in the meta-synthesis process for the previous review (15) was structured explicitly around concepts in the COM-B model and TDF. This implied that our chosen theory was sufficiently broad and a good fit to capture the data. In this current synthesis, the "best fit" method not only tested the theory, i.e., alignment with the COM-B model and TDF, but also supplemented the foundational theory of the COM-B model. The original COM-B model accorded equal value and importance to "capability", "opportunity" and "motivation" as influencing behaviours (23). The focal point of our novel synthesized conceptual model was "opportunity" (also known as the "environmental context"), appearing as a key target in influencing, shaping and regulating healthcare professionals' behaviour towards improved adoption. Consistent with previous studies (16, 57), context was key in the acquisition of professional knowledge and clinical skills in the learning of the biopsychosocial approach to pain, and it could either enable or hinder learning and practice behaviours.

Rationale for the selection of BCTs at the micro-level

In order to improve healthcare professionals' pain education training, our findings suggest that we need to prioritize intervention efforts at "knowledge" and "cognitive and interpersonal skills" and target the micro-level (clinical interface). Review-level evidence indicates that existing healthcare professionals' communication skills training uses a combination of information (delivered in the form of written instructions, didactic lectures, on-line learning or clinical tools), verbal or video feedback, modelling, problem-based learning, and practice (58, 59). More broadly, Cochrane reviews have stated that interventions such as education meetings (60), as well as printed educational materials (61), when used alone or combined with other interventions, can be effective to improve healthcare professionals' practice behaviours, but with small effect sizes. Educational meetings alone do not necessarily translate to changing healthcare professionals' ingrained practice behaviour and improved patients' outcomes (17, 20). To increase effectiveness, considerations are therefore needed in the design of education to use interactive, combined with didactic formats (60). To improve the fidelity of education/training interventions, incorporating the following BCTs; "4.1 instruction on how to perform the behaviour", and "8.1 behavioural practice/rehearsal" into training may be beneficial.

Rationale for the selection of BCTs at the meso- and macro-level

In order to adequately support pain education for healthcare professionals, our findings suggest a crucial need for targeted intervention efforts at the meso- (health services and workforce training) and macro-level (systems/policy), specifically for TDF domains "environmental context and resources" and "social influences". Here, aligning implementation efforts of biopsychosocial pain care to the health services and system levels is paramount. As a first step, addressing how clinical communities and the lived environment is structured to modify or create new knowledge, clinical practice guidelines, health services and policy is key. Target levers to support implementation include: establishing strong multi-sectoral partnerships and advocacy across clinical communities, people with lived experience of pain, work and professional organisations, universities, funding and insurance agencies and governments. This can strengthen health systems to support high value musculoskeletal pain care (62). Examples of existing partnerships and collaboration may include: partnering with patient advocates from the Global Alliance of Partners for Pain Advocacy (GAPPA) task force (63) or people with lived experience of pain to create better outcomes in the understanding, research, teaching and management of musculoskeletal pain (64–66); partnering with consumer representatives from Cochrane musculoskeletal review group to develop meaningful and person-centred clinical practice guidelines (46); delivering biopsychosocial-informed education to promote improvements in insurance workers' pain beliefs and helpful claims management behaviour (67); aligning country-level strategies to address the burden of pain to the newly developed global blueprint/framework for musculoskeletal health (68, 69). Additionally, as highlighted by our previous qualitative review (15), there is a critical need within health systems to support interdisciplinary or multidisciplinary care, especially for complex and chronic pain presentations. Appropriate funding or a reorientation of funding to develop models of care to deliver high value musculoskeletal pain care is required (68). There is an urgent need for governments, insurers, and health services to support and invest in high-value pain care, while concurrently disinvesting in low-value or no-value pain care (62). A change in the funding criterion and regulations within health systems for multidisciplinary services that aligns with and supports the use of a biopsychosocial approach will facilitate a change in the environmental context in which biopsychosocial pain care can be optimized. Hence, we incorporated the BCTs "3.1 Social support (unspecified)" and "3.2 Social support (practical)" into the synthesized framework because high value, biopsychosocial musculoskeletal pain care is the result of relationships, collaboration, coordination and authentic communication across the whole-of-health.

The availability of courses, and the re-design of curricula and capabilities/competencies across health disciplines is required to mobilise the knowledge and interpersonal skills required to support quality person-centred biopsychosocial musculoskeletal pain care. The design of value-add clinical systems learning roles as entrustable professional activities can enable healthcare students to learn tacit and contextualized knowledge. This could help bridge the gap between fulfilling a checklist of competencies and applying the knowledge and skills in dynamic, complex real-life situations (70). Here, the BCT "12.1 Restructuring the physical (learning) environment" is suggested.

Finally, the work spaces in which healthcare professionals practise is important. To implement behaviour change, introducing an environmental stimulus such as allocating a designated waiting room (with soundproof walls and a door), allows for a safe space for screening of psychosocial factors and can facilitate sensitive disclosure about patients' pain experience (64). The same contextual cues may help strengthen the context-behaviour association (71, 72) of the healthcare professional practising using a biopsychosocial approach in a safe space. Here, the BCT "7.1 Prompts/Cues" is suggested.

A worked example of how the derived framework of BCTs could be operationalised to improve adoption of biopsychosocial musculoskeletal pain care across the whole-of-health can be found in **Supplementary Table S7**. **Supplementary Table S7** has specific examples on how to use our identified BCTs to target on healthcare professionals, educators, guideline developers, workplace managers and policymaker, in order to facilitate the implementation of biopsychosocial pain care.

Potential strategies to empower healthcare professionals to *assess*, *identify* and *analyse* biopsychosocial factors

Though not an explicit aim of the study to answer *what* "knowledge" and "cognitive and interpersonal skills" are needed, and *how* to empower healthcare professionals to assess, identify and analyse biopsychosocial factors, the team was able to map potential strategies from best-level evidence during the inductive analysis process to derive the framework of BCTs. These suggestions are by no means comprehensive in scope but may serve as useful insights to implementation interventionists.

Review-level evidence highlights that a strong therapeutic alliance underpinned by trust, rapport, an affective bond demonstrating emotional sensitivity to patients; patient-centred empathic communication; and agreement on tasks and treatment goals can affect pain outcomes and physical functioning (78–80). Specific to patient-centred communication, strategies such as asking open-ended questions, discussing options, encouraging questions, expressing empathy and providing reassurance, explaining and providing information (59, 79), and validating the disclosure of patients (81, 82) are all important. This means biopsychosocial musculoskeletal pain care involves establishing meaningful connections with patients, shared-decision making, and supportive self-management (64, 83, 84). This will require communication behaviours synonymous to health coaching and/or motivational interviewing to navigate and optimise the clinical consultation (64, 84).

The communication behaviour in health coaching closely aligns with a recently developed classification of motivation and behaviour change techniques (MBCTs) derived from self-determination theory (73). Of note, self-determination theory is not part of the 19 theories used to formulate the BCW (23, 24) and MBCTs belong to a different taxonomy (not part of BCTTv1) (73). MBCTs offer unique insights into the specific behaviour change techniques that respond to human primacy needs of autonomy, competence and relatedness (73). Especially in persistent pain or centrally maintained pain states, there are more than biological factors driving a human pain experience (85). Restoring health and well-being requires healthcare professionals to consider these needs. Using MBCTs as a tool, or as "instructions on how to perform the communication behaviour" may support and enable healthcare professionals to better *assess* biopsychosocial factors. Behavioural counselling skills can help enable persons with chronic musculoskeletal pain to make positive lifestyle changes and encourage adherence to self-management (77). Here, the use of MBCTs may help motivate health behaviour change in patients with musculoskeletal pain. See **Supplementary Table S8** for list of MBCTs.

To empower healthcare professionals to learn to *identify* and *analyse* biopsychosocial factors, a focus of intervention might consider designing educational training programs. Here the aim would be to illustrate the multidimensional interacting biopsychosocial factors associated with musculoskeletal pain and identify how, for each person, these interacting factors create a unique multidimensional experience of pain. Our previous qualitative evidence synthesis highlighted that healthcare professionals, while aware of the importance of psychosocial factors, were unclear about what those specific factors were (15). While addressing biological factors remains important, a broader view that captures the impact of psychological and social dimensions, reflects the multidimensionality of each individual's unique pain experience. During the inductive analysis process, we developed a list of recommendations to address healthcare professionals' training (see **Box 1** below). This list can be further strategized, contextualized and incorporated into training curricula to enhance healthcare professionals' understanding of the common psychosocial factors associated with musculoskeletal pain presentations.

Box 1 A suggested list of evidence-informed strategies[*] to help promote and enhance healthcare professionals' awareness of psychosocial factors associated with musculoskeletal pain.

Suggestion 1: Applying the International Classification of Functioning, Disability and Health (ICF) framework to gauge the level of health or disability for a person's pain presentation, by taking into account the person's bodily function, activity limitation and participation restriction and contextual factors that might influence function (86, 87). This may increase awareness of the impact of pain on a person's life.
Suggestion 2: Providing information about the social determinants of health (SDH) that can influence recovery of patients with musculoskeletal impairments (88), may increase awareness and early recognition of the contribution of SDH to disparities in musculoskeletal pain conditions, such as low back pain outcomes (89).
Suggestion 3: Providing evidence that early life stress, adverse childhood experiences, stressful life events, perceived injustice, and iatrogenic factors are associated with musculoskeletal pain and increased risk of developing chronic pain (90–99). Pain can be triggered by all these factors, and these factors can also lead to /prolong pain.
Suggestion 4: Applying a lifespan perspective to the teaching and understanding of acute, recurrent, and chronic musculoskeletal pain to raise awareness that pain can emerge, resolve, recur, and persist from childhood to old age (100, 101).
Suggestion 5: Incorporating medical humanities into the teaching of pain science in musculoskeletal pain may provide a more authentic and compelling understanding of peoples' pain narratives, and a more vivid description of the impact of pain on quality of life (102, 103).
Suggestion 6: Providing evidence that psychological factors such as fear avoidance beliefs, increased fear of pain and pain-related anxiety are associated with greater pain intensity and disability (104–106), giving agency to enquire about these factors when assessing and managing people experiencing pain.
Suggestion 7: Providing evidence that chronic musculoskeletal pain is associated with higher prevalence and levels of depression, disability, decreased participation in social aspects of daily life, lower quality of life and close relationships conflicts (107), giving agency on what to expect when managing people experiencing chronic pain.

ICF, international classification of functioning, disability and health; SDH, social determinants of health.

[*] References to inform and support suggestions are drawn from systematic reviews or best-level evidence where possible.

Practicing biopsychosocial pain care requires healthcare professionals to believe their patients about their report of pain, i.e., validation is critical. From a person-centred frame, this involves doing what is right for each person (aligned to their priorities and goals) at the right time, and taking into account relevant biological factors, their psychological wellbeing and social and environmental circumstances. It is important to educate healthcare students' and health professionals to be listen carefully to each person's pain narrative/story and work in partnership to address various contextual life events within a person-centred evidence-based framework. This approach flips the lens towards the person rather than their condition. Such an inversion that is required of the healthcare professional is not easy but can be trained (64). Here, the focus becomes training healthcare professionals to empathise with their patients, to create more authentic communication and emotional connection that builds therapeutic alliance and supports recovery.

The biopsychosocial model of pain 40 years on: How this work improves what may be limiting implementation

Most research focus on improving the adoption of the biopsychosocial model at the micro-level, i.e., the clinical interface (11, 83, 84, 108). In this regard, we highlighted and proposed how the training of communication strategies and empathic listening (64, 81, 82) and insights from behavioural change techniques (31, 73) can help to enhance training efforts to support implementation and improve the quality of musculoskeletal pain care. At the meso- and macro-level, contextual factors and the interdependencies between various stakeholder groups in the whole-of-health within modern healthcare systems have not been adequately addressed and have not been addressed well in health systems strengthening strategies (68, 109). This may be one key to limiting effective implementation. Our work gives a refreshing whole-of-health perspective to a more-than-four-decade old biopsychosocial model of pain care.

Implications for research and practice

Further research and road testing is required to check the validity, credibility and transferability of our derived BCT framework, including through relevant stakeholder engagement or an interdisciplinary partnership model. In this context, the evaluation of contemporary musculoskeletal models of care and policy-into-practice initiatives that incorporate a biopsychosocial approach, will be useful (109–112).

Conclusion

From a behavioural perspective, implementation of a biopsychosocial approach to musculoskeletal pain care is a highly complex task. We have derived a conceptual model and a framework of BCTs to support future implementation efforts. Other than healthcare professionals, this requires a system-wide initiative from multi-stakeholders such as educators, to workplace managers and non-medical professions involved in healthcare (e.g., insurance workers, vocational rehabilitation providers), to guideline developers and policymakers. At the micro-level, prioritizing intervention efforts aimed at educational upskilling in a biopsychosocial approach, critical clinical reasoning and effective communication behaviours to strengthen therapeutic alliance are proposed. At the meso- and macro-level, encouraging multi-sectoral partnerships across the whole-of-health, increasing the availability of health workforce pain training programs and the re-design of curricula to strengthen interdisciplinary pain competency are crucial.

Data availability statement

The original contributions presented in the study are included in the article/supplementary material, further inquiries can be directed to the corresponding author/s. The data analyzed in this study was obtained from https://journals.lww.com/pain/Abstract/2021/08000/Barriers_and_enablers_influencing_healthcare.2.aspx, the following licenses/restrictions apply [Copyright © 2021 International Association for the Study of Pain]. Requests to access these datasets should be directed to PAIN or Wendy Ng, w.ng21@postgrad.curtin.edu.au.

Author contributions

WN conceived and designed the study, mapped the data, collated the results at every step of the BCW process, conducted the analysis, interpreted the data, formulated the conceptual model and framework of BCTs, participated in discussions and drafted the manuscript. HS participated in research team discussions as an independent team member/subject matter expert not privy to the BCW process, and contributed to interpretation of primary data, discussions and conceptual framing of the study outcomes, drafting and revising the manuscript. DB and DFG contributed to the initial conception of the study design and data mapping, participated in group discussions, advised as subject matter experts, interpreted the results, and revised the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpain.2023.1169178/full#supplementary-material.

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Supervised interprofessional student pain clinic program - efficacy with the utilization of zoom

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Introduction: Current medical education curricula in pain management are insufficient to match the prevalence of chronic pain and the needs of patient populations. The Supervised Student Inter-professional Pain Clinic Program (SSIPCP) aims to train healthcare professional students to improve their abilities in chronic pain management in interprofessional (IP) teams. Due to the COVID-19 pandemic, Zoom was employed to allow the program to continue. In this study, survey data from students who participated during and before the COVID-19 pandemic were compared to determine if the program carried out via Zoom can maintain its effectiveness.

Methods: Student pre- and post-program survey data were entered into Microsoft Excel spreadsheet and then graphed and analyzed with Sigma Plot. Surveys assessed knowledge in chronic pain physiology and management, attitude towards IP practice, and perceived team skills in the form of questionnaires and open-ended questions. Paired *t*-tests and Wilcoxon Signed-rank tests were used for two-group comparisons and two-way repeated ANOVA followed by the Holm-Sidak *post-hoc* tests were used for multiple group comparisons.

Results: Overall, students continued to exhibit significant improvement in major areas assessed even with the use of Zoom. Strengths of the programs were also shared across student cohorts regardless of Zoom usage. However, despite their improvements, students who utilized Zoom stated that they would have preferred in-person program activities.

Conclusion: Although students prefer in-person activities, the SSIPCP successfully trained healthcare students in chronic pain management and working in an IP team through Zoom.

KEYWORDS

zoom, interprofessional education, chronic pain, teamwork, COVID - 19

1. Background

Chronic pain is an ongoing issue that affects millions of U.S citizens. In 2016, the CDC estimated about 50 million adults in the United States experience chronic pain and 19.6 million adults had chronic pain that impacts daily activity (1). Due to the prevalence of chronic pain in the U.S, it costs the nation up to $635 billion each year in the form of medical treatment and lost productivity (2). Although chronic pain continues to be a huge problem, medical school curriculum regarding chronic pain remains lackluster. A study at Johns Hopkins University examining medical schools in North America revealed that pain education is limited and fragmentary (3). Lack of adequate pain education leads to inefficient care for chronic pain patients. A qualitative study reported that medical school students and medical residents felt inadequately prepared to treat chronic pain patients. Without adequate training, students lacked the skills and empathy to treat chronic pain patients effectively (4).

Maine is also no stranger to chronic pain. According to data analysis from Maine All Payer Claims Database (MEAPCD), 29.5% of the total Maine population suffers from chronic pain (5). In the attempt to fill the gap of lack of chronic pain education in Maine, the Supervised Student Interprofessional Chronic Pain Program (SSIPCP) at The University of New England College of Osteopathic Medicine (UNE COM) was created to provide students with the experience of chronic pain patient care in an interprofessional (IP) setting. Students were able to significantly improve their background knowledge regarding chronic pain physiology while improving their ability to work in an IP setting with students from other health care professions (6).

The program has successfully trained students using in-person and on-site settings up until the end of Fall 2019. However, during the acute COVID-19 pandemic, physical distancing measures and state mandates severely limited on-site teaching activities. To combat this, HIPPA-compliant video conferencing utilizing Zoom was employed to allow students to observe the attending physiatrist at the Northern Light Mercy Pain Center in Portland, Maine, perform office visits with chronic pain patients, as well as conduct team meetings. The program in Spring 2020 utilized Zoom for the final team meeting while in Spring 2021 it was completely reliant on Zoom sessions. In this study, survey data from students who participated during and before the COVID-19 pandemic were compared to determine if the program carried out via Zoom could maintain its efficacy.

1.1. Zoom as a real time video platform for education

Zoom is a video communication service that was founded in 2011 but has recently gained traction during the COVID-19 pandemic due to its versatility and ease of use. Zoom provides video, voice, and chatting services across all types of electronic devices (7). Within the education sphere, Zoom has been involved in many different school systems supporting traditional, virtual, and hybrid classrooms in the midst of the pandemic. Zoom provides many features, like breakout rooms, screen sharing and annotating to allow for team exercises and presentations. Within medical schools, Zoom has been an important tool as it gave students ease of access to lectures and presentations from home. For students, time that was previously allotted to commuting could be used elsewhere. For hospitals, such as Mercy Hospital, Zoom has been adopted for telehealth appointments during COVID-19 pandemic while protecting patients' privacy. To continue with the SSIPCP during the pandemic, we utilized the Zoom program subscribed by Mercy Hospital. We took advantage of many features of Zoom that contributed to the success of the educational program during COVID-19 pandemic.

2. Methods

2.1. The supervised student inter-professional pain clinic program (SSIPCP)

The SSIPCP is a 12-week interprofessional training program that recruits students from various health care professions including nursing, osteopathic medicine, occupational therapy, pharmacy, physical therapy, and social work within the University of New England (6). Students were placed into teams with other professions in which they would assess a patient with chronic pain and then create a treatment plan under the supervision of the attending physiatrist. Students have a total of 3 appointments with the patient (students are required to attend at least one appointment due to their class schedules) and 4 team meetings for team discussion. Pre- and post-surveys consisting of questionnaires assessing knowledge in chronic pain physiology and management, attitude and perception towards IP practice, and perceived team skills were conducted. Patient confidentiality and privacy was protected throughout the program. For more details regarding the program, see our previous publication (6).

The SSIPCP began in Spring of 2016 and has been held each semester except that the program in the Fall of 2020 that was cancelled due to COVID-19. The program has successfully trained students using in-person and on-site settings up until Fall 2019. Due to the COVID-19 pandemic, HIPPA-compliant Zoom was employed to allow the program to continue running without physical contact. Participating students in Spring 2020 utilized Zoom for their final team meeting. During patient appointments, the attending physiatrist would be with the patient in the exam room while participating students attended via Zoom. Students in Spring 2021 were completely reliant on Zoom sessions.

The project received IRB exemption from University of New England (protocol#112515-014) and IRB approval from Mercy Hospital (protocol#135).

2.2. Outcome measures from the program

Pre- and post-surveys included information about prior interprofessional/chronic pain experiences, KnowPain50 (KP50), Revised Neurophysiology of Pain Questionnaire (RNPQ), Interprofessional Education Perceptions Scale (IEPS), Team Skill Scale (TSS), and open-ended questions. The KP50 quantitatively measured students' knowledge of chronic pain physiology through 50 questions scored out of a total of 250 points. This was a self-assessment tool created to numerically gauge a physician's expertise regarding chronic pain management but can also measure the effectiveness of pain management education programs (8). The RNPQ also quantitatively measured students' knowledge through a true or false survey scored out of 12 points for 12 questions. It was previously used to help patients conceptualize the biological mechanisms of their chronic pain (9). Students' attitude and perception towards IP practice were evaluated using the IEPS, a structurally stable and reliable measurement tool for

TABLE 1 Number of students from each health professional program that participated each semester[a]

Programs	# of participants in Spring 2019	# of participants in Fall 2019	# of participants in Spring 2020	# of participants in Spring 2021	Total # of students
Nursing	0	1	0	2	3
Occupational therapy	2	3	1	2	8
Osteopathic medicine	4	3	4	4	15
Pharmacy	2	2	3	1	8
Physical therapy	0	2	3	1	6
Physician assistant	1	0	0	1	2
Social work	3	3	2	4	12
Total # of students	12	14	13	15	54

[a] Program was cancelled in the fall of 2020; participating students in Spring 2020 utilized Zoom for their final team meeting while students in Spring 2021 were completely reliant on Zoom sessions.

undergraduate health and social care students (10). The IEPS measures 3 sub items: professional competence and autonomy, perceived need for cooperation, and actual coop for further analysis. Students' perceived abilities to work together in an interdisciplinary setting was measured utilizing the modified TSS (11). In addition, students also assessed their achievement of program learning objectives in the post-survey via a questionnaire using Likert scale (1= Strongly disagree, 2 = Disagree, 3 = Agree, and 4 = Strongly agree, and 0 = N/A).

2.3. Statistical analysis

Student de-identified pre- and post-program survey data from Spring 2019, Fall 2019, Spring 2020, and Spring 2021 were entered into Microsoft Excel and then graphed and analyzed with SigmaPlot 10 with Sigma-Stat embedded (Systat Software, Inpixon, Palo Alto, CA). Data from 8 students was removed from data analysis due to missing post-survey data. Paired *t*-tests (when normality tests were passed) and Wilcoxon Signed-rank tests (when normality test did not pass) were used for two-group comparisons and two-way repeated analysis of variance (ANOVA) followed by the Holm-Sidak *post-hoc* tests were used for multiple group comparisons of log transformed data. Data are presented as mean ± SEM. $p < 0.05$ is considered as statistically significant.

2.4. Qualitative data analysis

Open ended questions allowed students to evaluate program learning objectives (using Likert scale), along with providing feedback on the strengths and weaknesses of the program. The open-ended feedback questions included were: (1) What did you like best about the training program? (2) What did you like least about the training program? If you could change or improve the training program to address this, what would you do? (3) What about your experience in this training program genuinely surprised you or challenged your previous perceptions both in interprofessional practice and chronic pain management? (4) How do you think this training experience might influence your healthcare practice in the future? Answers for each of these questions were copied and grouped into Microsoft Word to identify the most common themes from students in each participating year. Selected quotes representing major themes are discussed in the results section.

3. Results

3.1. Participating students and prior experience

There was a total of 54 students from 7 different health care professions who were enrolled into the program from Spring 2019—Spring 2021. Eight students were unable to complete the post-survey but had filled out a pre-survey which was included in the analysis (Table 1).

In terms of students' prior experience with chronic pain, the majority of participants (48 in 54, 88.9%) had no prior chronic pain-related experiences while the rest either observed chronic pain patient care or worked in a pain clinic (Figure 1A). In regard to interprofessional education experience, a slightly over half of the participants (29 in 54, 53.7%) of the participating students stated they have had prior interprofessional experiences (Figure 1B).

3.2. Overall improvement in outcome measurements

When students' knowledge in chronic pain physiology and pain management before and after the program was analyzed, there were significant increases in the participants' revised RNPQ score (Figure 2A, Wilcoxon signed-rank test, $p < 0.001$) and KP50 score (Figure 2B, Wilcoxon signed-rank test, $p < 0.001$).

The perception of participants' attitude and abilities to work in an interprofessional setting significantly improved as is reflected in an increased score in the IEPS questionnaire (Figure 3A, two-tailed paired t-test, $p < 0.002$). Students' overall perception of their teamwork abilities were significantly increased as well, which is shown by a significant increase in the TSS score (Figure 3B, two-tailed paired t-test, $p < 0.001$).

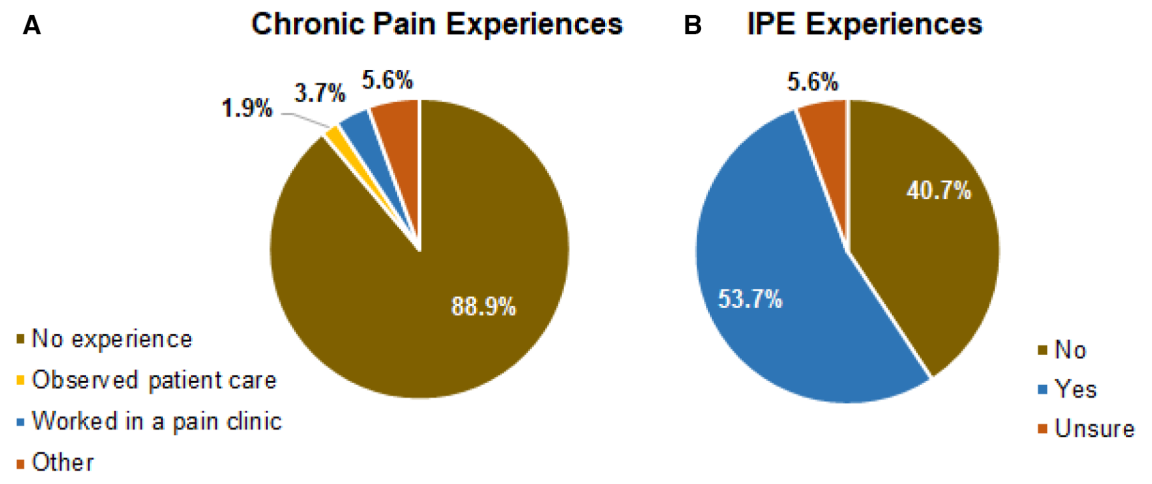

FIGURE 1
(A,B) student participants' previous chronic pain and IPE experiences. Percentage of students who have or have not had prior experiences working with chronic pain patients and in what form are shown in (A). Percentage of students who have or have not worked in an IP setting are shown in (B).

3.3. Improvement in outcome measurements by semester/year

The improvement regarding knowledge in chronic pain physiology and pain management was compared between each program session. Although the average scores of RNPQ were increased in all semesters, statistical significance was found in Spring 2019 and Spring 2020 sessions (Figure 4A, ANOVA, $p = 0.036$, $p = 0.019$, respectively). Pre vs. Post program KP50 scores revealed significant improvement regardless of the semester/year of participation (Figure 4B, ANOVA, $p < 0.05$ for all). When students' perception and attitude towards interprofessional practice were analyzed, IEPS scores significantly increased in Fall 2019 and Spring 2021 (Figure 4C, ANOVA, $p = 0.048$, $p = 0.012$, respectively) with the overall increase in the average score observed in all sessions. Regarding students' perception of their teamwork abilities, TSS scores were significantly increased in all program sessions (Figure 4D, ANOVA, $p < 0.05$ for all). When comparing between the participating years, there were no significant differences in the extent of student improvement after program completion. Furthermore, when the 3 IEPS sub-items (professional competence and autonomy, perceived need for cooperation, and actual cooperation) were analyzed, there were no notable patterns of significance when comparing extent of improvement between Spring 2019, Fall 2019, Spring 2020, and Spring 2021 (sub-item data not shown). Within the category of professional competence and autonomy, Fall 2019 (ANOVA, mean 25.333 ± 0.748, $p = 0.038$) and Spring 2021 (ANOVA, mean 26.231 ± 0.718, $p = 0.030$) displayed significant improvement. The category of perceived cooperation revealed no significant differences. The third category of actual cooperation showed significant improvement in only Spring 2021 (ANOVA, mean 26.500 ± 0.721, $p = 0.012$).

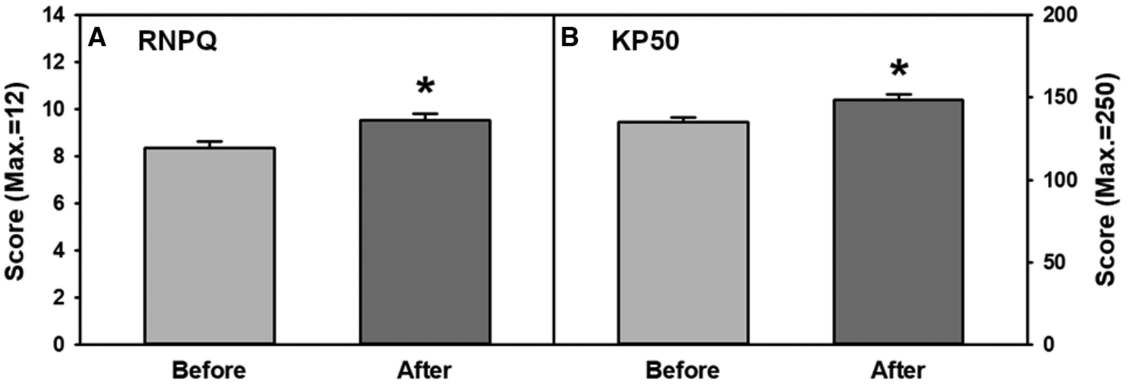

FIGURE 2
(A,B) overall combined improvements on participants' knowledge in chronic pain physiology and pain management measured with (A) RNPQ and (B) KP50 before and after the program. RNPQ, Revised neurophysiology of pain questionnaire; KP50, KnowPain50.

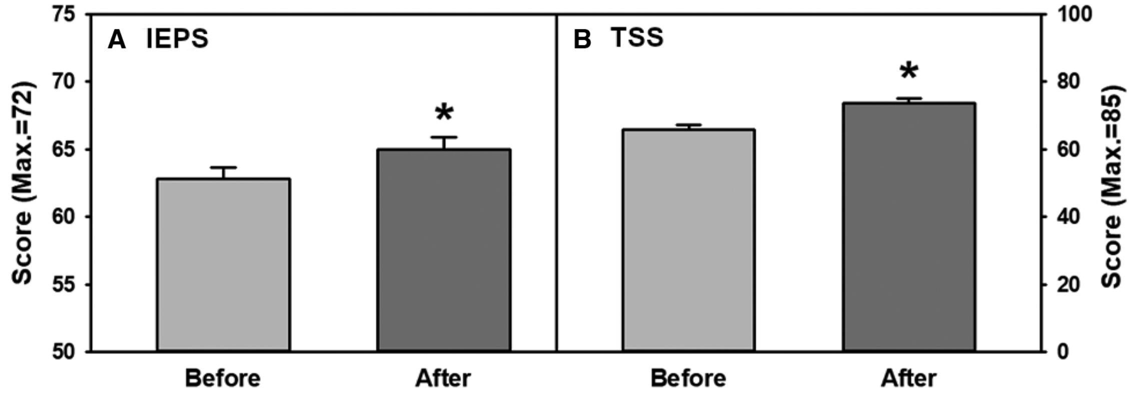

FIGURE 3
(A,B) overall combined improvements of participants' perception in interprofessional teamwork abilities measured with (A) IEPS and (B) TSS scores before and after the program. IEPS, Interprofessional education perceptions scale. TSS, Team skill scale.

3.4. Learning objective achievement

In the post-survey, students provided feedback on whether they felt they had achieved the learning objectives of the program (Table 2). The results revealed that the program successfully and consistently met al.l learning objectives in each program session. A total of 7 learning objectives were evaluated using a Likert scale from 1 to 4 (4 = Strongly agree). Out of the maximum score of 28, Spring 2019 had a mean ± SEM score of 26.91 ± 0.39, Fall 2019 was 24.75 ± 1.01, Spring 2020 was 24.8 ± 0.83, and Spring 2021 was 24.9 ± 0.90. There were no significant differences between sessions.

3.5. Open-ended questions

When responses to the open-ended questions (see "Methods" for questions) were analyzed, common and unique themes were identified. In response to question 1, students in all participating years commonly stated that the best parts of the program

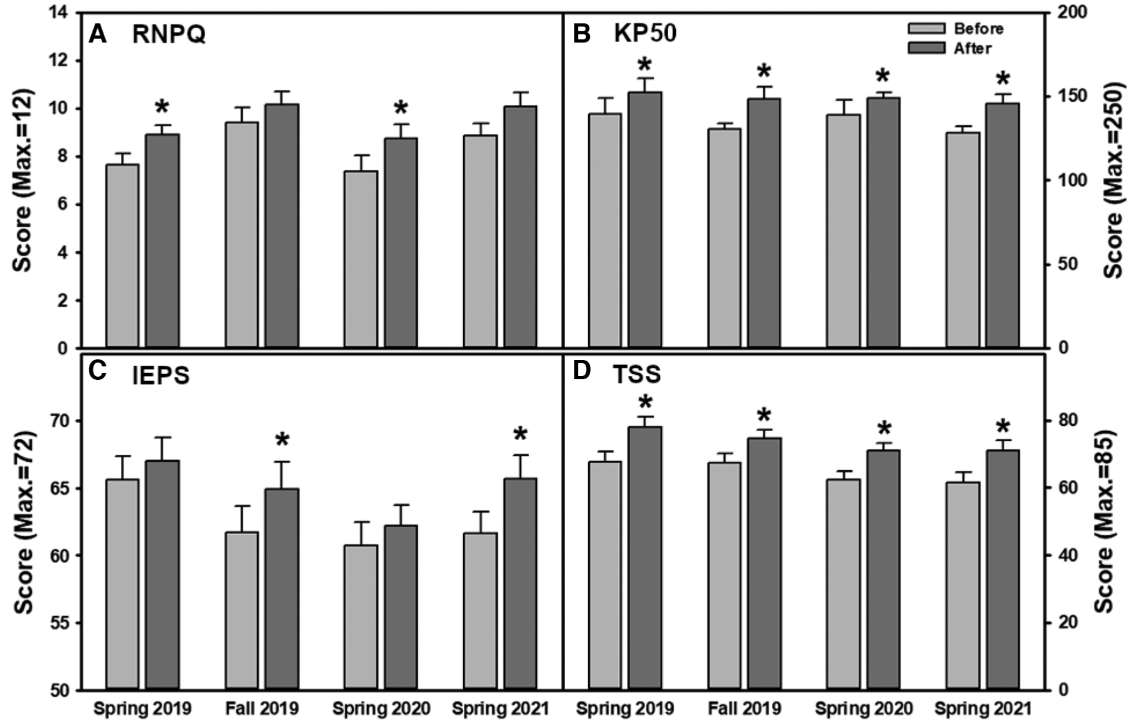

FIGURE 4
(A–D) changes in outcome measures for each program session. Knowledge in chronic pain physiology and pain management were assessed with (A) RNPQ and (B) KP50. Interprofessional teamwork abilities were measured through (C) IEPS and (D) TSS.

TABLE 2 Students' perception of achieving program learning objectives.

Learning objective no.	Learning objective	Students' perception[a]
1a	This training program helped me to obtain experience in team-based practice.	3.76 ± 0.06
1b	This training program helped me to obtain experience in leading an inter-professional medical team-for team leaders mostly	3.45 ± 0.14
2	This training program helped me become familiar with the roles of other health care professionals	3.74 ± 0.06
3	This training program helped me to improve clinical skills including but not limited to physical exam, effective communication, and promoting behavioral modification	3.49 ± 0.09
4a	This training program helped me to understand the basic concepts of managing patients with chronic pain	3.62 ± 0.08
4b	This training program helped me to understand the complexity of managing patients with chronic pain	3.70 ± 0.07
5	This training program helped me to review basic science knowledge related to pain including but not limited to relevant knowledge in the anatomy, physiology, pharmacology, pathology, and biochemistry	3.55 ± 0.08

[a]Each learning objective graded on a scale of 1–4 (4 = strongly agree, 1 = strongly disagree, 0 = N/A). Data are presented as mean ± SEM.

included, working in an interdisciplinary team, learning from the attending physiatrist's lectures, and having the opportunity to work directly with patients. An overwhelming majority of students agreed that the program "helped me build confidence while working in an interprofessional team" and that the attending physiatrist's lectures "provided the scientific background to help inform each discipline's understanding of chronic pain."

In response to question 2, students similarly noted that the program should increase the amount of time students spend with patients and create a more organized schedule for team meetings. Students noted that they "would like to have been more involved in follow-up cases to see improvements in the patient" to be able to "strengthen the clinical relationship with the patient." A topic unique to Spring and Fall 2019 was difficulty with attendance as personal scheduling would often overlap with team meetings and discussions. Unique themes from only Spring 2021 were the need for increased participation from all group members and a preference for non-Zoom activities stating that "it is difficult to stay engaged."

In response to question 3, students commonly stated that they found it surprising how important an integrated health care system is to adequately manage complex chronic pain conditions. Students unanimously agreed that "interprofessional practice is key in providing excellent patient care" while acknowledging that it can be challenging to create a balance within teams to provide empathetic patient centered care.

Finally, question 4 revealed that students in all program sessions would like to advocate for interdisciplinary teams in clinical settings to better care for and understand chronic pain patients in their future healthcare practice. Students agreed that they are "more empathetic and have a much better understanding of how pain works in the body" while also being able to "work more smoothly with people on diverse teams."

4. Discussion

In attempts to improve medical education regarding chronic pain, the SSIPCP was created in 2016 and has been able to successfully train students since then. Even with the addition of Zoom due to the COVID-19 pandemic, students were able to improve significantly in both chronic pain physiology knowledge and their ability to work together with others to provide patient centered care. The improved KP50 and RNPQ scores after the program indicate that students' general knowledge in chronic pain physiology improved regardless of program session, while the improved IEPS and TSS data showed that students' perception of their ability to work with other health care professionals also improved independent of the use of Zoom. Overall, program session and Zoom usage did not affect the effectiveness of the program.

It is typically assumed that to foster teamwork ability being in person with your team members is necessary to form bonds and understand workflow dynamics within a group. However, this study suggests the possibility that teamwork can be comparably nurtured in an online learning setting. Phenomenological research in 2018 comparing graduate students taking courses online vs. in-person revealed many commonalities between their teamwork experiences such as group efforts to create sustainable leadership and equal division of responsibility amongst team members. However, unique differences in each learning experience were discovered making it difficult to truly compare the two distinct modalities of learning (12). Our study confirmed that students partaking in online learning can create effective leadership while fostering an environment for sharing ideas and responsibilities. Students' open-ended comments showed that students enjoyed the experience and were able to learn from their colleagues regardless of Zoom usage. Students prior to COVID-19 voiced opinions regarding absent teammates at meetings which detracted from their experience. This was not an issue for those participating online, as students were able to log into a meeting from any location, increasing freedom and convenience for students. Further, students in all sessions stated that the SSIPCP met al.l its learning objectives while upholding its strengths regardless of Zoom usage. However, despite their improvements, students seem to have a propensity towards in-person learning as this is a common experience for clinical learning. Online learning has never been the traditional method of education and participating students most likely have grown up in face-to-face learning environments making it the more comfortable modality. Students utilizing Zoom may not be able to experience the comfortability or charm that comes with face-to-face learning, but those shortcomings are made up for in terms in freedom, availability, and convenience. It should be noted that in our program, students were not required to complete chronic pain related physical exams, but only required students to interview the patients to obtain relevant histories, which may have contributed to maintaining effectiveness of Zoom sessions.

Our results are also echoed by other reports. Recent studies during the pandemic in 2021 also provided strong support for the use of online platforms in medical training regarding Opioid Overdose Prevention and Response Training. They also showed that students preferred in person activities even when online resources were just as effective (13). A study in 2020 during the COVID-19 pandemic assessing students' attitudes towards online learning revealed that students may be more opposed to online learning because of technical difficulties, distractions due to being outside a classroom, and decreased practical/demonstrative segments of learning (14). Although online learning has its negatives, Zoom usage allows for increased schedule flexibility and enrollment of students that may have difficulties with transportation. Online learning is a viable and may be more equitable option for program activities considering the fact that it seems to be as effective as in-person learning.

Not only is Zoom useful for medical education, it can also be a beneficial tool for chronic pain patients. The emotional and mental aspect of chronic pain effects patients to a great extent. It was found that long term pain management support groups were an effective way at creating healthy coping mechanisms to maintain recovery (15). Zoom can be a way for patients to connect without having to commute, which can be difficult for someone living with chronic pain. Patients can receive the emotional and social aspects of support groups without the constraints of transportation. Online video conferencing services, such as Zoom, has potential to enhance both medical education and patient care by enhancing connections between patients and medical or other health professional students during didactic and clinical skill training. Zoom or similar platforms could significantly increase health professional students' encounters with patients throughout their training with ease of access without raising the cost dramatically. These virtual student-patient encounters are particularly beneficial for students to practice conducting in-depth interviews and to learn and further understand the psychosocial aspects of chronic pain.

Notably, the results revealed an insignificant increase in RNPQ in Fall 2019 and Spring 2021 which may be due to the increased baseline scores of the participants in those years. IEPS scores also reflected a similar pattern as no significance was found in Spring 2019 and Spring 2020. This is likely because 53.7% of students in this study have had interprofessional experience while in past sessions (Spring 2016–Fall 2018) only 36.05% had prior experience (6). This is coinciding with the increased IPE programs being implemented in various health professional programs at UNE. While we are excited about this positive change in IPE, it also reminds us that necessary future modifications of the program should be considered and implemented to adapt to the continued overall improvement in IPE.

5. Limitations

This study only reflects feedback and surveys from the SSIPCP, which is limited by a small sample size, changing participating students each session, and lack of a control group. Health profession may also be a contributing factor towards program efficacy, and the small and varied numbers of students from each profession made accurate analysis difficult, which may limit the study's generalizability. We were also unable to follow individual students long-term to see whether the program affected their practice later on. Program modification so that it will allow long-term assessment is desired and in consideration.

6. Conclusion

Although students prefer in-person program activities, the SSIPCP successfully trained healthcare students in chronic pain and its management, as well as working in an IP team through Zoom. In-person activities are important for an integrated learning environment but not always "must-to-have" in students' education. This opens new avenues to effectively enrich students' education, within and beyond the education in health care professional fields, particularly programs that are traditionally taught in-person only. Zoom and other virtual formats allow us to use various online resources more effectively to make the program more versatile, equitable, and convenient while effectively providing students with a fruitful experience. With this current experience, we are inspired to re-design our program and take full advantage of many new features of virtual teaching/learning that have been discovered by educators around the world during the COVID-19 pandemic period. This includes goals to make our program more flexible while engaging, enable more participants, and include more patient interactions in the near future.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by IRB exemption from University of New England (protocol#112515-014) and IRB approval from Mercy Hospital (protocol#135). The patients/participants provided their written informed consent to participate in this study.

Author contributions

BD helped conceive and present the idea, performed analysis and comparisons, and wrote manuscript with input from LC. LC performed original study in which data was contrived. LC verified analytical methods and supervised all aspects of the research. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Flipping the hidden curriculum to transform pain education and culture

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Though long-sought, transformation of pain management practice and culture has yet to be realized. We propose both a likely cause—entrenchment in a biomedical model of care that is observed and then replicated by trainees—and a solution: deliberately leveraging the hidden curriculum to instead implement a sociopsychobiological (SPB) model of care. We make use of Implicit Bias Recognition and Management, a tool that helps teams to first recognize and "surface" whatever is implicit and to subsequently intervene to change whatever is found to be lacking. We describe how a practice might use iterations of recognition and intervention to move from a biomedical to a SPB model by providing examples from the Chronic Pain Wellness Center in the Phoenix Veterans Affairs Health Care System. As pain management practitioners and educators collectively leverage the hidden curriculum to provide care in the SPB model, we will not only positively transform our individual practices but also pain management as a whole.

KEYWORDS

hidden curriculum, biopsychosocial, biomedical, chronic pain, sociopsychobiological, pain education, patient-centered, culture

Introduction

In 2011, the U.S. Institute of Medicine (IOM) called for a cultural transformation of attitudes toward pain, explaining that a person's pain experience is unique and influenced by a variety of factors beyond the biomedical ones. Prominent recommendations from the IOM report, emphasized by many additional experts, included an integrated approach to pain management with an emphasis on promoting self-management (1, 2). Over a decade later, biomedically focused pain management is still the norm, and this outdated model's attempt to provide a quick fix with medications or procedures continues to fall short of the IOM's recommendations. With all the discussion over the intervening years of how to change and improve pain management, why has change been elusive? We argue that the hidden curriculum that perpetuates the biomedical model in pain education and practice is at the root of our collective resistance to true cultural change. We submit that recognizing the undesired aspects of the hidden curriculum and intentionally modifying them will transform pain management culture from its current state to one that is conducive to the patient-centered sociopsychobiological (SPB) model.

The history of the hidden curriculum

Identified by Hafferty and Franks, “the hidden curriculum” was described as the vehicle by which students of medicine learned “the values, attitudes, beliefs, and related behaviors deemed important within medicine” (3). The concept described “a set of influences that function at the level of organizational structure and culture” that existed outside of the formal curriculum (4). A 2018 scoping review traced this idea of a “hidden curriculum” through over twenty years of discussion in the medical literature, noting that the effects of the hidden curriculum were often more influential than the formal curriculum and sometimes harmful (5). One study, for example, reported that learners exhibited decreasing empathy as they observed their clinical teachers (6). Because of its pervasive yet indirect influence, the hidden curriculum has been a widely discussed and repeatedly studied aspect of medical education at large and as well as in specific medical specialties (5).

Pain management is one of the specialties where the hidden curriculum has been explored, though not extensively. One Canadian study offered insight into the hidden curriculum when medical students reported observing physicians treating patients with pain as a “nuisance” rather than “taking the time to practice good pain management” (7). Another study interviewed 13 medical students about their pain management education and found that the hidden curriculum taught students that patients with chronic pain are “too difficult” (8). Furthermore, a study in the UK interviewed 21 medical students and found that the hidden curriculum modeled dismissive behavior toward patients with fibromyalgia (9). Similarly, a 2017 scoping review suggested that the hidden curriculum portrays patients with chronic pain as “a distinct downside of primary care practice in general” (10).

While discussion of the hidden curriculum was initially mostly focused on identifying the negative aspects of medical culture passed on to trainees in clinical training, recommendations followed for the medical community to take action and reform this negative hidden culture (11). For example, Senior wrote of the intentional hidden curriculum he strives to embody for the benefit of his students (12), and Webster et al. wrote that the hidden curriculum can be seen as a “fertile ground for critical reflection on how socialization processes could be better structured and enacted” (10). Others have suggested that working with the hidden curriculum can even be “exciting” when trainees are encouraged to critically evaluate and explore the hidden curriculum for themselves, with the aim of helping them feel empowered to act differently from those they may have observed (13). Indeed, a modern approach to pain education expects a certain degree of disconnect between the formal curriculum and what learners observe in clinical practice, and it embraces rather than eschews that didactic dissonance (14, 15). As the hidden curriculum has become ever more visible, educators have moved to put it on intentional display for each trainee to individually and critically explore. We would add that the hidden curriculum, and the culture it represents, ought now to be treated critically not only by trainees, but by each member of a pain management team. The hidden “values, attitudes, and beliefs” (3) embodied in the biomedically focused pain management culture would greatly benefit from careful and critical review.

Today’s hidden (biomedical) curriculum in pain education

The hidden curriculum of pain management education is usefully explored by a critical evaluation of the biomedical model. On rotations, trainees often see preceptors searching for a pathoanatomical cause of a patient’s pain (i.e., a single pain generator) and treating that generator as the primary source of a patient’s pain. This method, whether or not physicians themselves are conscious of it, suggests attitudes and beliefs out of sync with the IOM’s recommendations that healthcare practitioners consider a multiplicity of factors that influence the generation of pain (1). Trainees might also observe physicians’ emphasis on imaging (16) as another manifestation of implicit beliefs about pain generators, despite the poor correlation between anatomic abnormalities and pain (16–20) and the lack of an identifiable source of pain in nearly all patients with low back pain (21). Once a pain generator is identified, students are likely to see a formulaic approach to managing pain, often driven by a patient’s distress level, which includes spending the majority of the appointment time describing and recommending the next most potent medication or the next most invasive treatment. The allocation of time conveys to the patient, and to the trainee, that moving on to more invasive treatments is more important than exploring the social, psychological, and physical factors that are primary drivers of the experience of pain and pain-related disability. Unfortunately, trainees may also observe physicians feeling pressured to “do something” when patients are in high distress and repeatedly reporting lack of improvement with passive treatments. Indeed, physicians are likely to recommend progressively more invasive and more potent treatments, even though research suggests that this escalating approach does not often yield improvement (22, 23).

As trainees observe physicians relying on a pathoanatomic pain generator and responding to patient distress in order to direct a treatment plan, learners internalize that physicians are the active party in pain management—the one who assumes responsibility for both the treatment and subsequent outcomes—while patients are merely passive recipients. This approach contrasts with the emphasis on self-management and collaborative treatment planning promoted by the IOM. If a patient’s pain does not improve after multiple interventions aimed at the pain generator(s), instead of empowering the patient to move forward, a physician might determine that the patient does not, after all, have “real pain” or that the pain is “in their head,” and they might comment to a trainee that “the pain must be supratentorial.” This type of interaction perpetuates the outdated implicit belief that all pain has a physical pain generator that can be fixed and discounts the true driver of the chronic pain experience and pain-related disability that patients can learn to manage: the complex interplay of social, psychological, and biological factors.

Counteracting a practice replete with hidden values, attitudes, and beliefs at odds with current evidence is a daunting task, especially given that this particular hidden curriculum has resisted reform for decades. However, we argue that pain management's hidden curriculum, as well as the specialty as a whole, can move forward if a more helpful process is consciously adopted.

Defining the sociopsychobiological model

The sociopsychobiological (SPB) model is the model that addresses the pitfalls of the biomedical model as well as those of past attempts to implement the biopsychosocial (BPS) model. In 2014, Carr and Bradshaw (24) proposed the SPB model and described it as a necessary "flipping" of the BPS model that was first proposed by Engel in 1977 (25). While Engel's intent was to move beyond the reductionist view that ignored sociological and psychological factors' impact on the pain experience, Carr and Bradshaw argued that the way the BPS was actually implemented continued to give substantial attention to biological factors while the psychological and social ones were viewed as "messy and disturbing" and mere "distractions" (24). Carr and Bradshaw instead advocated for a top-down, SPB approach where pain is seen as "a population-based social phenomenon" and students are sensitized to "complex everyday pain and pain treatment-related problems such as disability certification, mental health issues, family embroilment, and diversion of analgesic medication" (24). In the SPB model, social and psychological aspects of pain are seen as integral and higher-order components rather than as afterthoughts, and patients are encouraged to share with their healthcare practitioner the responsibility of making and carrying out their treatment plan (26). Because of these qualities, the SPB model, if fully implemented, would reflect the change in culture called for by the IOM years ago. We submit that the hidden curriculum, though currently acting as a hindrance, can instead be harnessed to effect positive cultural change.

Leveraging the hidden curriculum to transform culture

We propose that the hidden curriculum can be leveraged to transform the culture of pain management, specifically from a biomedical to a SPB approach. The theory behind our proposal is based on Implicit Bias Recognition and Management (IBRM), which is a curricular approach for driving change that was developed by researchers working to target implicit bias—the unconscious and automatic evaluations that impact an individual's decision-making and behaviors (27). IBRM involves first recognizing that implicit biases and beliefs exist, thus making them visible. Then, after self-reflection and critical appraisal, intentional actions are taken to implement desired behaviors based on the insights gained (28–30).

Application of this strategy to pain management would require first acknowledging that there is a gap between the approach to pain care that is recommended by the IOM (e.g., the SPB model) and common practice (the biomedical model). Next follows a recognition and a "surfacing" step in which undesired implicit values, attitudes, and beliefs (such as focusing on pain generators and imaging, routinely relying on progressively more invasive treatments, and fostering a passive role for patients) are explicitly identified. Finally, intentional efforts are required to implement structural changes based on these insights gained, thus reframing the hidden curriculum to embrace a SPB approach.

Examples of structural changes that can reframe the hidden curriculum are exhibited by the Phoenix Veterans Affairs Health Care System's Chronic Pain Wellness Center (CPWC). The CPWC's structure reflects the SPB model in many ways. First, timing and staffing of patient appointments reflect the clinic's belief in the complexity of chronic pain as opposed to a single "pain generator." Whole person assessment and treatment is supported by allocating ample time (60–90 min) for initial patient evaluations and creating co-disciplinary appointments. During a co-disciplinary visit, two clinicians from different disciplines meet with a patient simultaneously (e.g., a physician and a pain psychologist) to fully assess all sociopsychobiological factors contributing to the pain experience. Additionally, interdisciplinary pain rehabilitation groups (31, 32) that bring together a physical therapist, pain psychologist, recreation therapist, and dietician are the cornerstone treatment for patients with high-impact chronic pain.

Second, once a patient chooses to engage with the CPWC, they are guided through an active self-management approach to pain management that favors evidence-based active therapies rather than a focus on identification and treatment of pain generators. A collaborative treatment plan is developed with the patient that emphasizes active therapies and aims to empower and equip the patient to meet their functional and quality of life goals. Passive therapies are selected to support active care and are prioritized to favor higher value treatments, with "value" defined as evidence of benefit divided by the product of cost and harm (31). Invasive procedures are reserved for patients with indications supported by clinical practice guidelines (33), and clinicians work with patients to help them gradually reduce their reliance on procedures and other high-risk therapies (e.g., high-dose opioid therapy).

Third, the CPWC structures time and space for team members across disciplines to develop shared attitudes and beliefs about the importance of using the SPB model and interdisciplinary teams to treat chronic pain. The clinic sets aside protected time for integrated treatment planning and reflection during weekly team meetings for case conferences and in a separate weekly Balint group. Balint groups explore the experience of both the patient and the healthcare practitioner(s) from a recent memorable interaction and offer space for team members to engage in self-reflection and develop into a more empathetic and effective clinician. During these sessions, one case is presented and team members focus on building an awareness and understanding of how a clinician's emotional state might influence an interaction with a patient; team members alternate acting as facilitator. Balint groups have been associated with a number of positive outcomes, including burnout prevention (34–38); increased competence and improved relationships with patients (39); and increased meaning in work, reduced depersonalization and emotional exhaustion (40). The CPWC's continual focus on interdisciplinary teamwork facilitates a cohesive culture and emphasizes the SPB value that patients receive whole person care from the team rather than from a single healthcare practitioner focused on a single pain generator.

CPWC intentionally uses additional structural characteristics to promote the SBP model: developing shared language, promoting continuous learning, and facilitating team development. Team members are taught patient-centered pain language that promotes a sense of safety, reduces a sense of danger (41, 42), and focuses on patients' goals for improving function and quality of life. Within the clinic, the team regularly discusses shared values, which include maintaining high levels of mutual respect, addressing challenges together, and developing the intellectual virtues of curiosity, humility, courage, and creativity (26). The team comprises healthcare professionals from the following disciplines: pain psychology, addiction, nursing, physical therapy, recreation therapy, complementary and integrative medicine, dietetics, health coaching, clinical pharmacy, and pain medicine. All team members are encouraged to complete shared reading assignments, including the SPB-focused *Arizona Pain and Addiction Curriculum* (26), as well as content about cognitive behavioral therapy for chronic pain (43, 44), acceptance and commitment therapy (45, 46), and pain neuroscience education (41, 47). Ten to twenty-minute mini didactic sessions in which rotating team members from all disciplines share information about their approach to pain assessment and treatment are regular components of weekly team meetings. Learning more about the unique approaches of each discipline fosters a high degree of mutual respect within the team, which is a foundational value for high functioning interprofessional teams (48). Lastly, an annual team retreat is intentionally used to regularly recalibrate and strengthen our SPB approach. Essential to each of these learning activities is an environment where team members feel engaged, empowered to ask questions, and comfortable offering dissonant opinions (49). Team leaders overtly work to create such a space, and that environment, combined with an iterative process of shared learning, helps the CPWC team continue to recognize new gaps, make visible the values and beliefs behind them, and implement structural changes to address them.

The culture within the CPWC is deliberately shared with trainees. Trainees at the CPWC will hear that patients with pain are "complex" rather than a "nuisance" and that they "may benefit from a higher level of care" rather than that they are "too difficult." Instead of modeling the biomedical model's reductionist approach of looking for a simple solution, the CPWC invites trainees to acknowledge the real complexity of chronic pain and to work as part of an interdisciplinary team that partners with the patient to manage it. Intentional structural changes have reformed the hidden curriculum, and the hidden curriculum at the CPWC is now one we hope trainees will take with them and replicate.

Discussion

Today's dominant pain management culture, like chronic pain itself, has no easy fix. However, by flipping the hidden curriculum and deliberately creating a SPB-supportive culture and practice structure, as illustrated by examples from the CPWC provided above, we propose that pain management clinicians and educators can take similar steps to initiate change. Deliberately flipping the hidden curriculum will likely start on a smaller scale than our CPWC example. For example, changing the language about pain that is used with patients and trainees may be the most feasible initial step. Subsequent steps might include introducing small structural changes, such as creating didactic sessions, team meetings, or patient visits that include clinicians from multiple disciplines. Eventually, teams may establish group discussions that serve as a forum for intentional dialogue about specific pain management values, attitudes, and beliefs. Determining how best to facilitate change on a large scale is then the next step.

We acknowledge that the healthcare system at large is often working against this cultural change. In a fee-for-service model that prioritizes reimbursement for brief visits and invasive procedures, time spent learning about the social, psychological, and physical complexities of our patients, time for interdisciplinary collaboration, and time to empower and equip our patients with the right tools is not time that is financially rewarded. However, a promising development in reimbursement reform aimed at incentivizing whole person, interdisciplinary care was finalized by the U.S. Center for Medicare and Medicaid Services (CMS) on November 1, 2022, effective January 1, 2023. With the introduction of new codes (G3002 & G3003), CMS aims to "prompt more practitioners to welcome Medicare beneficiaries with chronic pain into their practices, and encourage practitioners already treating Medicare beneficiaries who have chronic pain to spend the time to help them manage their condition within a trusting, supportive, and ongoing care partnership" (50). Armed with a process for leveraging the hidden curriculum for cultural change and the early steps favoring reimbursement reform, we urge pain management clinicians and educators to embrace the curiosity, humility, courage, and creativity required to move forward.

Additional examples of implementing the SBP model of pain management, particularly in a non-Veterans Affairs setting, are needed. Further examples of didactic content for ongoing group pain education and developing shared language would also be helpful. Finally, studies of the values, attitudes, and beliefs about pain exhibited by trainees who learn in practices exhibiting either the biomedical or the SPB model may also guide next steps.

Conclusion

A cultural transformation of pain management practice and education has continued to elude our best efforts for over a decade, in part because of an entrenched hidden curriculum that perpetuates a biomedical model of managing pain even when a more comprehensive approach is taught in the classroom. By identifying and making visible the hidden values, attitudes and beliefs that perpetuate the current culture, we will be able to take intentional steps to create a new culture, one that will support the SPB model. As more and more clinicians and practices leverage the hidden curriculum as a tool for deliberate change, we can expect progress toward the long-sought transformation of pain management as a whole.

Data availability statement

The original contributions presented in the study are included in the article; further inquiries can be directed to the corresponding author.

Author contributions

AM: project conception, drafting and critical revision of manuscript. LV: project conception, drafting and critical revision of manuscript. HQ: project conception, drafting and critical revision of manuscript. LC: project conception, critical review and revision of manuscript. TS: project conception, critical review and revision of manuscript. JM: project conception, drafting and critical revision of manuscript. AD-R: project conception, critical review and revision of manuscript. EH: project conception, critical review and revision of manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Didactic dissonance—embracing the tension between classroom and clinical education

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The United States is undergoing a transformation in the way pain is viewed and treated. This transformation affects pain education, as some degree of disconnect will be expected between what is taught in classroom settings and what learners observe in clinical settings. We term this disconnect "didactic dissonance" and propose a novel process to harness it as a learning tool to further pain education. Based on principles of transformative learning theory, we describe a structured, three-step process beginning with (1) priming learners to recognize didactic dissonance and identify specific examples from their education, followed by (2) encouraging learners to search the primary literature to resolve observed dissonance and reflect on the system factors that created and perpetuated the disconnect, and then (3) providing an opportunity for learner reflection and planning for how they will address similar situations in future practice and teaching environments. Fostering an environment conducive to learning—through modeling the intellectual virtues of curiosity, humility, and creativity—is a critical task for educators when implementing this process. Recognizing challenges faced by educators in both classroom and clinical settings, it may be a more feasible first step to integrate the concept of didactic dissonance into existing curricular elements. For programs able to implement the full three-step process, a discussion guide along with an example of a facilitated discussion have been provided. While proposed in the context of pain education, this transformational approach can be utilized across all topics in medical education to foster autonomous lifelong learning.

KEYWORDS
didactic dissonance, hidden curriculum, pain education, clinical education, transformative learning, adult learning theory

Introduction

Learning in both the classroom and clinical environments have long been key components of medical education. The storied 1910 Flexner Report established many of the present-day standard for the sequence of 2 years of basic science education in the classroom followed by 2 years of clinical education at the bedside (1, 2). An unintended consequence of this structure has been to create a separation between classroom and clinical education, which can contribute to a disconnect or even contradiction between what is taught in the classroom and what is taught during the rotations that comprise clinical education. This disconnect has been lamented as a problem that can degrade a high-quality education (3–6) and is exacerbated by changing cultural paradigms. Efforts to address this disconnect have often focused on reducing the gap by creating a more integrated curriculum (2) and introducing initiatives to enhance the transfer of classroom learning to the clinical settings (7). While these efforts are important, they are insufficient, as the constantly evolving state of medical knowledge and practice will always create some degree of disconnect in curricular content between classroom and clinical education.

This type of disconnect could be expected to particularly occur in pain education, as pain management and pain education are undergoing a cultural (8). For example, while learners may be taught about the lack of evidence for long-term opioid therapy for chronic pain in the classroom setting, they may see providers routinely starting opioid therapy in the clinical setting. Alternatively, a classroom curriculum might teach a one-size-fits-all approach to opioid tapering, while in clinic a learner might observe a complex and nuanced approach to it.

The term *didactic dissonance* was coined in the *Arizona Pain and Addiction Curriculum* [co-chaired by ASM and LV— (9)] and describes the disconnect learners experience between what is taught in the formal classroom setting and what is taught and observed in clinical practice, and we propose that it is essential to embrace as an educational tool.

The importance of addressing didactic dissonance was endorsed by the multidisciplinary authors of the *Arizona Pain and Addiction Curriculum* (9), a modern, evidence-based, public health-oriented curriculum that aims for statewide cultural transformation to address the dual challenges of chronic pain and addiction. The curriculum workgroup anticipated that learners who were exposed to the new curriculum would inevitably experience subtle to blatant didactic dissonance during their clinical rotations, and thus agreed that the curriculum should recommend harnessing this dissonance to reinforce principles of the formal curriculum. Upon evaluation of the curriculum's implementation, however, schools reported that addressing didactic dissonance was difficult to implement (10).

In this paper, we hope to meet the challenge of harnessing didactic dissonance. We provide an implementation process that applies transformative learning theory (11) to leverage aspects of this disconnect as a pedagogical tool. Rather than seeking to avoid or eradicate this didactic dissonance, we propose a method to embrace it while reinforcing key intellectual virtues to foster lifelong learning and information mastery.

Defining didactic dissonance

The term didactic dissonance combines the term didactic ("to teach") with dissonance, referring to the tension or clash resulting in learners' minds from the juxtaposition of two or more formal curricula or intentional teaching activities that differ in content.

Of note, didactic dissonance as described differs from the concept of the hidden curriculum (12). The hidden curriculum is a recognized set of ethical, moral and value-based influences that are informally passed to learners through observation in the clinical and classroom settings that have been shown to impact learner bias and future interactions (13–16). While the hidden curriculum in pain education might implicitly communicate to the learner that patients with chronic pain are exaggerating or fabricating their symptoms (17), didactic dissonance would be experienced by the learner when the approach observed in clinic differs from what was taught in the classroom. We are discussing didactic dissonance in the field of pain education. However, its occurrence in other fields, particularly those where external pressures are significant or emerging evidence has prompted a cultural shift in clinical care [e.g., antibiotics for a viral respiratory infection (18), hormone therapy in postmenopausal women (19)], highlights the potential usefulness of this approach both within and beyond the field of pain education.

Ideally, curricula are living and changing consistent with the evolution of knowledge and science. Realistically, both classroom and clinical teachings may become outdated or inconsistent with constantly changing medical literature. Therefore, didactic dissonance may be bidirectional such that modern best practices described in a formal classroom curriculum are contradicted in a clinical environment and vice versa. Additionally, learners may misidentify a discrepancy due to their misinterpretation of one or both of the curricula or practices. For expediency, the language in the remainder of this paper will primarily use the examples of a modern classroom curriculum and situations that diverge from that curriculum observed in clinical practice.

Leveraging transformative learning theory

Transformative learning theory provides an intellectual framework for leveraging didactic dissonance as a tool for learning. Transformative learning theory, originally described by Mezirow in 1978 (20), is a theory of adult learning founded on the premise that adult learners adjust their worldview through critical reflection as they encounter new information.

Transformative learning can be thought of as occurring in three key stages (21): (1) encountering a disorienting and confusing problem or experience, (2) undergoing self-reflection and critical evaluation, and (3) establishing a new course of action, which involves planning, acquiring new skills, and incrementally testing and adopting new actions. These three stages of transformative learning can be mapped to a three-step process to use didactic dissonance to foster lifelong self-directed learning among medical practitioners (Figure 1).

Harnessing didactic dissonance

We propose a three-step process to harness didactic dissonance as a learning tool, applying the key principles of transformative learning theory (Figure 1). The steps below have been intentionally designed with an eye toward ease of implementation and are based on preparing and facilitating a structured group discussion with learners.

Because didactic dissonance is based on identifying contradictions within two or more curricula, there could be a tendency for individuals or educators to think of these discrepancies as representing "faulty teaching." This type of labeling rooted in intellectual arrogance, complacency, and closed-mindedness, is polarizing and can impair or arrest lifelong learning. Therefore, when harnessing didactic dissonance in medical education, particular care should be taken to promote a

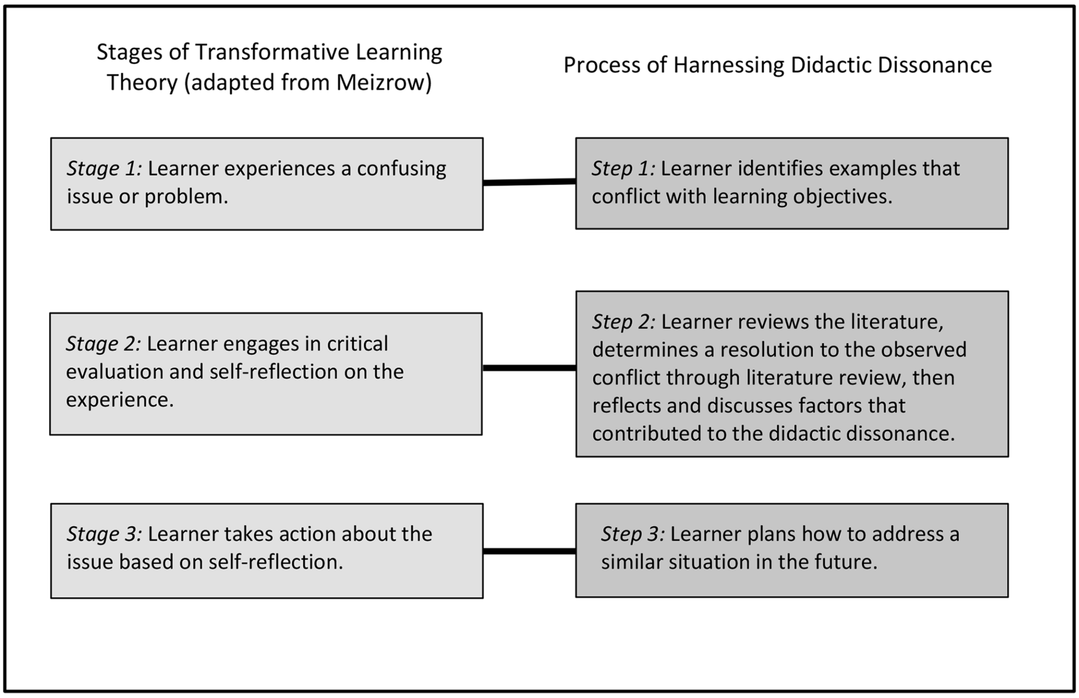


FIGURE 1
Stages of transformative learning mapped onto the proposed process of harnessing didactic dissonance. This figure shows the three main stages of transformative learning theory [from (20)] and how they correspond to the three steps of how to harness didactic dissonance.

learning environment based on the intellectual virtues of intellectual humility, intellectual curiosity, and intellectual creativity, with a primary goal of fostering autonomous thinking (22). Throughout each of the three steps below, students should be encouraged to consider the motivations behind observed actions and clinical instruction, to have healthy skepticism that leads them to check their own beliefs, and to foster a spirit of curiosity that seeks out answers.

Below, we describe our three-step process with a brief introductory description of the step and a suggested approach for implementation. Sample facilitator language in the form of a Discussion Guide is shown in Figure 2, and an example of a facilitated didactic dissonance group discussion is available in Appendix 1.

> *Step 1: Prior to clinical rotations, introduce learners to the concept of didactic dissonance and prime them to identify examples in the clinical setting that conflict with classroom learning objectives.*

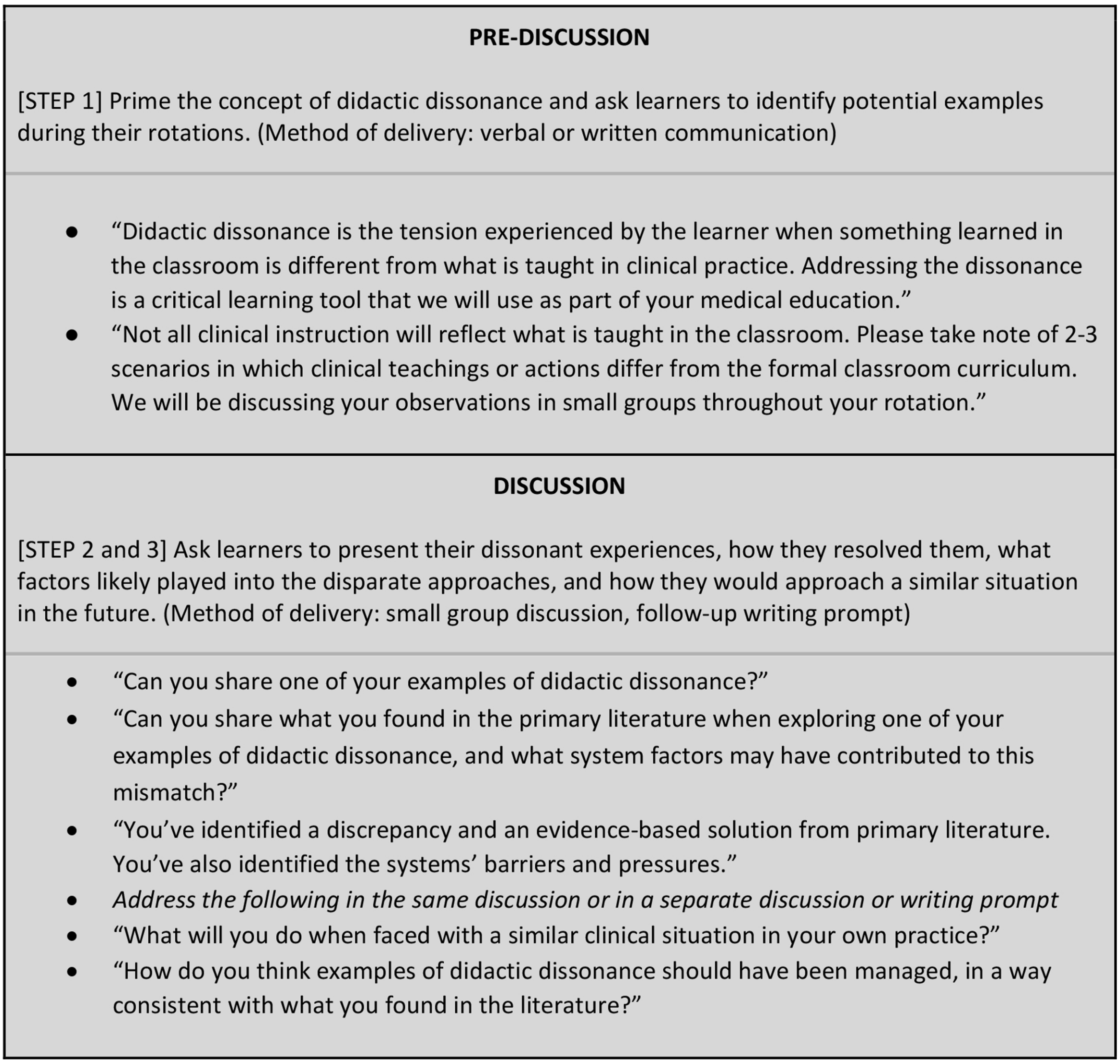
This step introduces the concept of didactic dissonance to learners and describes how it can be used as a tool for lifelong learning. Learners are encouraged to identify 2–3 examples of didactic dissonance where clinical teaching or observations differ from the classroom curriculum, and they are informed in advance that these examples will serve as the basis for future discussions. To promote the constructive learning environment we are seeking, medical educators can remind learners that the goal in identifying didactic dissonance is not to find fault, but rather to foster autonomous thinking, and that both classroom and teaching environments are subject to different factors that impact the real-world implementation of best practices.

This introductory or priming step can be implemented through an educator's verbal presentation, in writing, or through email reminders before the start of rotations.

> *Step 2: After clinical rotations, ask learners to pick one item on their list of examples and search the primary literature using principles of information mastery to determine a resolution to the dissonance. Learners should present their experience and path to resolution in a group setting, along with their reflection on the factors that created and perpetuated didactic dissonance.*

This step seeks to encourage learners' intellectual curiosity as a way to resolve their experienced dissonance and help them better understand the underlying applied practice of medicine. It is important to be aware that judgment, accusations or nonverbal cues about one approach over another may create an unhelpful learning and professional environment and encourage intellectual arrogance, self-assured fault-finding, and closed-mindedness. Instead, the goal of the exercise is to create and model intellectual humility (e.g., "Maybe I should think about this differently"), intellectual curiosity (e.g., "What can I learn from this?"), and intellectual creativity (e.g., "I could try 'X' next time").

It is essential to encourage learners to reflect on the factors that have created and perpetuated the observed examples of didactic dissonance. From the clinical perspective, examples could include short office visits (economic pressure), the desire to please patients (patient pressure), or outdated or misapplied knowledge. From the curricular perspective, factors could include individual biases and attitudes of curricular authors, adherence to national competencies, or the time burden required to create or update curricula.



PRE-DISCUSSION

[STEP 1] Prime the concept of didactic dissonance and ask learners to identify potential examples during their rotations. (Method of delivery: verbal or written communication)

- "Didactic dissonance is the tension experienced by the learner when something learned in the classroom is different from what is taught in clinical practice. Addressing the dissonance is a critical learning tool that we will use as part of your medical education."
- "Not all clinical instruction will reflect what is taught in the classroom. Please take note of 2-3 scenarios in which clinical teachings or actions differ from the formal classroom curriculum. We will be discussing your observations in small groups throughout your rotation."

DISCUSSION

[STEP 2 and 3] Ask learners to present their dissonant experiences, how they resolved them, what factors likely played into the disparate approaches, and how they would approach a similar situation in the future. (Method of delivery: small group discussion, follow-up writing prompt)

- "Can you share one of your examples of didactic dissonance?"
- "Can you share what you found in the primary literature when exploring one of your examples of didactic dissonance, and what system factors may have contributed to this mismatch?"
- "You've identified a discrepancy and an evidence-based solution from primary literature. You've also identified the systems' barriers and pressures."
- *Address the following in the same discussion or in a separate discussion or writing prompt*
- "What will you do when faced with a similar clinical situation in your own practice?"
- "How do you think examples of didactic dissonance should have been managed, in a way consistent with what you found in the literature?"

FIGURE 2
Didactic dissonance discussion guide. This discussion guide is a summary of sample language to help the educator address didactic dissonance as part of their curriculum. Of note, a subject matter expert in the fields of the particular rotation or in learning theory is not required.

This step can be implemented by scheduling a facilitated discussion post-rotation or at the end of the academic year in which students present, resolve, and reflect on the process.

> *Step 3: Provide an opportunity for learner reflection and planning about how they will address the observed clinical scenario in future clinical or teaching experiences.*

This step creates an opportunity to translate theory into imagined and eventually actual practice. How will the learner, in future clinical and teaching contexts, implement the best practice from what they resolved from Step 2? How will the learner confront economic, patient, time, and other pressures?

By envisioning their future clinical and teaching practice, learners acknowledge the reality that no clinical practice or curriculum is perfect. Incorporating the intellectual virtues and becoming an autonomous thinker can help guide the learners toward a lifelong process of investigation, assessment, and reflection.

This step can be implemented by asking these reflective questions during the aforementioned discussion, in a separate follow up discussion, or through an individual writing prompt.

Discussion

To our knowledge, this is the first description of a deliberate process to harness the divergent information that learners may encounter in the classroom and clinical settings as a force for learning. Our experience with didactic dissonance stems from pain education through the *Arizona Pain and Addiction Curriculum* (9), but we propose this process as one that can be applied to all domains of medical education, particularly those involving recent paradigm shifts or where challenges exist to implementing the best available science, such as addiction medicine, antibiotic stewardship, HIV pre-exposure prophylaxis, or vaccination.

We recognize that introducing a novel learning approach to an already crowded curriculum with competing priorities, overworked faculty and insufficient numbers of preceptors may face implementation challenges. These challenges may include concerns about feasibility or unintended consequences such as alienating clinical preceptors.

While the steps above were designed for implementation feasibility, a smaller, incremental approach may be a more achievable option for some programs. Schools could start small by linking the concept of didactic dissonance into already existing curricular elements, such as problem-based learning or humanities-in-medicine group discussions. A next step may be to carve out time for a structured small-group discussion, using Figure 1 as a Discussion Guide. The most comprehensive approach would be a longitudinal, multi-year incorporation of small group discussions and writing prompts to help learners internalize the process as part of their lifelong learning habits. Of note, it is not necessary for the discussion facilitator to have expertise in the specific clinical situation being explored; rather, the ideal facilitator would encourage critical thinking, skepticism, self-reflection, use of primary literature, and an environment of openness and curiosity.

Consideration of potential unintended consequences from any new process is key to success, and educators may be concerned that this practice could result in fault finding or finger pointing at an already short supply of preceptors. However, by acknowledging and exploring differences in curricular content, learners will likely develop a greater understanding of system factors that shape both the creation of classroom curricula as well as clinical practice. This awareness, combined with the information mastery to resolve observed differences and address similar situations in the future, should promote humility and a greater appreciation for the complexities of classroom teaching and clinical practice.

Parallel with the concern about finding adequate time to address didactic dissonance may be a cognitive bias to avoid direct identification of examples of divergent teaching content. However, didactic dissonance occurs whether time to address it has been allocated or not. Ignoring it would be a lost opportunity, and aiming to reduce or eliminate it would likely be more challenging and less feasible than the most favorable approach: adopting a deliberate educational process that leverages didactic dissonance to promote lifelong learning.

Particular care should be taken to promote a learning environment that fosters autonomous thinking and is based on the intellectual virtues mentioned previously in this manuscript: intellectual humility, intellectual curiosity, and intellectual creativity. Autonomous thinking is essential to becoming a lifelong learner, as it entails developing the cognitive skills and self-reflective inclination to critically assess one's knowledge, attitudes, and practices (20).

The transformational learning process of harnessing didactic dissonance can be applied longitudinally, throughout residency, fellowship, and continuing education. And beyond the sphere of health education, this process provides a mechanism for effective lifelong learning. As learners we can go through life with sets of fixed knowledge that impair future learning, or we can bring a spirit of curiosity and openness, a willingness to change opinions, and a desire to go deeper and reconcile the differences we encounter so as to continually experience transformative learning.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material; further inquiries can be directed to the corresponding author.

Author contributions

AM and LV: project conception, drafting, and critical revision of manuscript. LK, HQ, and EH: project conception, critical review, and revision of manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

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Innovative treatment formats, technologies, and clinician trainings that improve access to behavioral pain treatment for youth and adults

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Chronic pain is prevalent across the life span and associated with significant individual and societal costs. Behavioral interventions are recommended as the gold-standard, evidence-based interventions for chronic pain, but barriers, such as lack of pain-trained clinicians, poor insurance coverage, and high treatment burden, limit patients' ability to access evidenced-based pain education and treatment resources. Recent advances in technology offer new opportunities to leverage innovative digital formats to overcome these barriers and dramatically increase access to high-quality, evidenced-based pain treatments for youth and adults. This scoping review highlights new advances. First, we describe system-level barriers to the broad dissemination of behavioral pain treatment. Next, we review several promising new pediatric and adult pain education and treatment technology innovations to improve access and scalability of evidence-based behavioral pain treatments. Current challenges and future research and clinical recommendations are offered.

KEYWORDS

chronic pain, acute pain, psychological, treatment, behavioral, digital, education, pediatric

1. Introduction

Chronic pain is a global health crisis, affecting more than 20% of people worldwide (1, 2). The personal and economic burden of chronic pain is striking, with known impact on the individual and social contexts (e.g., parents, partners, employers) and societal costs exceeding 650 billion USD annually for pediatric and adult pain treatment costs and lost productivity (1, 2). Given the biopsychosocial nature and impacts of chronic pain, a multidisciplinary, person-centered treatment approach yields the best pain treatment outcomes at the lowest cost (3–8). Conceptualization of chronic pain through a biomedical lens, as well as the absence of behavioral approaches, can lead to overmedicalization and reliance on costly procedures, surgery, and pharmacology, which are options that carry substantial health risks and may be ineffective for relieving pain. In addition to being recommended as a best practice for pain treatment (7–12), behavioral approaches are notable because they are non-pharmacologic and non-invasive and have a very low-risk profile. While a number of effective behavioral pain interventions exist for youth and adults with chronic pain (13, 14), access is limited by multiple factors, including a shortage of treatment services outside of urban areas, significant treatment-related costs, long provider waitlists, and a lack of clinicians trained in behavioral pain management (12, 15, 16). Treatment burden is another formidable barrier. Most behavioral pain treatments involve multiple sessions, resulting in ∼16–20 h of total treatment time (e.g., cognitive behavioral therapy for chronic pain, acceptance and commitment therapy, and mindfulness-based stress reduction). Thus, there is a need for innovative, efficient, and scalable behavioral intervention formats for treating pain.

The multiple critical barriers to behavioral pain care have been recognized at the federal level, with the US Health and Human Services (HHS) National Pain Strategy (17), the Federal Pain Research Strategy (2), the Interagency Best Practices Pain Management Task Force (15), and the Centers for Disease Control and Prevention calling for better integration of behavioral pain treatments into national pain care pathways. To address the care gap, HHS has called for more robust and widespread training for behavioral clinicians in chronic pain and related sequelae. The Federal Pain Research Strategy and HHS also called for better study of behavioral pain treatments that leverage technological solutions to potentially scale pain treatments broadly and support improved patient access to care (2, 15).

To better understand the problem, in this scoping review, we first review data describing system-level barriers to broad dissemination of behavioral chronic pain treatment. Next, we review several promising new pediatric and adult pain education and treatment innovations that leverage technology to improve and scale access to evidence-based behavioral pain treatments that complement a patient's treatment plan or serve as a standalone intervention. Finally, this article points to current and future challenges and offers recommendations for clinical targets and future research.

2. System-level barriers to dissemination of behavioral chronic pain treatment

An important system-level barrier involves a biomedical culture of pain management in many Western countries. This culture permeates medical education and clinical care and can impede patient access to the needed behavioral and psychological services due to a lack of understanding about the importance of the biopsychosocial treatment model and downstream consequences (e.g., patients are not explained with the role of psychology and the importance of behavioral treatments in their pain care plan and a lack of in-house referral options and/or professional connections in the community).

In 2016, the American Academy of Pain Medicine (AAPM) Pain Psychology Task Force published the results of a multi-stakeholder US survey ($N = 1{,}991$) that assessed barriers to behavioral chronic pain treatment (i.e., pain psychology), including system-level barriers and needs related to pain education and training of clinicians (16). Survey responses were received from a total of 1,991 respondents, including 1,086 patients, 843 clinicians (psychologists/therapists, $n = 323$; pain physicians, $n = 203$; primary care physicians and physician assistants, $n = 221$; nurse practitioners, $n = 96$), and 62 graduate and post-graduate psychology training directors. For patients, costs and insurance coverage were cited as barriers to pain psychology services. Moreover, over a third of the sample cited insufficient access to pain-trained therapists, as well as not knowing how to locate skilled providers. Supporting these findings, a recent examination of US insurance claims data of adults with chronic low back pain ($N = 55{,}945$) found only 4% utilized psychological therapy due to high out-of-pocket costs and poor insurance coverage (18). One small study suggested that even when pediatric patients receive specialty evaluation in a multidisciplinary pain clinic, less than half ultimately engaged in the recommended behavioral treatment, citing "not interested" as the primary reason for their lack of engagement (19). Similarly, roughly one-quarter of community-based adults with chronic pain reported being disinterested in behavioral pain treatment because they understood their pain was "not psychological" and/or behavioral pain treatment "would not help" (16). Disinterest in behavioral or psychological approaches has been described by others (20, 21) and may be partially driven by stigma (8).

Stigma is a key barrier to treatment engagement and is a fundamental cause of health inequities (22). Pain-related stigma is commonly experienced among adolescents and adults when seeking medical care, such as having their pain dismissed, disbelieved, or perceived to be exaggerating their pain. These experiences are known to worsen pain, mental health, social isolation, and treatment engagement over time (23, 24). Marginalized communities, such as women, gender and sexual minorities, and racialized patients, experience greater stigma and discrimination when seeking medical care further worsening health outcomes (25). Compounding these experiences, many people describe resistance to engaging in behavioral treatments for fear of confirming harmful messages that their pain is not real or "all in their head" (26, 27). Patients also report mixed reactions to psychological explanations of pain (e.g., stress, emotions, and thoughts can worsen pain), with some noting that this messaging conveys a sense of control, while others felt stigma and shame about their mental health (27). Given that many patients experience stigma and invalidation, clinicians trained in-patient-centered communication strategies and behavioral pain interventions are vital to improving treatment engagement and patient wellbeing.

While system-level barriers (e.g., high cost, poor insurance coverage, stigma) are key drivers, poor access to pain psychology services is also a result of the lack of mental health clinicians who are trained and skilled in delivering behavioral treatment for chronic pain. Indeed, the Pain Psychology Task Force survey found that among graduate and post-graduate psychology training directors, 36% ($n = 21$) reported that their programs offered no training on health or pain management. Of the programs that included pain in their graduate curriculum, 32% ($n = 8$) reported offering 1–4 h of pain content, 40% ($n = 10$) reported 5–10 h of pain content, and 28% ($n = 7$) reported ≥11 h of pain coursework and instruction. Insufficient pain training is also evident in the survey results of clinical psychologists and mental health therapists wherein 88% ($n = 311$) reported poor confidence and/or competency to treat pain due to a lack of graduate and professional pain training. Historically, physician training has also lacked curricula on the assessment and treatment of chronic pain and its psychosocial sequelae (28–30).

The Pain Psychology Task Force survey revealed broad patient and clinician stakeholder support for increased training in pain psychology. Most patients surveyed stated they would (66%) or might be (21%) in favor of an initiative to train more therapists to provide quality pain psychology services. The vast majority of medical clinician respondents (84%–95%) reported a need for pain-trained behavioral health clinicians. Moreover, they supported a national effort to accomplish this training goal and stated that pain psychology services would benefit their patients with chronic pain. Finally, all graduate psychology training directors surveyed ($n = 55$) reported being interested in integrating a brief, high-quality, packaged pain psychology training into their doctoral programs if offered at no cost.

In summary, within the context of pain and in the USA specifically, patient access to psychology services is poor. High cost, poor insurance coverage, stigma, and a lack of trained mental health clinicians to deliver behavioral pain treatment are system-level barriers to address. Barriers to care will differ based on country; for instance, within Canada and the UK, patients may experience general health service wait times of 1–3 years. While evidence-based treatments should be promoted whenever available and feasible, the following section describes several innovative approaches that are helping shore clinician training gaps and provide the public and patients with new and convenient ways to receive pain education and care. Such novel educational and treatment options do not obviate the need for evidence-based pain care; rather, they can be useful and necessary in cases where other treatments are inaccessible or unwanted, to supplement existing therapies, and to provide general pain education to various stakeholder groups. These new approaches include digitally delivered pain education and support, scalable clinician trainings, innovative efficiencies in integrative care, and direct access to evidence-based behavioral pain treatments.

3. Innovations supporting accessible chronic pain education, clinician training, and behavioral pain treatment

3.1. Digitally delivered pain education and resources

Digital innovations, such as videos, podcasts, and web-based applications (apps), have increased public access to pain education and support. **Table 1** provides a non-exhaustive listing of key public and patient pain education resources.

A recent study systemically reviewed YouTube video resources focused on pain neuroscience education and identified 17 videos that addressed as least one target concept of pain education very well (31). One video, “Tame the Beast: It’s Time to Rethink Persistent Pain,” addressed all target concepts of pain education (32). This short (5-min) animated video explains the difference between acute and chronic pain, emphasizes the conditioning that occurs in the brain in the context of chronic pain, and provides a rationale for behavioral pain treatment. Additional video resources showing merit were posted by educational organizations like TED-Ed who partnered with academic and healthcare professionals to create highly engaging and accessible content. Video resources posted on this platform are particularly promising for delivering pain education that can be freely accessed on YouTube.com by clinicians, patients, and the public.

Other novel efforts leverage technology to support public dissemination of pain education. *One Thing* was created in 2020 by a team of pain scientists and is a platform where well-established pain researchers and clinicians can discuss “one thing” they want others to know about chronic pain, including the latest research and tips/tricks for engagement in pain treatment. *One Thing* enduring content is available in video and podcast formats (34). Other educational podcasts include *Comfort Ability* (40), an audio podcast that includes tips and skills for managing pediatric pain, and conversations with teens about their experiences with chronic pain and treatment.

The Curable app is a commercial monthly subscription product that provides audio-based pain education and pain management content, lectures, and tools (36).

The Manage My Pain app is a free customizable digital tracking and pain education platform that helps patients and doctors better measure and monitor pain so it can be better managed (35).

TABLE 1 Innovative digital strategies to enhance behavioral pain education, and scalable clinician resources and certifications.

Resources/trainings	Public resource	Patient/family resource	Clinician resource
Brief pain science videos [e.g., Tame the Beast (31–33), TED-Ed Mysterious Science of Pain]	X	X	
Podcasts [e.g., *One Thing* (34)]	X	X	
Free and commercial Apps [e.g., *Manage My Pain* (35); *Curable* (36)]	X	X	
VA ECHO Program (37)			X
Empowered Relief 2-day clinician certification workshop (38)			X
Comfort Ability site certification (39)			X

3.2. Scalable clinician trainings

More than a decade ago the Veterans Health Administration (VHA) developed the Specialty Care Access Network- ECHO program. ECHO offers clinicians across the US virtual standalone continuing education telementoring sessions on pain-related topics and integrative case consultation with content experts (37). ECHO helps overcome primary care providers' geographic barriers to specialty care. ECHO supports the increased use of non-opioid medications and rehabilitative services for chronic pain.

Beyond case consultations, many clinicians—both pain-trained and not—seek to efficiently address their clientele's behavioral pain treatment needs with efficient and standardized treatments. The *Empowered Relief* Clinician Certification Workshops are 2-day (11 h) interprofessional workshops that certify licensed clinicians of any discipline to deliver a one-session skill-based pain relief intervention ("Empowered Relief") (38). The *Empowered Relief* intervention is didactic and group-based, with highly standardized content (PowerPoint deck and an instruction manual with full scripts) and intervention fidelity supports. Moreover, it is suitable for clinicians with minimal prior pain training. Certified clinicians may integrate this packaged and brief intervention into healthcare settings of all types. The clinician certification workshops are online and available internationally.

Within the Veterans Healthcare Administration (VHA), thousands of healthcare students receive education and training in best practices. The VHA also offers national trainings for clinicians and students to implement treatments such as eight-session cognitive behavioral therapy for chronic pain (CBT-CP) and briefer versions designed to be integrated into primary care clinics (brief CBT-CP) (41). Technology has further allowed the VHA to educate their providers in pain neuroscience, as well as consult with experts in the field to provide better care for patients.

While current scalable clinician trainings in **Table 1** are promising, they are notably narrow in scope and number. Varied efficient and practical clinician trainings are needed to shore clinical competencies and expand patient access to evidence-based pain care.

3.3. Direct access to evidence-based behavioral pain treatments

Technological advances that directly increase patient access to pain care include AI-assisted cognitive behavioral therapy (CBT) for chronic pain, a one-session pain relief skill intervention (*Empowered Relief*) for acute and chronic pain, on-demand virtual reality (VR) device treatment for acute and chronic pain across the life span, and app-based interventions that teach cognitive and behavioral pain management skills (WebMAP Mobile; iGET Living) and opioid misuse in adults (*Empowered Relief* On-Demand).

The largest and most varied advances have occurred in behavioral pain interventions, some of which involve telehealth applications. A recent review of qualitative studies of enablers and barriers to telehealth interventions for people with chronic pain found that interventions with well-designed interactive platforms, flexibility to fit patients' routine, and the broad availability of material favor better engagement (42). Moreover, encouragement of self-efficacy is linked to successful telehealth-delivered self-management programs.

As outlined in **Table 2**, advances include efficient clinician-delivered youth–family interventions with and without telehealth supports, a range of clinician-delivered one-session interventions, and various digital "on-demand" treatments that do not require a therapist.

3.4. Clinician-delivered or clinician-assisted interventions that expand treatment access

Brief cognitive behavioral therapy for chronic pain (brief CBT-CP) typically involves 8–10 weekly treatment sessions. CBT targets increased patient engagement in pleasant activities, decreasing maladaptive cognitions such as catastrophic appraisals, and reducing arousal with relaxation training. Data from multiple chronic pain studies suggest that CBT decreases pain intensity and pain catastrophizing and increases mood, mindfulness, physical function, self-efficacy, and pain acceptance (14, 52, 72–74). It was designed to be integrated into primary care clinics and increase access to evidence-based pain care. Within US Veteran healthcare, full protocol CBT-CP involves 3 months of weekly hour-long sessions (12 h total); in contrast, the brief CBT-CP is a targeted, manualized treatment that consists of six or fewer 30-min sessions (3 h total) and is delivered either in-person in primary care clinics or via telehealth. Brief CBT-CP improves pain function, as is associated with high patient satisfaction and high perceived utility (51).

The *Comfort Ability* is a psychoeducational and skill-based intervention for adolescents with chronic pain and their caregivers. The *Comfort Ability* teaches teens and families about chronic pain and cognitive behavioral skills for pain management and functional improvement. The workshop has demonstrated improvements in functioning, depressive symptoms, and pain catastrophizing that are maintained at 1-month follow-up. Prior to the COVID-19 pandemic, the *Comfort Ability* was delivered in a 6-h, 1-day workshop, with youth and parents meeting separately. During the pandemic, the workshop switched to virtual delivery via telehealth (length and number of sessions variable across locations; e.g., six 1-h sessions, four 2-h sessions), with some locations continuing to offer the virtual delivery modality in addition to the in-person workshop. The *Comfort Ability* is currently delivered in 23 children's hospitals internationally. Information on how to adopt the workshop can be found on the *Comfort Ability* website (39). The cost of the workshop is variable, with some locations charging out-of-pocket costs ranging from roughly $150 to $300 and others billing insurance.

Empowered Relief is a one-session pain relief skill intervention for adults with acute and chronic pain. The 2-h intervention is delivered by interprofessional certified instructors (see above, clinician trainings). The standardized intervention is delivered to

TABLE 2 Innovative clinician-delivered treatments/interventions and interventions accessed through the medical setting (blue text for youth interventions).

	Public resource	Patient/family resource	Clinician-delivered intervention	Evidence-based	Format
Comfort Ability 1-day youth patient and family workshop (39) with corresponding website resource tools		X	X	X (43)	In-person or online
iGetLiving (44)		X	x		Digital
iCanCope (45)	X	X	x	X (46)	Digital
WebMAP (8-session online CBT for youth and families)	X	X	X	X (47–49)	Digital
SurgeryPal™ (online multi-session for youth undergoing surgery and family) (50)		X	X		Digital
Multi-session brief CBT for chronic pain (CBT-CP)			X	X (51)	In-person
One-session *Empowered Relief* intervention for chronic pain	X	X	X	X (52–54)	In-person or online
Digital On-Demand *Empowered Relief* for Surgery		X	X	X (55, 56)	Digital
One-session Emotional Awareness and Expression Training for chronic pain		X	X	X (57, 58)	In-person or online
One-session Mindfulness-Oriented Recovery Enhancement for chronic pain		X	X	Abstract (59)	In-person or online
Pain psychology and pain neuroscience self-evaluation intervention	X	X		X (60)	Digital
AI-assisted CBT		X	X	X (61)	Phone and digital
PainTrainer (on-demand self-paced CBT skills) (62)		X		X (63)	Digital
Virtual Reality Treatment for Chronic Pain[a]		X		X (64–68)	Digital device
Text support for opioid tapering (69)		X			Digital
Cancer pain management app (70, 71)		X			Digital

[a] Clinician-prescribed; home-based self-administered treatment device.

groups either in-person or online via Zoom or another conference platform. *Empowered Relief* is didactic and includes pain neuroscience education. The participants acquire three core pain management skills and complete a personal plan for empowered relief. Participants also receive a binaural audio app for integration into their personal plans and for daily use. An NIH-funded randomized controlled trial (RCT; $N = 263$) revealed that single-session *Empowered Relief* was non-inferior to 16 h of cognitive behavioral therapy at 3 months post-treatment for reducing pain catastrophizing, pain intensity, pain interference, pain bothersomeness, depression, anxiety, fatigue, and sleep disturbance (52). A second RCT compared online received *Empowered Relief* to Usual Care in 105 patients with mixed etiology chronic pain (53). The results revealed high patient engagement and satisfaction, in addition to a similar pattern of reductions in pain intensity, pain interference, pain catastrophizing, pain bothersomeness, anxiety, and sleep disturbance at 3 months post-treatment.

To date, 800 certified instructors are delivering *Empowered Relief* in 43 US states, 25 countries, and seven languages (Canadian French, Spanish, Italian, Dutch, Danish, Italian, and English). Separate versions of *Empowered Relief* exist for chronic pain and acute/surgical pain, and certification flexibly allows clinicians to deliver either or both versions. *Empowered Relief* is being delivered as "standard care" at multiple healthcare organizations, including Cleveland Clinic Spine Surgery and the Neurological Institute (54), the Phoenix VA, Cedars-Sinai Health Care, Lehigh Valley Health Network, Allegheny Health Network, Brigham and Women's Hospital, the Canadian VA, the NHS in the UK, and Humana Neighborhood. Standard care means that all patients are recommended to receive Empowered Relief, rather than the traditional model of psychological intervention wherein patients are typically screened for treatment or referred. A standard and uniform approach allows institutions to emphasize the applicability of the information and intervention to all patients, thereby destigmatizing it and boosting patient engagement. Empowered Relief is the subject of five in-progress clinical trials being conducted by five different principal investigators with the research funded by the NIH or the Canadian Institutes for Health Research. A PCORI-funded national comparative effectiveness national trial is underway in which 1,200 adults with chronic pain of any type are being randomized to online one-session Empowered Relief vs. online eight-session CBT (75). The goal of this research is to test which online and home-based treatment works best and for whom and to determine the heterogeneity of treatment effects for key subpopulations across a diverse national patient population. The development of *Empowered Relief* for Youth is underway. Patients may access the intervention through their healthcare systems, in the community, and publicly through online national registration offered by some certified instructors.

Another promising intervention is the one-session Mindfulness-Oriented Recovery Enhancement (MORE) for people with chronic pain and opioid use disorder, developed by Handley and Lingard (59). MORE includes aspects of mindfulness training, third-wave CBT, and principles from positive psychology into an integrative intervention approach. Coping strategies focus on mindfulness training to target automatic habit behavior and foster nonreactivity, positive reappraisal training to regulate negative emotions and nurture a sense of meaning in life, and training in savoring pleasant events and emotions to ameliorate deficits in positive affectivity. The one-session MORE resulted in reductions in pain up to 3 months post-intervention. In addition, a one-session Pain Psychology and Neuroscience Self-Evaluation Internet Intervention (PPN) was developed by Kohns et al. (60). PPN focuses on personalized pain neuroscience education where patients are engaged in exercises to evaluate various psychosocial risk factors with respect to their pain. PPN resulted in reductions in pain intensity and interference at 1-month post-intervention, but the results were not maintained at 10 months.

Finally, the one-session Emotional Awareness and Expression Training (EAET) (pain, stress, and emotions "PSE" class) was developed by Ziadni et al. for adults with chronic pain (57). EAET involves 2 months of therapist-delivered weekly 2-h-long treatment sessions (eight sessions; 16 h total). EAET advocates a pain treatment model in which pain can be substantially reduced by helping people resolve emotional problems that amplify or generate pain (76). Unresolved childhood trauma, relationship problems, and psychological conflicts augment the "danger alarm" of bodily pain via the brain's predictive coding. EAET includes emotional disclosure, emotional awareness/expression exercises, and relationship communication changes, all of which are thought to reduce fear and pain. EAET is a newer therapy, and several trials provide evidence of pain reduction and improved function (77). PSE is a distilled version of a longer-course EAET and is a 2-h one-session intervention that is manualized and delivered by doctoral-level psychologists with EAET training. The standardized intervention is delivered to patient groups either in person or via Zoom or another conference platform at the individual's home. PSE comprises didactic content (i.e., pain psychology and neuroscience education) and an interactive and experiential component designed to help patients practice emotional regulation skills. Participants also complete a personalized prescription plan with their individual goals.

Altogether, these brief clinician-delivered interventions can provide rapid access to care, particularly when delivered online, with early evidence for several interventions suggesting strong effects at 3 months post-treatment. Owing to their low-burden and often home-based formats, one-session behavioral treatments are likely to appeal to patients, providers, and insurers and enhance treatment engagement and completion. These interventions could help shift patient understanding of their pain and enhance readiness for pain self-management. Single-session treatments also be integrated and routinely offered in primary, specialty pain care settings and even possibly as a prerequisite to costly and invasive procedures (e.g., surgery).

3.5. Efficiency trends for historically intensive in-patient pain treatment

In-person interdisciplinary team (IDT) care has been cited as the gold-standard treatment approach because it tends to address each component of the established biopsychosocial model (78); however, it is typically offered inpatient and is resource-intensive and burdensome. An innovative practice at the Salem VA Healthcare System, primarily serving rural Appalachian Veterans, offers Veterans a lower burden brief interdisciplinary team care via shared appointments with the Veteran, support person, and a five-discipline interdisciplinary team, as well as monthly telephonic support. The model, called PREVAIL Center for Chronic Pain Interdisciplinary Track, also integrates whole healthcare, which was recently highlighted by the National Academies of Sciences, Engineering, and Medicine (79). While PREVAIL is not as brief and scalable as other innovations described in this article, it nicely illustrates the overall trend of leveraging technology and applying novel clinical efficiencies to meet the needs of a complex population. The PREVAIL Interdisciplinary Track is a 6-month program that involves standardized patient education, an initial in-person meeting with the Veteran, support person, and an interdisciplinary team (IDT; psychology, interventional pain, physical therapy, nutrition, and pharmacy) that develops a patient-centered, whole health, biopsychosocial treatment plan, monthly phone calls with a whole health coach, and a 6-month follow-up meeting with the Veteran, support person, and the IDT. This program was launched in January 2022, and, to date, more than 200 Veterans have completed the initial evaluation. Given the emphasis on shared decision-making within the IDT initial evaluation and tailoring the treatment plan to the patient, no treatment plan has ever been duplicated. The program's use of technology, namely, telehealth visits for the patient education component and phone coaching, also reduces patient time burden which may enhance access for Veterans that experience barriers to traditional care. This model also lowers the healthcare system burden by offering an interdisciplinary approach that avoids the resources associated with inpatient treatment (e.g., staffing, space) and requires fewer scheduling calls compared to traditional models that have patients meeting with providers individually. While this approach is still being studied, early findings support patient acceptability, and high satisfaction rates have been demonstrated: 9.2/10 ($N =$ 176 Veterans and caregivers who completed the initial IDT evaluation in 2022). With the PREVAIL reducing the burden for both patients and the healthcare system, it is hoped that the program may be scaled across the VHA and expand Veteran access to biopsychosocial pain care.

3.6. Digital, on-demand treatments

Fully automated behavioral treatments offer the benefit of rapid scaling. Here, we review several on-demand pain treatments and the supporting evidence for each.

3.6.1. Virtual reality

In-clinic and in-patient virtual reality (VR) has long shown analgesic effects for procedural-related pain (80–82). In recent years, VR has been adapted to treat other pain conditions, including fibromyalgia and chronic low back pain (64–68). An early study compared VR for chronic pain to the same therapeutic content delivered in an audio-only format (no VR or visual display) (66). The study findings revealed that while patient engagement in both modalities was similar, the VR group evidenced superior analgesic benefits post-treatment, thus suggesting that the VR modality potentially offers unique benefits. This early study led to the creation of the 8-week VR treatment device described below.

An FDA-authorized prescriptive VR device offers a home-based sequential multimodal self-administered immersive (3D) treatment (64). The 56-day involves daily VR sessions lasting 6–8 min each, for a total of ∼50 min per week for 8 weeks. The program incorporates evidence-based self-regulatory skills used in cognitive behavioral therapy for chronic pain (diaphragmatic breathing, biofeedback elements, cognition, and emotion regulation), mindfulness principles, and pain education. Researchers conducted an RCT that included 188 community adults with chronic low back pain to compare the VR therapeutic program to a VR sham that involved 2D non-skill content delivered through the same model of VR headset. The VR therapeutic program results revealed clinically meaningful reductions in pain intensity and multidimensional pain interference with effects superior to VR sham. Moreover, clinical benefits were sustained at 3, 6, and 24 months post-treatment, with nominal regression to the mean at distal follow-up timepoints (64, 67, 68). The benefits of therapeutic VR include the devices being mailed directly to patients' homes for on-demand self-administered treatment. Thus, prescriptive VR overcomes many of the primary barriers to access seen for traditionally delivered treatments and allows clinicians a convenient way to prescribe evidence-based behavioral pain care. In 2023, the Centers for Medicare and Medicaid Services (CMS) created the first HCPCS Level II health procedure billing code for a virtual reality program for chronic low back pain, describing the treatment device as durable medical equipment and creating a pathway for Medicare and commercial payer coverage.

3.6.2. Empowered relief for surgery

Earlier in this article content discussed the live instructor delivered of 1-session Empowered Relief (either in-person or via Zoom). To extend to surgical populations, *Empowered Relief* was tailored to the surgical context and digitized into video-based modules that patients could receive on-demand at home, in the clinic, or in the hospital after surgery. An RCT was conducted on women undergoing breast cancer surgery to compare the digital intervention (then called *My Surgical Success*) to a health education control intervention that involved no active pain relief skills (55). Women who engaged with *My Surgical Success* were found to require about 1 week less of opioids after breast cancer surgery relative to women in the control group, suggesting benefits for reducing the time to opioid cessation after surgery.

Researchers next conducted an RCT of the digital intervention in 84 orthopedic trauma surgery patients, with the majority receiving their assigned treatment on an iPad in the hospital on post-operative days 1–3 (56). Patients who received the digital 45-min version of Empowered Relief reported significantly less pain after surgery relative to controls, and the analgesic benefits persisted for 3 months after surgery. The results suggested that engagement with Empowered Relief produced clinically meaningful and sustained analgesia and enhanced recovery after surgery. Moreover, the results underscored the potential for low cost, low burden, brief education, and pain self-regulatory skills to alter the trajectory of surgical recovery.

3.7. Self-guided Internet and app-based interventions

WebMAP Mobile (49) is a self-guided app-based intervention developed from an 8-week Internet-based intervention, focused on teaching youth skills for chronic pain management relaxation training, cognitive strategies, sleep, and activity engagement. WedMAP Mobile reduced pain intensity and functional impairment and is freely available for Apple and Android. iCanCope is another web-based educational intervention for youth with pain (83). iCanCope seeks to empower youth by providing information related to chronic pain, as well as various evidence-based treatment modalities (e.g., physical therapy, pain psychology), and provides behavioral modification skills for various lifestyle domains (e.g., sleep, physical activity). An app-based version of iCanCope is currently the focus of the ongoing study. Current work is also underway on the development of a digital graded exposure treatment (GET) for youth with chronic pain (iGET Living) (44), targeting pain-related impairment by supporting youth in engaging in previously avoided activities. Adapted from an interdisciplinary outpatient GET (GET Living) (84), iGET Living aims to provide a self-paced intervention that youth could engage with daily (∼10 min/day) over the course of 6 weeks, during which they learn about chronic pain, the rationale for value-based activity exposures, and practice engaging in activities they are avoiding due to fear of pain. Current work is focused on the finalization of a prototype of iGET Living that is expected to undergo an examination of feasibility and preliminary effectiveness in the coming year. During the feasibility trial, the value of therapist involvement (as opposed to self-guided) will be systematically evaluated to inform the finalization of a scalable intervention that can be feasibly implemented into healthcare.

PainTrainer is an open-access website app that teaches evidence-based pain coping skills using a self-administered, home-based software program (62). The system delivers eight weekly sessions via any online platform. The digital curriculum covers progressive muscle relaxation, pacing, pleasant activity scheduling, recognizing negative automatic thoughts, pleasant imagery and distraction, problem-solving, and maintenance strategies. *PainTrainer* was studied in a participant-blinded trial of patients with chronic pain. At post-treatment, greater increases in function, pain coping, and global improvement were found for *PainTrainer* compared to a control condition. Benefits persisted at 52 weeks, and 91% of participants (older adults, largely from rural, low-income areas) completed all eight sessions (85). Rini et al. (64) found similar results in a controlled trial in patients with painful arthritis that demonstrated improved self-efficacy, reduced anxiety, and less pain-related interference with functioning.

Magee and colleagues in Australia have developed brief video intervention and text-based support for patients undergoing prescription opioid tapering (69). The intervention was co-designed with patients and aims to enhance patient self-efficacy for opioid tapering and tapering outcomes.

Finally, with 40%–90% of patients with advanced cancer experiencing pain, improved access to behavioral pain treatment is needed. As one important step, Dr. Desiree Azizoddin and US colleagues have developed gamified CBT for the palliative context (86) and a CBT-based mobile health intervention (app) for patients with cancer (71). The initial results of the CBT app suggest favorable patient appraisal, and two efficacy trials are currently underway (87, 88). Such smartphone-delivered interventions hold promise for delivering scalable patient education, pain management skills, daily text messaging, and other key supports for patients with cancer pain.

4. Discussion

A variety of innovations are needed to address the diverse needs of people who have pain. This article, while not exhaustive, reviewed several innovations that are offering patients and clinicians new avenues for training, treatment, and resources. New directions that can expand the portfolio of accessible pain care include brief and effective behavioral pain treatments that leverage technology via telehealth and fully automated interventions. There are four key areas of future research that could grow the impact of these innovations: (1) expanding the pain workforce, (2) improving dissemination and implementation, (3) using precision medicine to understand treatment selection, and (4) exploring necessary patient-centered tailoring.

There is a need to train a wide range of healthcare specialties in delivering pain education and behavioral pain care, and technological solutions can offer flexible and accessible opportunities to deliver widespread education. Successful education models have utilized telemedicine to provide pain education, case-based learning, and consultative services to clinicians treating adults and children with pain (89). Clinician decision support tools embedded into medical record systems can provide strategies for when and how to make appropriate pain treatment referrals and patient-centered prescription opioid stewardship (90). Asynchronous training modules and online workshops also offer opportunities to disseminate pain education in graduate and resident training programs and diverse medical settings (91). Building from these educational efforts, patients and clinicians would benefit from further research examining how to expand the dissemination and implementation of these educational tools across *all* healthcare settings and to *all* healthcare providers who may treat patients with pain. Examination of which specific formats and tools are most effective in each medical setting is needed. Further, the development and implementation of strategies to increase clinician engagement, translate knowledge into practice, and sustain long-term improvements are needed to ensure pain education and training are most effective. Strategies might include incentivizing clinician participation, standardizing pain education in medical training, and providing regular training opportunities available through chronic pain workgroups and consultation services (92).

In addition, the integration of pain education for patients and families across healthcare settings is needed. For example, approximately 60%–70% of patients that present to the emergency department have pain, and most report low pain management satisfaction (93). Those utilizing emergency services for pain are more likely to have worse chronic pain and psychological wellbeing (94). Few hospital settings offer pain education or behavioral pain care prior to or following surgical procedures, even though there is evidence that brief behavioral interventions can lower healthcare expenditures and improve surgical outcomes (95). Primary barriers include poor insurance coverage, high out-of-pocket costs, and the lack of flexible, patient-centered treatments that can scale within these settings (96). Several treatments detailed, including *Empowered Relief* (52, 56) and WebMap (49), may be viable pain treatments that could be freely available and easily integrated into a variety of medical settings. Additional research into the development, tailoring, and implementation of digital behavioral pain management tools is needed to continue expanding access and effectiveness across settings.

Effective patient-centered pain treatments must also be flexible and responsive to patient needs. Technology-enhanced digital pain treatments are designed to be delivered flexibly and can overcome access barriers. However, improving precision pain medicine with digital treatments, such as when, to whom, and at what dose of treatment, is needed. For example, depression, anxiety, and insomnia are highly comorbid in chronic pain and are associated with worse pain treatment outcomes (97). Pain catastrophizing is also a robust predictor of poor pain outcomes (98). Some patients may likely benefit from integrated pain treatments that can also improve comorbid depression, anxiety or insomnia, or targeted CBT skills that focus on reducing pain catastrophizing. Yet, little is known about who may respond most effectively to which treatment length or modality, and exploration of patient phenotypes and their impact on treatment responsiveness would greatly improve our ability to deliver the right treatment to the right patient. Additionally, *when* treatment is delivered is likely to be an important factor. Early exposure to biopsychosocial pain care is associated with a reduced risk of acute to chronic pain transition, and those with worse disability and psychological comorbidities are at the highest risk for developing chronic pain (99). Therefore, identifying patients at the highest risk of developing chronic pain and providing pain treatments before invasive procedures may improve patient outcomes and reduce healthcare expenditures.

Lastly, treatments must be patient-centered and ensure that patients feel welcomed, understood, and respected. To do this, the use of patient-centered, first-person language is crucial to help patients understand the biopsychosocial nature of chronic pain without feeling as though they are being blamed or exaggerating their pain. Additionally, the integration of cultural adaptations can help patients from different backgrounds feel seen and heard. For example, Indian and Chinese populations describe cultural responses to pain, such as suppressing pain responses, to be important to address along with the inclusion of spiritual and holistic approaches beyond traditional Western treatments (100). People who experience race-based trauma and stress (RBTS) are also disproportionately at higher risk for developing chronic pain. Developing and tailoring treatments that are sensitive to the needs of specific racialized groups and address cultural, structural, and institutional factors that result in RBTS and pain (101). Intersecting factors, such as stigma and medical mistrust, toward behavioral pain treatments and clinicians are also important to address to increase treatment engagement. Digital treatments offer a unique opportunity to reduce biases and misinterpretation of pain experiences, which contribute to poor pain outcomes (102). Additionally, digital interventions that are low-burden, accessible, and skill-based may mitigate stigma toward the use of behavioral interventions in chronic pain care.

Innovative digital pain education and treatments are capable of transforming how evidenced-based pain care is delivered to clinicians and patients and are uniquely situated to reduce many access, dissemination, and implementation barriers that many face. Further research into how these technological advancements can be implemented in a wide variety of medical settings and effectively serve diverse patient populations will enhance patient outcomes and reduce the societal burden of pain.

Author contributions

BD conceptualized the manuscript with the primary shaping of scope and content from LH, LS, and KE. BD produced the initial draft. All authors contributed to the original content and provided multistage editing. KE drafted the abstract and discussion. All authors contributed to the article and approved the submitted version.

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Conflict of interest

BD is Chief Science Advisor at AppliedVR and she receives consulting fees for this role. BD receives royalties for four pain treatment books she has authored or coauthored. She is the principal investigator for two pain research awards from the Patient-Centered Outcomes Research Institute. BD is principal investigator for two NIH grants. BD serves on the Board of Directors for the American Academy of Pain Medicine, is on the Board of Directors for the Institute for Brain Potential, and is on the Medical Advisory Board for the Facial Pain Association. BD is a scientific member of the NIH Interagency Pain Research Coordinating Committee, a former member of the Centers for Disease Control and Prevention Opioid Workgroup (2020–2021), and a current member of the Pain Advisory Group of the American Psychological Association.

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Improvement in medical students' knowledge on chronic pain assessment through integrative learning approaches: a randomized controlled trial

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Introduction: This study aimed to compare the knowledge and skills of medical students in chronic pain assessment after being trained using the PQRST (P, provoke and palliate; Q, quality; R, region and radiation; S, severity; T, time) and ACT-UP (A, activity; C, coping; T, think; U, upset; P, people) mnemonics with those using only the PQRST mnemonic.
Methods: A double-blind, randomized controlled trial was conducted at the Faculty of Medicine, Universitas Indonesia, including forty students who participated in a simulation-based chronic pain assessment workshop. Pre- and post-test scores were used to assess participants' knowledge. Two independent raters assessed the students' skills.
Results: No significant differences in knowledge or skills were observed between the groups; however, a significant improvement in the post-test scores (85.71 [71.43–95.24]) compared to the pre-test scores (61.90 [25.87–90.48]) was observed. The students reported high satisfaction with the workshop.
Conclusions: Training with the PQRST and ACT-UP mnemonics is not better than training with the PQRST mnemonic alone in improving students' knowledge and skills in chronic pain assessment. Nevertheless, this pain education workshop was beneficial for student learning. Learning of patient-oriented chronic pain assessment should be provided in a repetitive and integrative fashion using different approaches, such as lectures, demonstrations, simulations, and interactions with patients experiencing chronic pain. To conclude, mnemonics are helpful but not a primary learning tool.

KEYWORDS
chronic pain assessment, PQRST, ACT-UP, pain education, randomized controlled trial

1. Introduction

Chronic pain affects psychological conditions, reduces productivity and daily activity, and significantly affects a patient's social and economic status (1, 2). The prevalence of chronic pain varies worldwide, with an estimate of 10.1%–55.2% of the adult populations, indicating that pain management initiatives frequently face barriers (1, 3).

One of these barriers is the lack of knowledge and skills among health professionals to comprehensively understand the subjective pain experienced by patients (4). Studies have shown that the competence of health professionals in pain-related assessment is inadequate (5, 6), and pain education is not a priority in their training curricula (7). Therefore, the paradigm of pain learning should change radically, focusing not only on biological aspects but also on psychosocial aspects (8, 9). An essential part of pain learning is pain assessment (10). Pain assessment is a process that involves dialogue between patients and health professionals regarding the description of pain and its intensity, patient's response to pain, and the impact of pain on patients' lives (11). Although pain assessment has been discussed in the literature, research on this topic is still limited (12).

The PQRST mnemonic (P, provoke and palliate; Q, quality; R, region and radiation; S, severity; T, time) has been used for pain assessment in clinical practice and education (11, 13). Mnemonics offer several benefits. First, mnemonics are helpful for systematically memorizing and operationalizing concepts (14). Second, mnemonics are simple and fit well into the context of communication between patients and health professionals with time constraint (15). Nevertheless, the PQRST mnemonic focuses on the biomedical aspects of pain and is less supportive in exploring the psychosocial aspects of patients (11, 13).

Some experts have recommended the use of ACT-UP (A, activity; C, coping; T, think; U, upset; P, people) in patients with chronic pain. The ACT-UP mnemonic has an additional value in helping students conduct functional and psychosocial chronic pain assessments more comprehensively (16, 17). A combination of PQRST and ACT-UP is helpful and straightforward in guiding students to perform a comprehensive pain assessment. This can help students memorize and structure their history-taking process (18). However, the use of this combination for pain education has not yet been studied.

This study aimed to investigate whether pain assessment training using the PQRST and ACT-UP mnemonics is more effective than that with the PQRST mnemonic alone in improving the knowledge and skills of medical students. We hypothesized that pain assessment training using the PQRST and ACT-UP mnemonics is more effective in improving the knowledge and skills of medical students than the PQRST mnemonic alone. The results of this study could guide the development of pain education programs for students.

2. Materials and methods

We conducted a double-blind, randomized controlled trial. The study population comprised pre-clinical medical students in the Faculty of Medicine, Universitas Indonesia. Participants were chosen randomly from a list of third-year pre-clinical students. Eligibility criteria included students who completed modules on pain physiology, had basic knowledge of diseases causing pain in primary care, physical examinations, and communication skills. Students with experience in extracurricular chronic pain assessment training and those with chronic pain were excluded. Non-attendance or students who did not finish the workshops were considered as dropouts. Sample size was calculated based on a difference of five points, power of 90%, alpha of 5%, one-way, and dropout of 25%. The sample size was 40 for two groups of participants.

In this study, the competence of pain assessment was in concordance with the pain curriculum of International Association for the Study of Pain (IASP) (10) and the Indonesian Standard of Competence of Medical Doctors (19). The study process is described below and summarized in **Figure 1**.

2.1. Preparation

Learning materials and research instruments were developed based on the literature and discussion among the research team. The research instruments included (i) pre- and post-test scores to assess knowledge; (ii) a checklist to assess skills; and (iii) a questionnaire to assess student's satisfaction with the training (see **Supplementary Files**). The skill assessment scenario involved a case of low back pain. The instruments were validated by eight experts from Indonesia, the Netherlands, and USA. They were anesthesiologist and pain management physicians, family medicine physicians, and experts in medical education and communication skills training. One of them was the inventor of the ACT-UP mnemonics. The final drafts were translated into Indonesian language and back-translated into English language by an independent translator. Cultural and language comprehension was ensured by an independent bilingual third party with a background in anesthesiology.

Three national experts conducted a content validation. Aiken's V Coefficients (range, 0–1) were calculated for each item, with a score of >0.5 considered adequate (20, 21). The Aiken's V coefficient for the knowledge test was 0.78–1; for the checklist was 0.78–1, and for the questionnaire was 0.89–1. Finally, the instruments were piloted and their reliability was measured.

We conducted preparation courses for facilitators, raters, and simulated patients through lectures, demonstrations, and practice sessions. The raters piloted the checklist and measured its reliability.

2.2. Intervention

We conducted a one-day integrative workshop on chronic pain assessment in the Simulation-Based Medical Education and Research Center, Indonesia Medical Education and Research Institute. An independent party conducted the randomization. The students were blinded to the group allocation, but they knew that there were two learning approaches.

To ensure that both groups received equal intervention, all students participated in the first integrative sessions together. A patient with chronic pain shared her experiences of living with pain and its influence on functional and psychosocial conditions. An expert in pain management provided interactive lectures. The ACT-UP mnemonic was not used to ensure blinding.

Thereafter, the intervention and control groups were separated into two locations to maintain blinding. Each group underwent a demonstration of chronic pain assessment using a doctor-patient

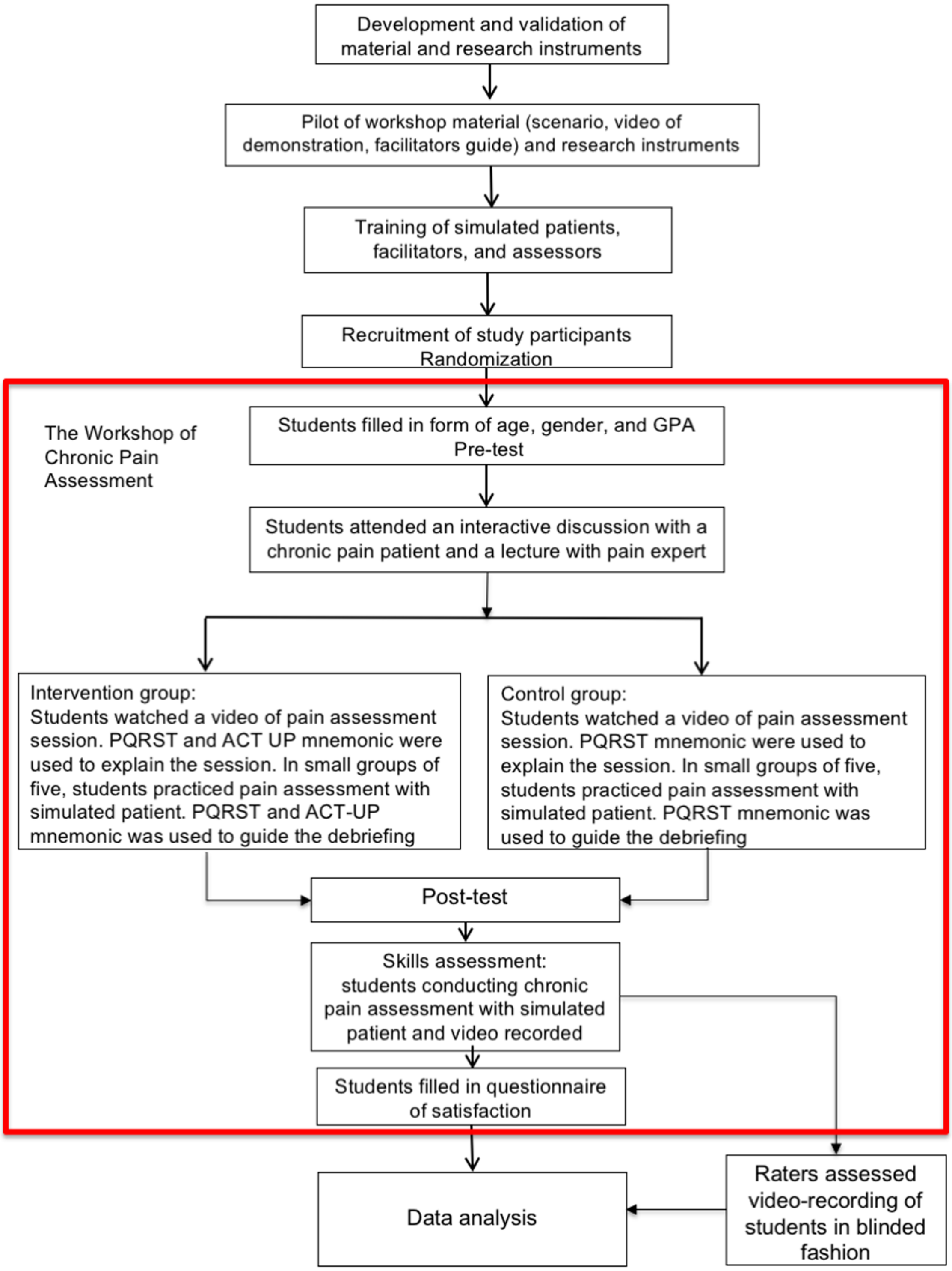

FIGURE 1
Study process.

simulation video. There was a significant difference between the videos of the two groups. In addition to the explanation of the PQRST mnemonics and principles of comprehensive chronic pain assessment, the intervention group received an explanation of the PQRST and ACT-UP mnemonics in the video.

Subsequently, the students practiced pain assessment in small groups of five with one facilitator. Each student practiced a one-time simulation and provided feedback to the other group members. There were four scenarios, based on diseases (chronic low back pain or headache) and functional and psychosocial problems. We provided a flipchart with information on the mnemonics; the intervention group obtained information about the PQRST and ACT-UP mnemonics, whereas the control group obtained information about the PQRST mnemonic only. Differences in the use of mnemonics were also noted in the feedback session.

2.3. Data collection

The students completed the pre- and post-tests at the beginning of the training and at the end of the workshop. They conducted a chronic pain assessment on a simulated patient with back pain, which was video-recorded. Four raters, blinded to the group allocation, assessed the video recordings of the simulations. Each student was independently assessed by a pair of raters. At the end of the training, students completed questionnaires on satisfaction.

2.4. Data analysis

We used Statistical Package for the Social Sciences (SPSS) version 20.0 for data analysis. An independent *t*-test was used to compare means between the groups, or the Mann–Whitney *U*-test was applied when the data were not normally distributed. We compared pre- and post-test data using the Wilcoxon signed-rank test.

2.5. Ethical consideration

Ethical approval was granted by the Ethical Committee of the Faculty of Medicine, Universitas Indonesia and Cipto Mangunkusumo General Hospital (0467/UN2. F1/ETIK/2018). All the participants had the right to obtain information about the study and refuse to participate. Refusal did not influence the students' academic assessments. Students who agreed to participate signed an informed consent form.

To ensure blinding, the students were informed about the different intervention approaches in the two groups; however, they were no given detailed information about the differences. Furthermore, the information sheet and consent form did not mention the PQRST or ACT-UP mnemonics. This concealment did not pose an additional risk to the students and was approved by the Ethical Committee.

3. Results

The participants' flow chart is presented in Figure 2. Table 1 shows the comparable characteristics of the participants in each group. The pre- and post-tests consisted of 21 items with a split-half reliability of 0.70, showing moderate reliability (22). Table 2 shows a comparison of students' knowledge and skills between the two groups. Knowledge was assessed by calculating the percentage of correct responses. Difference was obtained by subtracting the pre-test score from the post-test score. This difference was $p = 0.066$ or >0.025 (one-tail hypothesis). The skill assessment was used to obtain the skill score by calculating the total score × weight × 100 divided by the maximum score. The reliability test between raters showed an adequate agreement of Intraclass Correlation (ICC) 0.76 (23). This finding indicates that the knowledge and skill levels of students trained with the PQRST and ACT-UP mnemonics were not higher than those trained with the PQRST mnemonics only.

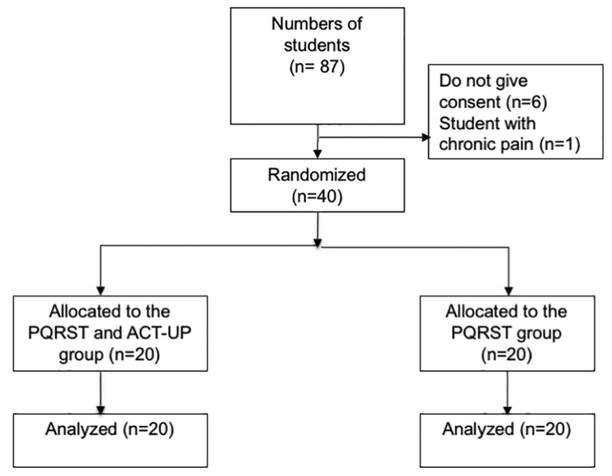

FIGURE 2
Participants' flow chart.

TABLE 1 Characteristics of students in both the groups.

Characteristics	PQRST and ACT UP	PQRST
	(*n* = 20)	(*n* = 20)
Age (year)[a]	20 (SD, 1)	21 (SD, 0.5)
Gender[b]		
Male	12 (60)	12 (60)
Female	8 (40)	8 (40)
Grade point average[a]	3.39 (SD, 0.14)	3.39 (SD, 0.21)

[a]Data are presented as mean (SD).
[b]Data is presented in *n* (%).

TABLE 2 Comparison of students' knowledge and skills between the two groups.

	PQRST and ACT-UP	PQRST	95% CI from the mean difference	*p*-Value
Knowledge				
Pre-test	63.81 (SD, 14.69)	66.67 (SD, 8.18)		0.183[a]
Post-test	85.95 (SD, 6.08)	82.14 (SD, 8.30)	3.17 (−1.54–7.89)	0.106[b]
Difference	22.14 (SD, 12.29)	15.47 (SD, 9.88)	5.00 (−4.71–13.80)	0.066[b]
Skills	71.92 (SD, 7.26)	74.00 (SD, 9.63)	−2.08	0.445[b]
			−7.54 (SD, 3.38)	

For the readers' accessibility, all data are presented in mean (SD).
[a]Mann–Whitney test.
[b]Independent *t*-test.

TABLE 3 Comparison of students' pre- and post-test scores.

	Knowledge	*p*-Value
Pre-test	61.90 (25.87–90.48)	0.000[a]
Post-test	85.71 (71.43–95.24)	

[a]Wilcoxon signed-rank test.

However, there was a significant difference between the pooled group of 40 participants in their knowledge before and after the workshop (**Table 3**).

In the satisfaction questionnaires, the participants responded on a scale of 1–4 to the question, "How do the following items support your learning process?" (1 = not very supportive, 2 = not supportive, 3 = supportive, 4 = very supportive). The questionnaire for the intervention group consisted of 15 items, while that of the controlled group consisted of only 14 items; the item "the use of ACT-UP mnemonic" was not asked. Therefore, the alpha coefficient of reliability was calculated using the questionnaire with 14 items. The alpha coefficient was 0.76 and was considered acceptable (24). The level of satisfaction in both the groups was high, with a median score of 3.8 (3.33–4) for the PQRST and ACT-UP group and 3.75 (3.07–4) for the PQRST group. The results of the questionnaire are presented in the **Supplementary Material**.

4. Discussion

This study aimed to investigate whether the incorporation of the ACT-UP mnemonic in pain assessment training could improve the knowledge and skills of medical students. The intervention and control groups were comparable. There were no significant differences in knowledge at the beginning of the intervention. After the training, there was no difference in skills or knowledge between the intervention and control groups. This showed that training with the PQRST and ACT-UP mnemonic was not better than training with only the PQRST mnemonic.

Theoretically, mnemonics work as a tool to help memorize and structure lines of thinking (14, 18, 24). Our result differs from those of the other studies that have compared the two mnemonics during training in an emergency context, showing that mnemonics are superior in supporting memory and organizing the causes of emergencies (14). The ACT-UP mnemonic, consisting of functional and psychosocial items, potentially helps students perform a comprehensive chronic pain assessment. However, our study showed that even without the ACT-UP mnemonic, students in the control group could perform a comprehensive pain assessment. Our results also showed a significant difference between the pre- and post-test scores and high post-test and skills test scores of the pooled group of 40 students.

These findings indicate that in our study, an additional mnemonic may not be necessary to improve students' learning, or that our measurements may not have the sensitivity to illuminate the psychosocial and functional strengths of the ACT-UP mnemonic. We believe that the integrative approaches, structured from simple to complex, consisting of various methods, including talk shows with real patients, expert lectures, demonstrations, and simulations, are beneficial and adequate as learning tools. The students' improvement was also attributed to the reinforcement of chronic pain assessment principles across various learning activities (25). A systematic review has shown that simulations can improve students' skills (26), while interactions with patients with chronic pain provide exposure to real-world scenarios (27, 28). This result was consistent with the high satisfaction of students in both the groups. Students reported that the different integrative approaches used in this workshop supported learning.

This is the first empirical study on the ACT-UP mnemonic. Previous studies on the ACT-UP mnemonic have not included empirical data (16, 17). Additionally, previous studies on pain learning did not use control groups (29) or blinding (12, 28). Thus, the internal validity of this study was adequate. An independent party conducted the group allocation, and blinding was maintained for both the groups (23). Expert validation showed that the items measuring knowledge, skills, and satisfaction had good content validation. The reliability of these instruments is moderate and reasonable (24).

This study has some limitations. First, we limited the training to one day in order to maintain blinding and prevent students from communicating the differences between the interventions. Additionally, repeating the simulation was also difficult, owing to time constraints. Each student was able to conduct the simulation once and participate in the other four simulations in a group. Therefore, we could not assess the skills retention (30). Long-term training evaluation can be conducted when students are exposed to real patients during their clinical rotations. Second, this study was conducted at a single institution, and the adoption of this study should take into consideration the curriculum and student characteristics. Future studies should be conducted in other institutions, involving other health professionals or in a continuing education context.

In conclusion, to improve the knowledge and skills of medical students, training with the PQRST and ACT-UP mnemonics is not superior to that with the PQSRT mnemonic alone. Mnemonics are helpful, but they are not a primary learning tool. Patient-oriented chronic pain assessment learning should be integrated and provided repetitively using different approaches, such as lectures, demonstrations, simulations, and interaction with patients experiencing chronic pain.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by The Ethics Committee of the Faculty of Medicine, Universitas Indonesia. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

RFS and APS initiated the study, RFS, BS, AF, and APS designed the study. BS and APS were in charge for data collection. All authors conducted the data analysis. APS drafted the manuscript and all authors approved the final version of the manuscript. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fpain.2023.1210370/full#supplementary-material

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Evolving Project ECHO: delivery of pediatric pain core competency learning for interprofessional healthcare providers

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Introduction: Healthcare providers (HCPs) practicing in community settings are critical to improving access to pain care, yet there are significant gaps in training opportunities designed for interprofessional learners. Project Extension for Community Healthcare Outcomes (Project ECHO®) is an established model for delivering online HCP education through virtual clinics and cultivating a community of practice. However, to our knowledge, the integration of pain core competency education into the *ECHO®* model has not been previously attempted. This innovation could enhance the *ECHO®* model while also addressing the growing calls for more accessible interprofessional pain curricula. This paper describes efforts to implement and evaluate core competency curricula within the context of *Pediatric Project ECHO for Pain*, one of the first pediatric-pain focused ECHO programs in the world.

Methods: Needs assessments informed curricula development. The first delivered core competency model consisted of synchronous webinar-style sessions while the second model included a mixture of asynchronous (eLearning course) and synchronous (virtual clinical debrief) elements. A convenience sample of HCPs was recruited from ECHO program registrants. Participants completed baseline and follow-up surveys to assess core competency acceptability as well as impact on knowledge and self-efficacy related to managing pediatric pain. Usability of the eLearning platform (model 2 only) was also evaluated. Surveys used 5-point Likert scales to capture outcomes. *A priori* targets included mean scores ≥4/5 for acceptability and ≥80% of learners reporting knowledge and self-efficacy improvements. The study received local research ethics approval.

Results: The core competency was found to be highly acceptable to interprofessional learners ($n = 31$) across delivery models, surpassing *a priori* targets. Specifically, it was characterized as a worthwhile and satisfactory experience that was helpful in supporting learning. The core competency was also associated with improvements in knowledge and self-efficacy by 97% and 90% of learners, respectively. The eLearning platform was reported to have high usability with clinically realistic cases (100% of respondents) that were helpful to inform care delivery (94% of respondents).

Conclusion: The integration of core competency learning within the *Project ECHO*® model was a successful approach to deliver pediatric pain education to interprofessional HCPs.

KEYWORDS

pediatric pain, Project ECHO, core competency, tele-education, distance education, continuing professional development, community of practice, interprofessional

1. Introduction

Pain is a significant health problem for children and youth that can impair all aspects of life (1–4). Pediatric acute and chronic pain have differing profiles, with acute pain arising from tissue harm (e.g., surgery, injury, disease), which usually resolves as tissues heal. Timely pain management is essential to mitigate the risk of transition from acute to chronic pain (5, 6). Chronic pain is defined as pain lasting more than 3 months with significant emotional distress and/or functional disability (7–9). It is subdivided into chronic primary pain (i.e., disease in its own right, such as headache, abdominal pain, musculoskeletal pain) or chronic secondary pain (i.e., caused by another health condition such as juvenile idiopathic arthritis or sickle cell disease) (7–9). Chronic pain affects 1 in 5 children and youth, particularly from equity seeking populations (4, 7, 8, 10–12). Specialty tertiary care clinics generally manage children and youth severely impacted by pain. Unfortunately, prolonged wait times to access specialized pediatric pain management programs can have detrimental impacts on patients and families (13, 14).

In 2019, Canadian healthcare providers (HCPs) and families (children, youth, and caregivers) impacted by pain identified "better access to pain care" and "increasing healthcare provider training, knowledge, recognition, beliefs, attitudes, and communication" related to pediatric pain as top priorities (15). This need has been further articulated by policymakers and key stakeholders such as in the federal government's "Action Plan for Pain in Canada", which has emphasized the critical need to engage HCPs from primary and secondary care settings in managing pediatric acute and chronic pain (12). However, there are significant gaps in available pain education for HCPs and a need for more opportunities to support interprofessional training in pain management across Canada and worldwide (10, 16, 17).

Since the 1990's, the International Association for the Study of Pain and the global pain community have recognized the importance of core pain curricula for interprofessional HCPs (18–21). Specific to pediatrics, a 2019 review found that, "education regarding the assessment and treatment of pain in children is needed across all relevant disciplines including within medicine, nursing, physiotherapy, and psychology" (p. 4) (17). This review also identified that "…innovative pain education programmes are generally not well implemented; both accessibility to and assessment of these programmes must be improved to facilitate positive changes in current practice" (p. 4) (17).

Project ECHO® *(Extension for Community Healthcare Outcomes)* is an established model for delivering online HCP education through virtual clinics and cultivating a supportive community of practice (22, 23). *ECHO*® uses a "Hub-and-Spoke" structure, wherein the Hub (i.e., a specialty interprofessional team) regularly connects via videoconference with multiple Spokes (i.e., community-based HCPs) to learn together with the shared goal of enhancing local patient care. The traditional *ECHO*® model is centred on virtually delivered "TeleECHO clinics" wherein a brief didactic presentation is followed by de-identified case presentation from a community HCP and facilitated group discussion to generate best practice recommendations for case management. The presenting HCP then has autonomy to apply the recommendations to their specific patient case, while other Spoke learners can reflect on how the discussed principles can be applied to their own practices. The overarching goal of *ECHO*® is to empower HCPs with training, mentorship, and support to locally manage their patients with specialized health needs within the framework of a virtual community of practice. ECHO programs have been developed to support a wide variety of health conditions, including acute and chronic pain (22, 24, 25).

Pediatric ECHO® *For Pain*, based in Ontario Canada, is one of the largest pediatric pain-focused *ECHO*® programs in the world (26). Program scope is inclusive of multimodal, evidence-based approaches to support interdisciplinary management of pediatric acute, chronic, and transitional pain. Since 2017, this program has delivered more than 100 TeleECHO clinics to an interprofessional audience of over 1,800 HCPs from 27 different disciplines. These TeleECHO clinics are associated with significant improvements in interprofessional HCP pain knowledge and self-efficacy as well as positive practice impacts (26).

To our knowledge, the integration of pain core competency education (i.e., focus on foundational education) into the *ECHO*® model has not been previously attempted. However, *Pediatric ECHO*® *For Pain*, with its robust infrastructure and interprofessional audience, offers a timely opportunity to explore the implementation of core competency alongside the prototypical TeleECHO clinics. This innovation could enhance the *ECHO*® model while also addressing the growing calls for more accessible interprofessional pain curricula.

Our group has previously reported on pilot delivery of a pain core competency within *Pediatric ECHO*® *For Pain* (26). While this model was positively received by attendees, many HCPs found it challenging to find the time to participate in the core competency in addition to the TeleECHO clinics. For instance, in a survey probing on reasons for low program attendance, over 50% of respondents ($n = 123$) cited lack of availability during the scheduled sessions (27).

In response to these identified learner needs, the program has trialed different core competency delivery models, including both asynchronous and synchronous elements. In this paper, we will describe efforts by *Pediatric ECHO® For Pain* to refine the delivery of core competency curricula for interprofessional HCPs related to managing pain in children and youth. Evaluation data from varying delivery models will be presented related to acceptability as well as impacts on knowledge and self-efficacy. These data will inform recommendations for integrating core competency learning within the *Project ECHO®* model as well as broader implications for the HCP pain education landscape.

2. Methods

This study received research ethics board approval from The Hospital for Sick Children (#1000057321) and adhered to the Canadian Tri-Council Policy Statement on Ethical Conduct for Research Involving Humans.

2.1. Description of delivery models

Model 1 (Synchronous): The initial offering of Core Competency consisted of webinar-style sessions conducted live over Zoom. Interprofessional HCPs could register for the sessions and join remotely from their personal web-enabled device (e.g., computer, tablet, smartphone). Each session was facilitated by a member of the Pain Hub team, located at The Hospital for Sick Children (SickKids), which is the largest pediatric tertiary care hospital in Canada. Sessions were 60 min in duration and the curriculum was delivered over 8 installments delivered once a week. The curriculum content was informed by a previously reported online needs assessment (26).

Model 2 (Hybrid of Asynchronous and Synchronous): The subsequent Core Competency offering consisted of a mixture of asynchronous and synchronous elements. An asynchronous eLearning course dedicated to the fundamentals of pediatric pain management was created in partnership with AboutKidsHealth (i.e., the patient and family health education group within SickKids). Curriculum content was informed by a needs assessment of interprofessional learners registered for the *Pediatric ECHO® For Pain* program (26). The eLearning course consisted of four individual modules designed to offer an interactive user experience through embedded resources, quizzes (e.g., multiple choice, multiple responses, fill-in-the-blank, matching), and case studies. The eLearning platform (Articulate Rise 360) had a responsive design and was accessible on any web-enabled device (e.g., desktop, tablet, mobile). The synchronous model component was a 60-minute clinical debrief of the Core Competency eLearning content, conducted live over Zoom. The debrief was offered to HCP learners as an opportunity to discuss the curriculum content with peer learners and the Pain Hub team.

2.2. Model implementation and evaluation

Each Core Competency model was implemented as part of the program-level offerings of *Pediatric ECHO® For Pain*. The synchronous model was delivered between November 2017 and January 2019, while the hybrid model was delivered between October and December 2021. Differences in duration of model delivery were a function of requirements from the program funder (Ontario Ministry of Health).

HCP learners who registered for either model completed a baseline survey to assess their expectations as well as current knowledge and self-efficacy related to managing pediatric pain. Learners who either attended at least one synchronous session (model 1) or completed at least one eLearning module (model 2) were sent a follow-up survey to assess acceptability as well as any changes in knowledge or self-efficacy since starting the program. All survey administration was managed using REDCap, a secure electronic data collection tool hosted at SickKids (28).

2.3. Data analysis

Quantitative survey data were summarized using descriptive statistics. Where item-level survey response options differed between models (e.g., 7-point Likert vs. 5-point Likert), a merged scale was used. For instance, the response items of "2 = disagree" and "3 = somewhat disagree", drawn from a 7-point Likert agreement scale, were re-coded as "2 = disagree" within a 5-point Likert scale. The *a priori* targets for assessed constructs were mean acceptability scores ≥4 (possible scores ranged from 1 to 5); ≥80% of learners reporting improvements in knowledge related to managing pediatric pain; and ≥80% of learners reporting improvements in confidence related to managing pediatric pain. In addition to the constructs described above, the usability of the eLearning platform (Model 2 only) was also assessed. The *a priori* targets for platform usability were mean score ≥4 for ease of use (possible scores ranged from 1 to 5); ≤5% of learners reporting major technical issues; and ≥80% of learners describing the exemplar patient cases within the modules as both clinically realistic and helpful in informing their delivery of care. Data were exported from REDCap and analysis was conducted using Microsoft Excel Version 16.60 by authors CL and VM.

3. Results

3.1. Characteristics of HCP learners

Demographic characteristics of the HCP learners are summarized in **Table 1**. Many expectations for the Core Competency learner experience were shared across models ($n = 31$), including:

- Expand knowledge and confidence with up-to-date information to guide clinical practice (100%)
- Integration of case-based learning (88%)
- Joining an interactive community of practice that accommodates different learning styles (69%)

TABLE 1 Demographic characteristics of core competency learners ($N = 31$).

Characteristic (n, %)	Model 1 (Synchronous), $n = 15$	Model 2 (Hybrid), $n = 16$
Profession		
Child Life Specialist	0 (0)	4 (25)
Nurse Practitioner	2 (13)	1 (6)
Registered Nurse	3 (20)	9 (56)
Rehabilitation Specialist		
(e.g. physiotherapist)	6 (40)	1 (6)
Physician	3 (20)	1 (6)
Missing	1 (7)	0 (0)
Gender Identity		
Man	0	0 (0)
Prefer not to answer	0	1 (6)
Woman	15 (100)	15 (94)
Race		
Black	1 (7)	1 (6)
East Asian	0 (0)	1 (6)
Indigenous	0 (0)	1 (6)
Prefer not to answer	0 (0)	2 (13)
South Asian	3 (20)	0 (0)
White	11 (73)	11 (69)
Age		
0–19 years	0 (0)	1 (6)
20–29 years	3 (20)	4 (25)
30–39 years	6 (40)	4 (25)
40–49 years	4 (27)	3 (19)
50–59 years	2 (13)	3 (19)
Prefer not to answer	0 (0)	1 (6)
Years of Practice		
Less than 1 year	2 (13)	3 (19)
1–4 years	3 (20)	2 (13)
5–10 years	1 (7)	5 (31)
Greater than 10 years	7 (47)	5 (31)
Prefer not to answer	2 (14)	1 (6)
Primary Practice Setting		
Academic Hospital	9 (60)	5 (31)
Community	1 (7)	4 (25)
Family Health Team	1 (7)	1 (6)
Non-Academic Hospital	1 (7)	2 (13)
Other	0 (0)	2 (13)*
Private Practice	3 (20)	1 (6)
Prefer not to answer	0	1 (6)

*Other: Hospice; Not specified.

3.2. Acceptability

All learners ($n = 31$) characterized the Core Competency as a worthwhile and satisfactory experience. Average Likert scores for this construct, which could range from 1 (“strongly disagree”) to 5 (“strongly agree”), were 4.4 ± 0.5 for Model 1 and 4.7 ± 0.5 for Model 2, respectively.

The Core Competency was also characterized as effective and helpful in supporting learning by nearly all participants ($n = 30$; 97%). Average Likert agreement scores for this construct were 4.3 ± 0.6 for Model 1 and 4.6 ± 0.5 for Model 2, respectively.

Nearly all Model 1 participants ($n = 13/14$; 93%) agreed that the Core Competency training environment created a supportive community of practice. Given the more independent learning style of Model 2 (i.e., asynchronous eLearning with option for live group debrief), those participants were asked to characterize their perceptions about level of peer interaction. Of the $n = 8$ respondents to this item, 7 (88%) felt that Model 2 included “the right amount of opportunities for peer-to-peer learning”.

3.3. Knowledge and self-efficacy impacts

Nearly all learners (29/30; 97%) reported improvements in their knowledge related to managing pediatric pain. The relative magnitude of knowledge impact across models is illustrated in Figure 1.

Similarly, most learners (27/30; 90%) reported improvements in their self-efficacy or confidence in clinical management of children and youth with pain. The relative magnitude of self-efficacy impact across models is illustrated in Figure 2.

3.4. Usability of eLearning platform and anticipated applications

All Model 2 learners ($n = 16$) characterized the eLearning platform as easy to use. The average Likert score for this item, which could range from 1 (“very difficult”) to 5 (“very easy”) was 4.5 ± 0.7. No major technical issues were encountered with the eLearning platform during the delivery period.

The exemplar pediatric pain cases within the eLearning modules were well-received with all Model 2 participants ($n = 16$) describing them as clinically realistic. Similarly, nearly all participants ($n = 15$; 94%) characterized the patient cases within the modules as helpful to inform their patient care.

Planned applications for the eLearning modules by learners ($n = 16$) included:

- Gaining new knowledge and skills, such as reviewing an eLearning course for their own interest and/or to enhance their clinical practice (94%);
- As a refresher to stay up-to-date on best practice guidelines (88%);
- As a recommended resource for colleagues (77%);
- As a resource for local trainees (41%); and
- Just in time training such as reviewing a specific module prior to seeing a complicated pain case (24%).

4. Discussion

This study sought to evaluate the delivery of core competency curricula for interprofessional HCPs related to managing pain in children and youth. *Project ECHO*®, an established model for delivering accessible virtual education, was adapted to integrate different core competency modalities. The first model consisted of synchronously delivered sessions while the second model used

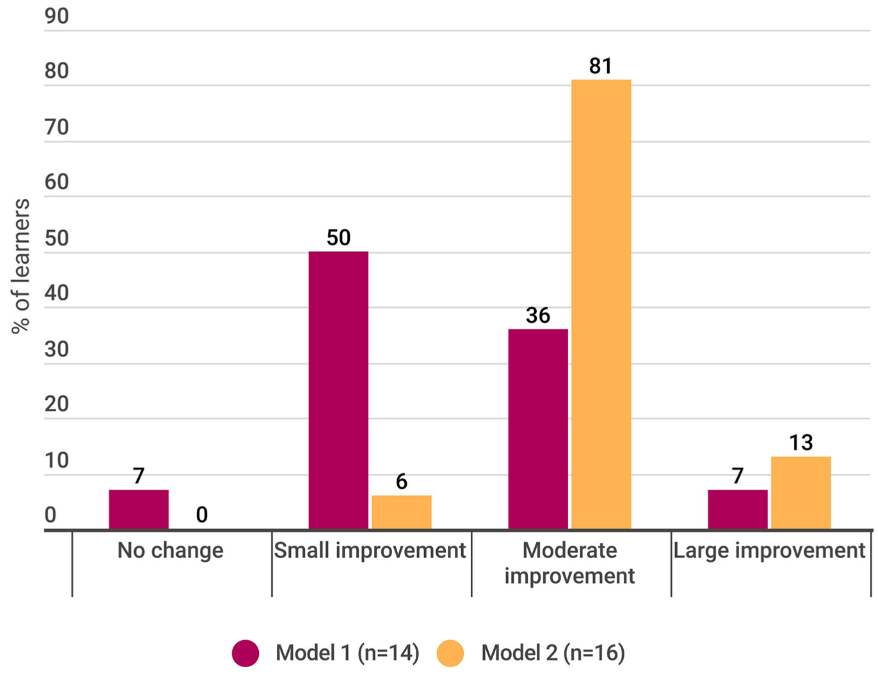

FIGURE 1
Impact of core competency on learner knowledge of pediatric pain.

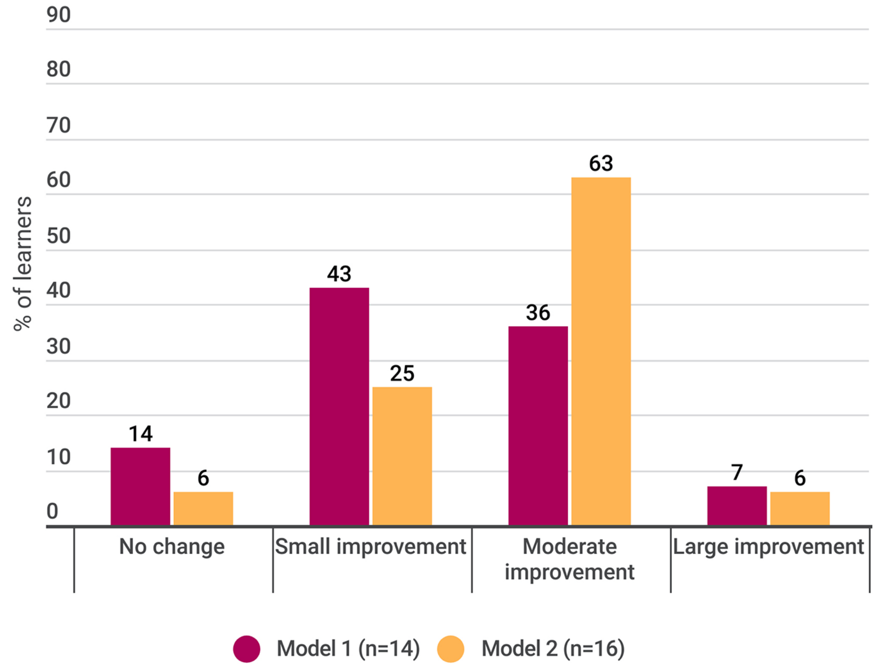

FIGURE 2
Impact of core competency on learner confidence in managing pediatric pain.

a hybrid approach of asynchronous eLearning modules paired with a synchronous debrief.

The *Pediatric ECHO*$^{®}$ *For Pain* core competency was found to be highly acceptable to interprofessional learners ($n = 31$) across delivery models, surpassing *a priori* targets. Specifically, the pain core competency was characterized as a worthwhile and satisfactory experience that was helpful in supporting learning. The core competency was also associated with reported improvements in knowledge and self-efficacy by 97% and 90% of learners, respectively. The eLearning platform utilized for Model

2 was reported to have high usability, surpassing *a priori* targets. Moreover, the demonstrative patient cases within the eLearning platform were characterized as clinically realistic (100% of respondents) and helpful to inform care delivery (94% of respondents).

Overall, the integration of core competency learning within the *Project ECHO*® model was a successful approach to deliver pediatric pain education. While the traditional *ECHO*® model concentrates on the TeleECHO clinic as a learning modality (i.e., didactic paired with patient case discussion), our data suggest that the model can be leveraged to also offer foundational education to an interprofessional learning community. Nascent and established *ECHO*® programs may wish to consider the integration of core competency elements into their curricula. A stepwise approach including needs assessment to understand learner requirements, environmental scan of existing educational opportunities, and pilot evaluation is recommended. Our group also recommends the inclusion of asynchronous components such as eLearning modules to enhance accessibility (e.g., opportunity to reinforce knowledge uptake through on-demand access to content, accommodation of different learning styles, optimizing screen readability, option for alternative text).

Strengths and Limitations: Study participants represented numerous professions and clinical disciplines, reflecting the real-world care management of pediatric pain, and enhancing the generalizability of findings to a broad group of HCP learners. Another study strength was the evaluation of different delivery modalities for pain core competency within the ECHO model. A limitation of this study was low diversity in terms of gender identity and race of participants. Given this was a pilot study using a convenience sample of learners, future evaluations will seek to purposively include a larger and more heterogeneous group of HCP learners. Findings are also subject to the limitations of self-reported knowledge and self-efficacy scores due to the lack of validated tools designed to measure these constructs across the varied healthcare professions that care for children with pain.

A 2023 survey study sought to characterize the continuing professional development needs of Canadian HCPs related to pain management among an interprofessional sample of $n = 230$ HCPs, including nurses, pharmacists, physicians, rehabilitation therapists, and dentists from a variety of practice settings (20). In this study, the most frequent pain education activities were reading journal articles (56%), online independent learning (44%), and attending hospital rounds (43%). Overall, 17% of respondents did not complete any pain learning activities in the past 12 months. Participants also stressed the need for more resources related to the care of children and youth with different pain conditions. The authors concluded that, “Canadian post-licensure [HCPs] require greater access to and participation in interactive and multimodal methods of continuing professional development to facilitate competency in evidence-based pain management” (p. 1). There is an opportunity for the *Pediatric ECHO*® *For Pain* core competency to begin to address this need related to pediatric pain. The eLearning modules, focused on headache, chronic widespread pain, functional gastrointestinal pain, and needle poke pain respectively, are now publicly available at https://sickkids.echoontario.ca/elearning/. Synchronous core competency sessions are continually offered through the program at no-cost to learners (see: https://sickkids.echoontario.ca for curriculum details).

Recently, Agley and colleagues completed a comprehensive qualitative study of five different ECHO programs with the aim of better understanding the model and identifying areas for improvement in implementation (29). A key recommendation was to “consider and experiment with ways that barriers to access can be overcome without diluting the model” (p. 7) with suggested solutions such as recording didactics for more convenient access. The pain core competency begins to address this identified need by offering on-demand access to session recordings (model 1) as well as eLearning modules (model 2). Future uptake of the resources amongst the ECHO community will be assessed through ongoing aggregate-level analytics to inform further core competency improvements.

The guiding principles of the Project ECHO model include amplification (i.e., using technology to leverage scarce resources), promotion of best practices (i.e., to reduce disparities in care), case-based learning, and continuous data collection to monitor program impacts (22). The core competency is aligned with each of these principles and may enhance the model by offering a new multimodal pathway to disseminate knowledge, which can then be applied locally to patient care. The ECHO model is also hypothesized to support “force multiplication” wherein learners eventually become local topic experts who can informally mentor colleagues in their community (22). The extent to which the pain core competency is associated with these more distal outcomes will be explored through future research.

Future research should also focus on the relationship between core competency curricula for pediatric pain and HCP practice implementation. Although the core competency model has evidence of positive impacts on HCP knowledge and self-efficacy, downstream effects on the direct care of patients and families are currently unknown. Future research will also examine the relationship between participation in the ECHO core competency education and subsequent engagement with TeleECHO clinics.

5. Conclusion

Pediatric Project ECHO® *For Pain* has innovated the ECHO model by integrating pain core competency. Adaptations of the competency model have sought to refine the delivery of accessible, convenient, and useful pediatric pain education. This advancement has demonstrated value for interprofessional HCPs who manage children and youth with pain needs.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Research Ethics Board, The Hospital for Sick Children. The patients/participants provided their written informed consent to participate in this study.

Author contributions

CL: conceptualized the study and conducted data acquisition, analysis, and interpretation as Research Lead for the *Pediatric Project ECHO*® program. VM: is the Research Coordinator for the *Pediatric Project ECHO*® program and carried out data acquisition, analysis, and interpretation. FC, JT, GM: were the previous program leads (2017–2020) responsible for delivering the *Pediatric Project ECHO*® *for Managing Pain in Children and Youth* program. They contributed to data interpretation and manuscript revisions. NS and SK: are the current program leads (2020-present) responsible for delivering the *Pediatric Project ECHO*® *for Managing Pain in Children and Youth* program. They contributed to data interpretation and manuscript revisions. JS: is the founding program lead of *Pediatric Project ECHO*® and contributed to data interpretation and manuscript revisions. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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US medical school curriculum on opioid use disorder—a topic review of current curricular research and evaluation of winning student-designed opioid curricula for the 2021 Coalition on Physician Education in Substance Use Disorders curricular competition

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The opioid crisis in the US severely affected and continues to affect population's health. The opioid crisis was in part fueled by inadequate pain management, which is in part due to the inadequate education in both pain and opioid use disorder (OUD) for health care professionals. In 2021, the Coalition on Physician Education in Substance Use Disorders (COPE) organized a curricular competition soliciting US medical students-designed OUD-related curricula. Twelve winning curricula were identified. Here, we first conducted a topic review regarding current US medical school OUD curricula. Then we evaluated the COPE winning curricula and compared them to the curricula identified in the topic review. For the topic review, ten relevant databases were searched up to December 31, 2021 using a combination of pre-determined keywords. Total of 25 peer-reviewed articles were selected based on the pre-determined criteria, which included 5 articles describing opioid curricular development at the state level (AZ, CA, MA, PA, and RI), 17 research articles evaluating a curriculum developed in a single institution, 2 literature reviews, and 1 article detailing curricular development and validation processes in a single institution. Although vary in organizations and formats, state-level curricula were comprehensive and could be adopted by other states or institutions with necessary local issue-based modifications. Faculty development and critical resources were major challenges for curricular implementation. The 17 research articles exhibited good scientific quality (Medical Education Research Study Quality Instrument (MERSQI) score = 11.94 ± 2.33 (maximal score = 18)). All research articles reported to some extent, the success of respective curriculum, in improving students' knowledge in and/or attitude towards OUD, based on primarily pre- and post- comparisons. Compared to these published curricula, winning students-designed curricula had more specific focuses, diverse learning activities, and varieties in assessment methods. For all curricula, long-term evaluations were lacking. Except for the state level curricula, majority of the other curricula did not emphasize specifically on chronic pain education or the biopsychosocial approach. Interprofessional education approach was also lacking. Our topic review and curricular evaluation highlighted the needs for integrating OUD and chronic pain medical curricula, developing long-term assessment tools, and more OUD curriculum research overall.

KEYWORDS

opioid use disorder, addiction, chronic pain, medical school, curriculum, medical student

1. Introduction

Opioid use disorder (OUD), a chronic relapsing mental disorder affecting ∼16 million people worldwide and over 2 million people in the US (1), is defined as a problematic pattern of opioid use that leads to significant impairment or distress (2), which can involve misuse of prescribed opioids and use of diverted opioid medications or illicit opioids (such as heroin) (3). The opioid crisis in the US severely affected and continues to affect population's health. In the US, the OUD epidemic is estimated to have an annual economic cost of over one billion dollars (4) and has caused more than a half million opioid-overdose deaths from 1999 to 2020 without a sign of slowing down (5). The most recent data estimated a total of 80,816 opioid-overdose deaths in 2021 in the US (6). Opioid-overdose related death continued to contribute to the reduction of life expectancies observed in the US despite the COVID-19 pandemic (7). It is well known that the first wave of opioid-overdose death was largely driven by the increased opioid prescription during the 1990s, which led to the publication of the guidelines for prescribing opioids for chronic pain as opioids are most often prescribed to treat pain (8). Opioid crisis also raised the concern of physician training regarding OUD and opioid management (9–11). As the result, the development of OUD curricula for medical school training has been increased. Yet the evaluation of these curricula remains incomplete and a crucial task. Thus, in this study, we first conducted a topic review regarding current research on US medical school curriculum on OUD. The involvement of chronic pain-related topics in these reported OUD curricular was also explored. Further, the Coalition on Physician Education in Substance Use Disorders (COPE) is a voluntary organization with a mission on training physician to manage substance use disorders. In 2021, COPE organized its first curricular competition soliciting US medical students (allopathic and osteopathic medical students)-designed OUD-related curricula. Twelve winning curricula were identified. Therefore, in the second part of this report, we also evaluated the COPE winning curricula and compared them to the curricula identified in the topic review which were primarily designed by the educators. Through our results, we hope to raise further awareness of the strengths and weaknesses regarding the development and evaluation of OUD-related medical school curricula.

2. Materials and methods

2.1. Literature review of curricula on OUD in US medical schools

We followed the previously published general guidelines for systematic reviews (12–14) to conduct our literature review wherever it is applicable to ensure a non-biased literature selection and review process.

2.1.1. Review objectives and inclusion/exclusion criteria

The overall objective of the literature review was "Review the current literatures regarding medical education curriculum on OUD in US medical schools". Before searching for eligible articles, we established the following eligibility criteria. Inclusion criteria: (1) Peer-reviewed full reports/articles; (2) In the format of systematic review, guideline, or research study; (3) Described the curriculum items used in the US MD or DO medical schools; (4) Related to undergraduate medical student education; and 5) Could involve students of other health professions, i.e., interprofessional or medical profession only. Exclusion criteria: (1) Abstract/poster presentations, short editorials, opinions, commentary, or individual views; (2) Reports that did not involve medical students (e.g., the program for medical residents); (3) Reports that were not related to opioids; (4) Reports that described specific one-time non-curricular activity/event, i.e., event that was not intended to be added to existing medical school curriculum; and (5) Reports that did not involve US medical schools (MD or DO).

2.1.2. Identification of articles for review

The literature search was conducted with the following key words: *medical curriculum, medical student, substance use disorder, addiction medicine, opioids, used simultaneously*. The following databases were used in the literature search: (1) AccessMedicine (provider: McGraw. Hill), (2) APA PsycINFO [provider: Elton B. Stephens Company (EBSCO)], (3) CINAHL Plus® with Full Text (provider: EBSCO), (4) Clinical Key (provider: Elsevier), (5) Education databases (provider: ProQuest Information and Learning Company), (6) Education sources (provider: EBSCO), (7) ERIC (provider: EBSCO), (8) PubMed [provider: United States National Library of Medicine (NLM)], (9) Scopus (provider: Reed Elsevier), and (10) Teacher Reference

Center (provider: EBSCO). Except for PubMed, the author used the library resources from the Johns Hopkins University to help identify relevant databases (such as those databases in topic areas of "Education" and "Education & Health Sciences") to conduct the search. For all databases, all available resources up to December 31, 2021 were included in the search. Within each database, abstract-only items (such as conference poster presentations) were excluded first before downloading the identified items. All saved items were further screened to remove duplicated items. The abstracts of the remaining items were screened again based on the pre-determined inclusion/exclusion criteria. Then, full-text articles of all remaining items were obtained and reviewed in detail, followed by further selection of eligible articles for literature review based on the pre-determined inclusion/exclusion criteria. During the process of obtaining the full articles, "Similar articles" function within PubMed was also used to help identify potential additional articles. These potential additional articles were also reviewed based on the same inclusion/exclusion criteria described earlier.

2.1.3. Data extraction and summary report of the identified articles

All identified articles are subjected to further data extraction using the Excel program (Microsoft office Professional Plus 2019, version 1808). Each article was assigned with a numeric ID to be used during the review process. The following items are extracted from each original article: Authors, Year of publication, Title of the article, Journal/issue/pages, Article type: Review/guideline development/research study, Study methods, Objectives, Training targets, Training topics, Training format, Assessment (outcome measures), Involvement of interprofessional/interdisciplinary students, Outcomes, and Author-identified limitations. Articles were further grouped based on the article types and separate analysis were conducted within the same types of the articles. For research studies, Medical Education Research Study Quality Instrument (MERSQI) (15) was used to assess the quality of each of the study.

2.2. Evaluation of COPE 2021 winning student curricula on OUD

2.2.1. Identification of winning curricula for evaluation

During the spring of 2021, COPE announced a call for submissions to *the Medical Student Curriculum Challenge: Innovative Learning and Teaching About Substance Use/ Opioid Use Disorders* with the support of the Opioid Response Network (https://opioidresponsenetwork.org). COPE invited medical student individuals or teams to submit integrative curricula under the guidance of a faculty mentor. Among the 36 curricula received, 8 were identified as Winners and 4 as Honorable mentions. All of these winning curricula (12 total) are available for free downloading through COPE's web page (https://www.copenow.org/innovative-curriculum-downloads/).

2.2.2. Data extraction and summary report of the winning curricula

An Excel (Microsoft) file was set up to record extracted information from each curriculum, which included: Title, School(s) or organization of origin, Topic of focus, Learners targeted, Delivery methods, Learning activities, and Assessment, as well other information such as Integration to existing curriculum, and Possibility of virtual delivery. Information were organized and presented in a series of tables, and summary text was provided in the Results.

3. Results

3.1. Literature review of curricula on OUD in US medical schools

3.1.1. Article identification

Articles were first identified using the key words and databases listed in the Materials and methods. After removal of duplicated items, further selection of articles for analysis was made by applying the pre-determined inclusion/exclusion criteria (Materials and methods). The step-by-step process used in article selection was described in the Materials and methods, and are summarized in **Figure 1**. Total of 25 articles were selected to be used in the article analysis in this literature review, which are summarized in **Table 1**. Besides one article was published in 2003 (16), the rest of the selected articles were published after 2010 ranging from 2013 to 2022 (note some were available online in 2021) with most of them published in 2020 and 2021 (**Figure 2**).

3.1.2. Quality review of selected articles

The 25 articles selected for analysis can be divided into 4 categories: (1) Curriculum development at state level—5 articles, IDs 1 (MA), 2 (PA), 20 (CA), 22 (AZ), and 23 (RI) (**Table 1**). (2) Evaluating a particular curriculum at a single institution in a research study—17 articles, IDs 3–13, 15–16, 19, 21, and 24–25 (**Table 1**). (3) Scoping reviews—2 articles, IDs 21 and 22 (**Table 1**). And (4) Curriculum development and validation at institutional level—1 article, ID 14 (**Table 1**).

For articles that describing the curricular development at the state level (17–21), due to the descriptive nature, no quality review was conducted. Comments regarding the process and content of each curriculum are included in the analysis. The two scoping review articles (22, 23) were from the same research group and were written by adhering to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews guidelines (24) with PROSPERO (https://www.crd.york.ac.uk/prospero/) registration numbers as CRD42018098874 and CRD42018098876, respectively. In the one article that described the detailed process of curricular development and validation in a single institution (25), the authors used the published curriculum development approach (26) to develop and validate their curriculum. This curriculum was further evaluated for its efficacy

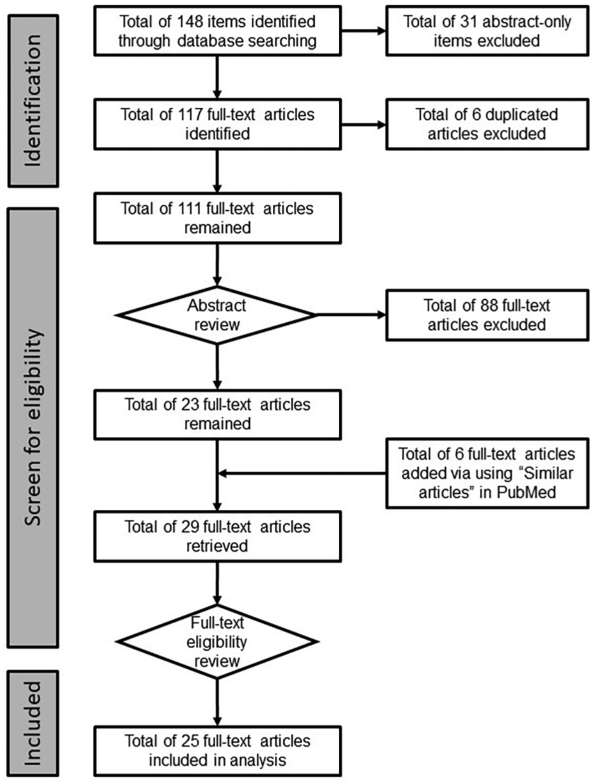

FIGURE 1
The selection process of identifying eligible articles for further analysis. Items were identified using the pre-determined key words and 10 databases as described in the Materials and methods. After removal of abstract-only items, all remaining items were subject to abstract review and subsequent full-text review based on the pre-determined inclusion/exclusion criteria. Additional articles were added via "Similar articles" function in PubMed during full-text article retrieval. Total of 25 articles were identified for further analysis.

in subsequent studies that were included in the 17 research study articles used in this review (27, 28). Therefore, the specific quality review was not conducted for the original curricular development article (25).

For the 17 research study articles that evaluated respective OUD curricula at institutional level, we conducted the quality review using the established instrument, MERSQI (15). The evaluation results are summarized in **Table 2** with a total MERSQI score at 11.94 ± 2.23 (mean ± SD) out of the maximum possible score of 18.

3.1.3. Information synthesis of state-level curricula

A total of 5 articles that described the development of medical school curriculum on opioid use disorder in 5 individual states: Arizona (AZ) (20), California (CA) (17, 19), Massachusetts (MA), Pennsylvania (PA), and Rhode Island (RI) (21). The general information regarding curricular development process, structure of the final products, and coverage on pain are summarized in **Table 3**.

Regardless whether it was the state or the medical schools who initiated the curricular development effort, in each of the 5 states, a working group was identified and available information (literature, existing guidelines and curricula, experts' opinions, and/or inputs from patients and students) was sought after and utilized to generate the final product. Besides the comprehensive components regarding SUD or OUD, all of these teams recognized the importance of addressing pain components in their respective final competencies/curricula (AZ developed a curriculum while others developed core competencies; **Table 3**). The document presented by RI, CA and AZ also had special emphasis on the biopsychosocial approaches to both pain and OUD. Further, SUD/OUD were viewed through the public health lens and public health components were included in all states' competencies/curricula. In addition, all states' competencies/curricula emphasized evidence-based practice. MA was the first state taking on this challenge, whose product was reviewed/referenced during the curricular development in other states. CA's competencies are the most updated as it was developed later and referenced materials from other states. AZ developed a comprehensive curriculum for all health professions, which could help to facilitate the collaboration and communications among all health professions in future practice as the curriculum provides the common language and concepts across all professions.

Regarding curricular delivery, while details in MA and PA were not described, the article from RI provided general guidelines on effective delivery with suggestions of using team-based, multidisciplinary activities, reflective writing, small group discussion, and empathy training, as well as incorporation of OUD training into the training for other chronic diseases. Articles from CA and AZ described the on-going effort of developing teaching resources for educators. Article from PA mentioned the state's effort in promoting sharing among medical schools regarding implementing the new competencies.

Regarding assessment, the article from RI provided general guidelines on effective assessment suggesting competency-based, qualitative (observational or open-ended writing) and/or subjective assessments, as well as using patient outcomes during assessment and longitudinal assessments. MA and AZ established annual review and evaluations of the curricular implementation and effects on learners, while CA focused on the development of assessment for the UC Clinical Performance Exam (CPX).

Potential challenges in curricular implementation include identifying times for additional curricular items, strategies for curricular integration, faculty development, clinical resources, and funding for education research to improve future curricular development and evaluation. AZ addressed the faculty development challenge by (a) producing a 150- page *Arizona Pain and Addiction Curriculum Faculty Guide* that detailed the evidence, reasoning, and supporting content behind each objective, and (b) organizing a teaching faculty submit discussing the new curriculum.

3.1.4. Information synthesis of research studies

When the 17 research articles were reviewed, we found that most curricula covered the core components of OUD: pharmacological knowledge of opioid and medications for OUD, signs and symptoms of plus risk factors for OUD, treatment of OUD, with the primary focus on basic science and clinical

TABLE 1 List of the 25 selected articles that were included in the analysis.

ID	Authors	Year	Title	Journal/issue/pages
1	Antman et al.	2016	Developing core competencies for the prevention and management of prescription drug misuse: A medical education collaboration in Massachusetts	Academic Medicine 91 (10): 1348–1351
2	Ashburn and Levine	2017	Pennsylvania State Core Competencies for Education on Opioids and Addiction.	Pain Med 18 (10): 1890–1894
3	Berland et al.	2017	Opioid overdose prevention training with naloxone, an adjunct to basic life support training for first-year medical students.	Substance Abuse 38 (2): 123–128.
4	Berland et al.	2019	Use of online opioid overdose prevention training for first-year medical students: A comparative analysis of online versus in-person training.	Subst Abus 40 (2): 240–246
5	Brown et al.	2013	Knowledge of addiction medicine among internal medicine residents and medical students.	Tennessee medicine: journal of the Tennessee Medical Association 106 (3): 31–33.
6	Dumenco et al.	2019	A qualitative analysis of interprofessional students' perceptions toward patients with opioid use disorder after a patient panel experience.	Subst Abus 40 (2): 125–131.
7	Egelund et al.	2020	Recognizing opioid addiction and overdose: An interprofessional simulation for medical, nursing and pharmacy students.	Journal of Interprofessional Education & Practice 20: 100347.
8	Estave et al.	2021	Opioid stewardship training during the transition to residency to prepare medical students to recognize and treat opioid use disorder.	Subst Abus 42 (4): 1040–1048.
9	Goss et al.	2021	A Comparative Analysis of Online Versus in-Person Opioid Overdose Awareness and Reversal Training for First-Year Medical Students.	Subst Use Misuse 56 (13): 1962–1971.
10	Jennings et al.	2020	Identification and Treatment of Opioid Withdrawal and Opioid Use Disorder in the Emergency Department.	MedEdPORTAL 16: 10899.
11	Lien et al.	2021	Eight-hour medication-assisted treatment waiver training for opioid use disorder: integration into medical school curriculum.	Med Educ Online 26 (1): 1847755.
12	Monteiro et al.	2017	An interprofessional education workshop to develop health professional student opioid misuse knowledge, attitudes, and skills.	Journal of the American Pharmacists Association 57 (2): S113-S117.
13	Moore et al.	2021	Medical Student Screening for Naloxone Eligibility in the Emergency Department: A Value-Added Role to Fight the Opioid Epidemic.	MedEdPORTAL 17: 11196.
14	Moses et al.	2022	Developing and validating an opioid overdose prevention and response curriculum for undergraduate medical education.	Substance Abuse 43 (1): 309–318.
15	Moses et al.	2022	Long-term effects of opioid overdose prevention and response training on medical student knowledge and attitudes toward opioid overdose: A pilot study.	Addict Behav 126: 107172.
16	Moses et al.	2021	Training medical students in opioid overdose prevention and response: Comparison of In-Person versus online formats.	Med Educ Online 26 (1): 1994906.
17	Muzyk et al.	2019	Substance Use Disorder Education in Medical Schools: A Scoping Review	Acad Med 94 (11): 1825–1834.
18	Muzyk et al.	2020	Interprofessional Substance Use Disorder Education in Health Professions Education Programs: A Scoping Review.	Acad Med 95 (3): 470–480.
19	Riser et al.	2021	Integrating DATA 2000 waiver training into undergraduate medical education: The time is now.	Substance Abuse 42 (2): 236–243.
20	Servis et al.	2021	Responding to the Opioid Epidemic: Educational Competencies for Pain and Substance Use Disorder from the Medical Schools of the University of California.	Pain Med 22 (1): 60–66.
21	Spangler et al.	2020	Opioid Use Disorder and Assessment of Patient Interactions Among Family Medicine Residents, Medical Students, and Physician Assistant Students.	MedEdPORTAL: the journal of teaching and learning resources 16: 11012.
22	Villarroel et al.	2020	Pain and Addiction: Creation of a Statewide Curriculum. Public health reports	Public health reports (Washington, DC: 1974). 135 (6):756–762.
23	Wallace et al.	2020	Developing an opioid curriculum for medical students: A consensus report from a national symposium.	Substance Abuse 41 (4): 425–431.
24	Welsh	2003	OD's and DT's: Using movies to teach intoxication and withdrawal syndromes to medical students.	Academic Psychiatry 27 (3): 182–186.
25	Zerbo et al.	2020	DATA 2000 waiver training for medical students: Lessons learned from a medical school experience.	Subst Abus 41(4): 463–467.

knowledge. Many also included additional items related to OUD, such as opioid epidemic, racial/ethnicity and disparity in opioid epidemic, social stigma towards OUD, social barriers in treatment of patients with pain and/or OUD, and relevant law and regulations. Four programs used Drug Addiction Treatment Act of 2000 (DATA 2000) waiver trainings developed either by professional organizations or in-house (29–32). However, despite the recognition of the contribution from comorbid psychiatric disorders and relevant social factors, none of these articles mentioned specifically the use of biopsychosocial approaches in their curricula. Further, only 3 out of the 17 studied curricula mentioned pain in their major topic areas and the pain topic had a limited focus on managing pain in patient with OUD (29, 30, 33). In addition, a small number of programs focused on students' clinical skills, such as team-based practice, motivational interview and application of SBIRT (Screening, Brief Intervention, and Referral to Treatment), patient screening and education (34–36).

All programs studied were standing-alone as an addition to the respective existing medical school curricula with the reported total length ranging from 0.5–2 h (8 studies) or 8–11 h (6 studies) (3 articles did not specify the length of their programs). One

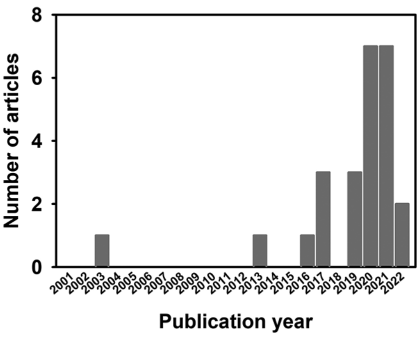

FIGURE 2
Numbers of selected articles by publication year. Numbers of articles that were selected for analysis were illustrated by their respective publication year. Majority of articles were published in 2020 and 2021 with 7 in each of these years.

article only assessed the effects of the "Patient panel", one component of a standing-alone interprofessional education workshop, on students' attitude toward patients with OUD and perceived value of an interprofessional team in managing patients with OUD (37). Most of the programs studied targeted to medical students except 3 articles (34, 37, 38) that described interprofessional education programs although some of the other programs also had non-medical students participated in the training in parallel (32, 35, 39).

OUD curricula were delivered to medical students at various training stages during the 4-year period: year 1 (5 studies), year 2 (3 studies), year 3 (5 studies), year 4 (1 study), and mixed years (years 1–4, years 1–3, or years 3 + 4) (3 studies). Although most curricula were delivered in a non-clinical setting, 2 were in the emergency department (36, 39) and 1 during internal medicine clerkship (30). Three studies compared the effectiveness of training using online vs. in-person programs (28, 40, 41).

In terms of curricular delivery, majority of the programs had didactic components with or without a combination of various other components, such as group discussion, case-based learning, simulations, patient panels. Most studies used pre- and short-term post-tests to evaluate the effectiveness of their programs, with two studies evaluated students' responses at 12 weeks (27) and 6 months (38) after training respectively. The respond rates were much lower when longer intervals were used in the post-test. Notably, one study used reflective writing as an assessment tool after students attended patient panels (37); two studies focused on assessing learners' hands-on clinical skills (one used a simulated scenario involving an OUD case at emergency department, and one used videos involving role-playing physician-patient interactions) (34, 35); and one study assessed patient outcomes (naloxone kit uptake) following students performing patient screening and education (36).

The common limitations identified by these studies were single institution setting with selected study cohorts, using self-reported measures, and that assessments were mostly limited to pre- and post- tests or post-test only without using randomized control study design. Some studies encountered lower than optimal responding rate and small sample size.

3.1.5. Additional information from other articles

The findings from the two scoping review articles on SUD education for health professional students (22, 23) emphasized the needs for increased OUD education, incorporation of first-person experience during training, and interprofessional learning. The one article that detailed the OUD curricular development within a single medical school described the curricular development and validation process in great detail and could be used as a model reference for future curricular development by others (25).

3.2. Evaluation of COPE 2021 winning student curricula on OUD

Table 4 lists all winning curricula including their titles and submitters' institutions/organizations. Out of the 12 winning curricula, 8 were from medical schools in the Northeast region, with 3 in New England; and 3 from NY, 1 from PA and 1 from NJ. The other 3 were from OR, FL and IL, and one submission was by the Student Osteopathic Medical Association (SOMA) Opioid Overdose Prevention Task Force. Nine winning curricula were from allopathic (MD) medical schools and two were from osteopathic (COM) medical schools.

Tables 5, 6 (Parts 1 and 2) summarize the content, curricular design, assessment and other features of all winning curricula. The ID numbers in Table 4 are used to identify each curriculum in Tables 5, 6. In contrast to the knowledge-based curricula that were in published studies (3.1), student-designed curricula appeared to be more practice-focused with special emphases on clinical knowledge and skills. Three of them (IDs 3, 4, and 10) did report a comprehensive curriculum (Table 5 Part 1). Similar to the published studies, the proposed curricula targeted learners at various levels and across all 4-years of undergraduate medical education. The time needed to complete each of the curriculum ranged from 1.25–15 h with one curriculum (ID 1) stated that the program could be flexible and did not provide estimated total time. Most of the curricula were stand-alone program, with 4 (IDs 3, 5, 7, and 9) had integration plan including 1 (ID 7) that aimed to be integrated into the entire 4-year medical school curriculum.

Compared to the published studies, winning curricula proposed notably diverse learning activities with the top five activities being: Asynchronous self-directed learning (11 out of 12) > Involvement of patient or community members (10 out of 12) > Small group session (9 out of 12) > Case-based learning (no standardized or real patient) (8 out of 12) = didactic session (8 out of 12). Additional activities included standardized patient (4 out of 12), role-play (3 out of 12), simulations (2 out of 12), and clinical shadowing (2 out of 12), plus 1 winning submission proposed journal club presentations and 1 proposed attending community member meetings respectively (Table 5 Part 1). However, none of the programs specifically involved inter-professional education activities, which may be due to that the curricular challenge asked to focus on medical student training.

TABLE 2 Summary of quality review of research studies using the MERSQI[a].

Domain	MERSQI item	Possible score	Mean (SD) domain score	Number (%) of 17 studies
Study design	***1. Study design***		*1.59 (0.51)*	
	Single-group cross-sectional or single-group posttest only	1		4 (23.53)
	Single-group pre- and posttest	1.5		8 (47.06)
	Nonrandomized, 2 groups	2		4 (23.53)
	Randomized controlled trial	3		1 (5.88)
Sampling	***2. Institutions***		*0.50 (0.00)*	
	Single institution	0.5		17 (100.00)
	Two institutions	1		0 (0.00)
	More than 2 institutions	1.5		0 (0.00)
	3. Response rate		*1.21 (0.36)*	
	Response rate < 50% or not reported	0.5		2 (11.76)
	Response rate 50%–74%	1		6 (35.29)
	Response rate ≥ 75%	1.5		9 (52.94)
Type of data	***4. Type of data***		*2.53 (0.87)*	
	Assessment by study subject	1		4 (23.53)
	Objective measurement	3		13 (76.47)
Validity of evaluation instruments' scores	***5. Content***		*1.00 (0.00)*	
	Not reported or not applicable	0		1 (5.88)
	Reported	1		16 (94.12)
	6. Internal structure		*0.63 (0.50)*	
	Not reported or not applicable	0		7 (41.18)
	Reported	1		10 (58.82)
	7. Relationships to other variables		*0.63 (0.50)*	
	Not reported or not applicable	0		7 (41.18)
	Reported	1		10 (58.82)
Data analysis	***8. Complexity of analysis***		*1.59 (0.51)*	
	Descriptive analysis only	1		7 (41.18)
	Beyond descriptive analysis	2		10 (58.82)
	9. Appropriateness of analysis		*0.94 (0.24)*	
	Data analysis inappropriate for study design or type of data	0		1 (5.88)
	Data analysis appropriate for study design or type of data	1		16 (94.12)
Outcomes	***10. Outcomes***		*1.47 (0.45)*	
	Satisfaction, attitudes, perceptions, opinions, general facts	1		4 (23.53)
	Knowledge, skills	1.5		12 (70.59)
	Behaviors	2		0 (0.00)
	Patient/health care outcome	3		1 (5.88)
Total MERSQI score		18	11.94 (2.23)	

[a] MERSQI scores for individual articles are available from the corresponding author upon request.

Regarding assessment, the top three methods were Pre- and post- surveys (10 out of 12) > Group discussion and debriefing (7 out of 12) > Formal recorded reflections (6 out of 12). Similar to the published studies reviewed, long-term evaluation is lacking. In addition, the detailed descriptions of proposed assessment plans were not presented in most of the curricula.

4. Discussion

This reported study was conducted during the time when there has been an increasing need of OUD training in undergraduate medical education and many medical schools have been actively developing and testing their OUD curricula. We first conducted a topic review on published studies regarding OUD curricula in US undergraduate medical education and then evaluated the winning curricula in response to the call for submission for Medical Students Curriculum Challenge in 2021 by COPE.

From the published studies regarding OUD curricula in undergraduate medical education, we realized that although some studies had a special focus in their training program, for majority of the studies, the general content of the respectively described OUD curriculum included the common core components: pharmacological knowledge of opioid and medications used to treat OUD, signs and symptoms of OUD, treatment of OUD (primarily medications used to treat OUD), and risk factors for OUD. Most of these were knowledge-based curricula. Particularly, review of the published state level OUD curricula

TABLE 3 Summary of opioid curricular development process at the state level.

State[a]	MA	PA	AZ	RI	CA
Initiator	State	State	State	The single RI medical school	The six UC medical schools
Working group composition	Medical education working group: Medical school Deans and faculty, Leaders from MA Department of Public Health and MA medical Society	Pennsylvania Physician General task force: Representatives from all PA allopathic and osteopathic medical schools and various state and federal governmental agencies	Voluntary working group: Deans and curricular representatives from all 18 AZ health programs co-chaired by one individual from Arizona Department of health and Services and one from Phoenix VA Health Care System	Symposium participants at the opioid curricular development breakout group: 33 educators representing 14 health professional institutions from 14 states	Opioid crisis workgroup: representatives from all UC medical schools
Working time period	2015 October-December	2015–2016	2018 January - July	2018 June 10–12	2018–2019
Sources of information	Literature review, current medical school practice and existing curricula (the 4 schools), and national and local standards for treating SUD	Literature review and survey of graduating medical students	Existing federal level guidelines/reports, other state-level curricula, licensing board requirements, and professional competencies	Input from symposium participants: 113 Professionals from 23 states and 30 institutions including individuals served at state and federal levels, as well as patients and students	Available resources including competencies from other states, institutions, and that in the publications, as well as existing online teaching resources
Product title	Core competencies for the prevention and management of prescription drug misuse	Core competencies on opioids and addiction	Arizona Pain and Addiction Curriculum	Opioid curriculum and core competencies	University of California pain and substance use disorder competencies
Structures	10 core competencies organized into three domains: Primary (3), Secondary (3), and Tertiary (4) prevention domains	9 core domains with specific competencies listed within each domain	10 core components organized into 3 curricular areas: Redefine pain and addiction (3), Whole-person approach (4), and Systems perspective (3); with detailed objectives listed for each component.	15 core competencies organized under 3 general categories: Pain management (4), OUD (5), and Other areas-flexible items (6)	9 domains organized under 3 sections: Pain (4), SOD (4), and Public health (1), with specific competencies listed within each domain
Pain coverage	3 out of 10 core competencies with 2 in primary and 1 in secondary prevention of prescription drug misuse	6 out of 9 domains: pain assessment (1), acute pain treatment (2), and chronic pain management (3)	Pain and SUD addressed together within each core component	1 major section on pain management: pain physiology, assessment, treatment, and biopsychosocial nature	1 section with 4 domains: Multidimensional nature of pain, pain assessment, pain treatment, context of pain

[a] States are listed in the order of the chronological time when each curriculum was developed.

indicated that the core OUD curriculum has been well defined and established, and became increasingly comprehensive involving growing numbers of public health-related issues, as the later ones (AZ, RI and CA) have been built upon the earlier ones (MA and PA). Therefore, during any future OUD curricular development, each institution could use a state-level, experts-developed core curriculum as a guideline/starting point, while pay special attention to the locally identified critical OUD-related issues. Therefore, based on the reported challenges encountered during curricular development, it is best to allocate limited resources to be utilized to improve curricular delivery strategies, faculty development, and creation and implementation of appropriate assessment methods rather than re-invent the content. In fact, we suggest the establishment of a national-wide, easily accessible “information-hub” that could provide up-to-date resources for curricular development including but not limited to expert content, teaching materials, assessment tools, and associated strengths and limitations, which could become a one-stop shop for anyone who is interested in developing their own OUD curriculum. This hub can be created by one professional organization or several organizations together. Potential organizations include but not limited to American Psychiatric Association (APA), American Medical Association (AMA), and American Osteopathic Association (AOA). Smaller organizations such as COPE could contribute to this endeavor as well. Besides relevant private foundations and medical education institutions, additional funding could come from federal agencies such as Substance Abuse and Mental Health Services Administration (SAMHSA), Health Resources and Services Administration (HRSA), and Department of Education (DOE), Department of Veterans Affairs (VA) through appropriate grant mechanisms. Besides hosting an OUD curricular library, the hub should also be active in organizing periodic information-exchange sessions, such as webinars, curricular demonstration, annual conferences to promote information flow and communications between medical schools, clinical training sites and medical students [our review of students-generated curricula highlighted the importance of including students in curricular development (see below)], as well as help address any curricular limitations [such as the ones identified in this curricular review (see below)]. Further, it should be noted that many reports recognized the needs of an evolving OUD curriculum that matches the current status of opioid epidemic, new knowledge regarding OUD, and emerging relevant laws and regulations. Through the proposed activities, a common

TABLE 4 List of winning curricula.

ID	Title	School
1[b]	Bias and stigma/preparing rising physicians for encounters in SUD care	University of New England College of Osteopathic Medicine
2[b]	Build structural competence and introduce harm reduction principles	Albert Einstein College of Medicine
3[a]	Comprehensive SUD curriculum for second year medical students	Frank H. Netter MD School of Medicine at Quinnipiac University
4[a]	Flipped classroom curriculum approach to learning about substance use disorders and their treatment	Philadelphia College of Osteopathic Medicine
5[b]	Humanizing substance use	Donald and Barbara Zucker School of Medicine at Hofstra/Northwell
6[a]	Introduction to addiction medicine	Oregon Health and Science University
7[a]	LICENSE (Language, impact, communication, engagement, non-stigmatizing, effectiveness)	Renaissance School of Medicine at Stony Brook University
8[b]	Opioid overdose identification and naloxone administration training	Florida International University Herbert Wertheim College of Medicine, FL
9[a]	Opioid use disorder: online workshop	Rutgers New Jersey Medical School
10[a]	Reduce overdose deaths	Student Osteopathic Medical Association Opioid Overdose Prevention Task Force
11[a]	Reducing stigma by unmasking unconscious bias	Rush Medical College
12[a]	Substance use disorder in pregnancy	Boston University School of Medicine

[a]Winners.
[b]Honorable Mention.

central "information-hub" could also help individual curricular development teams learn about necessary updates and modifications of existing OUD curricula therefore continue to improve their curricula and education. To our knowledge and based on the topic review we conducted, an "information-hub" as described is currently not available and one needs to explore extensive number of resources in order to develop an OUD curriculum.

One important distinction revealed from the curricular review is the differences between competencies vs. curricula. Particularly, most of the state-level reports (except AZ) provided core competencies. Most of the research articles and student-designed learning documents described the curricula for respective institutions. It is accepted that while curricula provides specific learning objectives, and methods for content delivery and assessment, competencies are generated based on the desired learner outcomes and serve as bases for developing curricula that suitable for individual education settings (42). Therefore, state-level competencies provide guidelines for curricular development within individual institutions. Individual institutions develop curricula to tailor their own needs and resources. It should be noted that although AZ developed OUD curricula, it provided core components and learning objectives while an optional toolbox for operationalization the curriculum, which ensure the flexibility of the curriculum to fit various health professions and individual institutions (20).

Our review showed that various methods were used to deliver OUD curriculum, while student-designed curricula proposed notably more diverse methods than what was described in the published studies. Regardless, all reviewed research studies (17 articles) reported the success of their respective curricula to some extent, particularly, in short-term knowledge gain and attitude improvement. This suggests that methods of OUD curricular delivery can be flexible and designed based on institutional resources. However, furfure studies need to be conducted to make comprehensive comparisons (ideally using randomized control study designs) of the long-term efficacy and patient outcomes between various curricular delivery strategies. In fact, many authors did identify that the lack of long-term assessment of curricular effectiveness (such as students' practice behaviors and downstream patient outcomes) was one of the limitations of their respective studies. Therefore, it is critical that resources are allocated to assist with the development, validation, and sharing of long-term assessment tools. We are happy to see that two of the articles reported outcome measures beyond immediately after the completion of their curricula (27, 38). In addition, hands-on clinical skill training and assessment were emphasized by students-designed curricula and a few studies reported their effort in this area (34–36). This is another area many of the reviewed studies identified as areas needing assessment tool development.

Our review also identified some curricular content areas that indeed need further development. One of these areas is incorporating chronic pain and its management into OUD curricula, particularly the individual institutional OUD curricula, as state-level curricula did include pain topics, particularly, AZ and CA curricula addressed pain and OUD/SUD in parallel. Although most curricula in the published studies discussed opioid use for treating chronic pain could be a risk factor of OUD, very few curricula specifically described chronic pain management related topics as part of the OUD curriculum [except three studies (29, 30, 33)]. We realize that it is possible that the majority of pain-related content may be taught elsewhere in respective medical curriculum. However, the inter-woven relationship between OUD and pain management necessitates the integration between OUD and pain curricular components when training medical students. The curricula developed in AZ and CA set up great examples in this area (19, 20). It should be noted that although MA was the first state publishing the OUD competencies for medical education, three years prior to this, teams of interprofessional experts developed a comprehensive set of pain management domains and core competencies for health profession students, which included a sub-competencies on dependence, substance use disorder, misuse, tolerance, and addiction (43). This further highlights the importance of joint effort of addressing pain and OUD in medical curricula. Further, another significant related gap was the emphasis on the biopsychosocial approach in OUD (as well as in pain). This approach was identified as focus areas in the three newer state-level curricula (RI, CA and AZ), and was not specifically mentioned in the 17 research articles. Given the complex nature of both pain and OUD, the existence of various psychiatric comorbidities and social factors associated with both pain and OUD, biopsychosocial approach offers the most comprehensive, interdisciplinary assessment and intervention for patients (44–46).

TABLE 5 Content, and design, and assessment of the winning curricula—part 1.

ID	Topic focused on	Learner level (year in school)	Length (h)[a]	Learning activities					
				Asynchronous self-directed	Didactic session	Small group	Case-based learning (no "patient"[b])	Patient/ community member involved session	Other(s)
1	Attitude/stigma; Patient interactions	Not specified	Flexible	Yes	No	Yes	No	Yes	Standardized patient; Simulation; Patient partner
2	Harm reduction; Patient-centered interview	Not specified	3	Yes	Yes	Yes	Yes	Yes	
3	Comprehensive in SUD + Pain and Current research	2nd	12	Yes	No	Yes	Yes	Yes	Journal club presentation
4	Comprehensive in SUD	Not specified	8	Yes	No	Yes	Yes	Yes	Role-play; Interactive game; SMART or AA meeting
5	Humanistic approach in medicine	Incoming 1st	1.25	Yes	No	No	Yes	Yes	
6	Comprehensive in SUD + Public health component	Pre-clinical	10–15	Yes	Yes	Yes	Yes	Yes	Standardized patient; Clinal shadowing
7	Social determinants of health	All levels	10	Yes	Yes (peer-teaching)	Yes	Yes	Yes	Role-play; Standardized patient; Clinical shadowing
8	Naloxone usage (in harm reduction)	Graduating 4th	8	Yes	Yes	Yes (≤ 25)	Yes	No	Role-play; Standardized patient; Simulation
9	Patient experiences and barriers to care	2nd and 3rd	2	Yes	Yes	No	No	Yes	
10	Student educator	Not specified	6–8	Yes	Yes	No	No	No	Students present their educational sessions
11	Stigma	4th	2	No	Yes	Yes	No	Yes	
12	SUD in pregnancy	All levels	2	Yes	Yes	Yes	Yes	Yes	

[a] Not all curricula included pre-program student prep time.

[b] Standardized or real patients.

The aforementioned three state-level curricula could serve as the starting point for one to further develop an OUD curriculum with an emphasis on the biopsychosocial approach (19–21).

Another area that requires further improvement is incorporating interprofessional education/practice when addressing OUD and pain in curriculum. This was found lacking in both published studies reporting institutional OUD curricula and students-designed OUD curricula, but specifically emphasized in several state-level curricula, such as RI, AZ, and CA curricula (19–21). Particularly, we applaud that AZ curriculum was designed for all health professions to use, which would provide common language in OUD and pain management for all professions, thus greatly improve the communications and collaborations between professions (20). According to the World Health Organization, "inter-professional education occurs when two or more professions (students, residents and health workers) learn with, about, and from each other to enable effective collaboration and improve health outcomes" (47). Despite that the benefits of interprofessional education are recognized by health care professionals and students, its implementation remains challenging, in terms of institutional support, organizational barriers, and faculty development (48, 49). Additional resources and administrative support, as well as creative integration strategies are critical in improving interprofessional training for better caring for patients with OUD and/or pain.

We recognized several limitations of our study. Broader and less restrictive key words and more databases could be used in literature search, which may result in more articles included in our evaluation. Medical schools outside of US could be included that may provide additional knowledge regarding OUD curricular development internationally as OUD is a global health concern (50, 51). Student-winning curricula from COPE curricular challenge do not represent all medical students regarding their preference towards OUD curricula, yet evaluation

TABLE 6 Content, and design, and assessment of the curricula—part 2.

ID	Assessment				Will it be integrated to existing curriculum	How to integrate?	Can it be virtual?
	Pre- and post-surveys[a]	Group debriefing	Recorded formal reflections	Other(s)			
1	Yes	Yes	Yes		No		Not specified
2	Yes	Yes	No		No		Not specified
3	Yes	Yes	No		Yes	During the 2nd year 2-week addiction medicine module	Not specified
4	Yes	No	Yes	Additional post-survey at the end of rotations; Write a plan to guide future clinical practice	No		Not specified
5	Yes	No	Yes		Yes	During 1st year orientation, right after EMT-B training	Yes
6	No	Yes	Yes	Post-program survey only; Share a resource to peers to encourage further reading and learning	No	(But completed over several weeks)	Yes
7	Yes	Yes	Yes		Yes	Entire 4-year medical curriculum	Yes
8	Yes	No	No		No		Yes
9	Yes	No	No		Yes	During 2nd year psychiatry pre-clinical block or during 3rd year psychiatric rotation	Yes
10	Not specified[b]	No	No	Generate an educational presentation	No		Yes
11	Yes	Yes	No		No		Yes
12	Yes	Yes	Yes		No	(but best to be used during clinical years when rotating in obstetrics, emergency medicine or family medicine)	Not specified

[a] Not all pre- vs. post-survey have the same content; some components may only be in either the pre- or the post-survey.

[b] Using existing online training modules.

of students-designed curricula suggested students' preference of hands-on skill training. This emphasizes the advantages of involving students in curricular development, which has been reported previously from students ranging from elementary education to professional post-graduate education (52–54). Further, although influences of patients' cultural background on patient care has been mentioned in many reviewed curricula, none of the them discussed how students' cultural background could potentially affect the delivery and efficacy of a specific curriculum. Involving students' voices in curricular design may help address this issue.

In summary, our report revealed that although incorporation of pain curriculum and interprofessional education is critical, comprehensive OUD core curricula have been well-established and can be used as guidance for future development. More resources should be devoted to curricular delivery including faculty and training resource development, and long-term assessments of student and patient care outcomes and curricular efficacy (55).

Data availability statement

The original contributions presented in the study are included in the article/Supplementary Material, further inquiries can be directed to the corresponding author.

Author contributions

LC: Conceptualization, Data curation, Formal Analysis, Methodology, Project administration, Visualization, Writing – original draft, Writing – review & editing. JV: Conceptualization, Methodology, Resources, Supervision, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

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Pain, comorbidities, and clinical decision-making: conceptualization, development, and pilot testing of the Pain in Aging, Educational Assessment of Need instrument

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Introduction: Pain is highly prevalent in older adults and often contextualized by multiple clinical conditions (pain comorbidities). Pain comorbidities increase with age and this makes clinical decisions more complex. To address gaps in clinical training and geriatric pain management, we established the Pain in Aging—Educational Assessment of Need (PAEAN) project to appraise the impacts of medical and mental health conditions on clinical decision-making regarding older adults with pain. We here report development and pilot testing of the PAEAN survey instrument to assess clinician perspectives.

Methods: Mixed-methods approaches were used. Scoping review methodology was applied to appraise both research literature and selected Medicare-based data. A geographically and professionally diverse interprofessional advisory panel of experts in pain research, medical education, and geriatrics was formed to advise development of the list of pain comorbidities potentially impacting healthcare professional clinical decision-making. A survey instrument was developed, and pilot tested by diverse licensed healthcare practitioners from 2 institutions. Respondents were asked to rate agreement regarding clinical decision-making impact using a 5-point Likert scale. Items were scored for percent agreement.

Results: Scoping reviews indicated that pain conditions and comorbidities are prevalent in older adults but not universally recognized. We found no research literature directly guiding pain educators in designing pain education modules that mirror older adult clinical complexity. The interprofessional advisory panel identified 26 common clinical conditions for inclusion in the pilot PAEAN instrument. Conditions fell into three main categories: "major medical", i.e., cardio-vascular-pulmonary; metabolic; and neuropsychiatric/age-related. The instrument was pilot tested by surveying clinically active healthcare providers, e.g., physicians, nurse practitioners, who all responded completely. Median survey completion time was less than 3 min.

Conclusion: This study, developing and pilot testing our "Pain in Aging—Educational Assessment of Need" (PAEAN) instrument, suggests that 1) many clinical conditions impact pain clinical decision-making, and 2) surveying healthcare practitioners about the impact of pain comorbidities on clinical decision-making for older adults is highly feasible. Given the challenges intrinsic to safe and effective clinical care of older adults with pain, and attendant risks, together with the paucity of existing relevant work, much more education and research are needed.

KEYWORDS

interprofessional, interdisciplinary, pain education, clinical decision-making, geriatric, multimorbidity, survey instrument, chronic pain

Introduction

Pain-associated conditions are prevalent in older adults who often experience high rates of medical and mental health conditions, i.e., pain comorbidities (1, 2). A range of professionals provide healthcare services to older adults; current models conceptualize this care in terms of interprofessional collaboration and view this care through the lens of interacting health conditions, i.e., multimorbidity, and systems of care, which taken together comprise multicomplexity (3–9). The multicomplexity intrinsic to healthcare for older adults increases the cognitive challenges which professional practitioners face in clinical decision-making (10–12). This is especially relevant with regards to pain management where failure to acknowledge and address the impacts of comorbidities and multicomplexity in the care of older adults may potentially diminish the effectiveness of educational efforts (13–18). At present, there is no evidence-based framework representing the real-world complexity of older adults living with pain and sufficient to support the construction of pain education modules for healthcare professionals (19).

Pain is so common in older adults that some have proposed that pain is a part of aging (20, 21). Others have argued that pain declines with age; however, the Global Burden of Disease studies indicate that pain rates rise steadily with age to decline only very late in life (2, 22, 23). The most prevalent pain-associated conditions affecting older adults relate to osteoarthritis, but other mechanisms, such as poor sleep quality, comorbid depression, and decreased recruitment of endogenous analgesia may contribute (8, 20, 24–26). Pain in older adults, separate from interactions with other conditions has intrinsic complexity (20, 27). This is compounded by the presence of comorbidities and the extent to which comorbidities increase the challenge of clinical decision-making in managing the pain of older adults is not well understood; the importance of understanding the context of pain has been highlighted by the IASP curricula (28–30). At the level of a single comorbid diagnosis, some diagnoses are known to be both highly prevalent and impactful in choosing therapies for older adults with pain (31, 32). Depression, for example, has a complex relation to pain, potentially increasing risks for and being increased by pain, as well as impacting compliance with pain therapies (25, 33–35). Heart disease, cerebrovascular disease, dementia, renal failure, and hepatic failure can all impact medication safety (36).

We and others have noted the need for intentionally designed educational curricula to address pain in older adults to prepare current and future healthcare practitioners (14, 37, 38). In order to create relevant and effective curricula, it is important to consider the real-world context in which practitioners treat chronic pain, i.e., a patient's medical and/or mental health comorbidities and the pharmacologic therapies used to treat them; in a formal curriculum development framework, this is a foundational preparation step termed "task assessment" (39). Needs assessment of the clinical contexts of pain management in older adults still requires additional refinement (40). Nonetheless, it is likely that comorbidities directly affect clinical decision-making in the treatment of chronic pain (1). In this study, we sought to formulate, and pilot test an instrument designed to assess the extent to which healthcare practitioners perceive common pain comorbidities as impacting decision-making pertaining to the treatment of pain in older adults.

Methods

This study followed an intentional mixed-methods process incorporating and integrating evidence from (1) an informationist-supported multi-step literature search, (2) review of Medicare-based population-level data about pain and comorbidities in older adults, and (3) advice from an interprofessional, subject matter expert panel (41–43).

Pain comorbidities literature search

A multi-stage approach was required for the literature search of pain conditions and comorbidities. An initial literature search, directed by a health science librarian, sought to examine the prevalence of chronic pain comorbidities in older adults and used the search terms, "prevalence AND chronic pain AND comorbid or comorbidities." Our target was to identify relevant literature encompassing pain-associated conditions with high prevalence in older adults, i.e., conditions for which prevalence was estimated to exceed 100 per 100,000. This search yielded 118 results, which were individual reviewed by BH and BS for relevance. A preliminary list of comorbidities was created after review of the articles with highest relevance, Table 1. Reference

TABLE 1 Scoping literature review—identification of potential key elements.

Preliminary literature review		Secondary literature review	
"Medical" conditions	"Neuropsyciatric conditions"	"Medical" conditions	"Neuropsychiatric conditions"
Obesity (44–46)	Anxiety (46, 47)	CHF (8, 24, 48–50)	Dizziness
Substance use (51)	Depression (44–46)	Stroke (8, 24, 26, 49)	Falls (24)
HTN (51)	Dementia (52)	HTN (8, 24, 26, 32, 48, 50, 53, 54)	Dementia (8, 24, 26)
HLD (51)	Pain conditions	CAD/IHD (8, 24, 26, 32, 48, 49, 54)	Delirium
Lung disease (51)	Headache (55)	Atrial Fibrillation (8, 24, 32)	Depression (8, 24, 49, 50, 54)
Diabetes (51)	Osteoarthritis (55)	HLD (8, 24, 32, 54)	Anxiety (24, 49, 54)
Heart disease (13)	Neck pain (55)	Anemia (24, 50)	OUD (24, 50)
Stomach disease (44)	Low back pain (55)	Asthma (8, 24, 32, 49, 54)	Pain conditions
	Polyneuropathy (55)	COPD (8, 24, 26, 49, 50, 54)	Headache (24)
	Fibromyalgia (51)	OSA (24)	Cervical spine pain (24)
	Chronic pain (44–47, 52, 55)	DM (8, 24, 32, 48–50, 54)	Thoracic spine pain
	Widespread pain (46)	Obesity (32)	Low Back pain (24, 32, 48–50, 54)
	TMD (8)	GERD (24, 32, 54)	Fibromyalgia (53)
		Hypothyroidism (24, 54)	Myalgias
		Renal Impairment (8, 24, 50)	DMPN (26)
		Hepatic Impairment (24)	Shoulder pain
		Osteoporosis (8, 32)	Hip pain (48)
		Vit. B12 Deficiency (24)	Knee pain (48)
		Vit. D Deficiency (24)	

HTN, Hypertension; *HLD*, Hyperlipidemia; *TMD*, temporomandibular joint disorder; *CHF*, Congestive Heart Failure; *CAD/IHD*, Coronary Artery Disease/Ischemic Heart Disease; *COPD*, Chronic Obstructive Pulmonary Disease; *OSA*, Obstructive Sleep Apnea; *DM*, Diabetes Mellitus; *GERD*, Gastro-Esophageal Reflux Disease; *Vit.*, Vitamin; *OUD*, Opioid Use Disorder; *DMPN*, Diabetic Peripheral Neuropathy.

lists from these articles were reviewed to identify additional articles of interest. The references from these additional articles were reviewed to find further additional relevant articles. Comorbidities from the articles selected in this manner were evaluated. Another literature search sought to examine the prevalence of chronic pain and medical comorbidities in older adults. A health science librarian used the following pain terms (in alphabetical order), "Chronic pain, Chronic widespread pain, Diabetic peripheral neuropathy, Diabetic neuropathies, Fibromyalgia, Headache, headache disorders, Hip pain, Knee pain, Low back pain, Lower back pain, Neck pain, Patellofemoral pain syndrome, Shoulder pain" along with the following comorbidity terms: "Comorbidity terms: Comorbid, Co-morbid, Complexity, Co-diagnosis, Multimorbid, Multi-morbid." A search utilizing pairs of chronic pain conditions and medical comorbidity terms yielded 104 unique literature results. Two study team members (BH and BS) reviewed results for relevance, and additional comorbidities were added to the preliminary list.

Population-level pain comorbidities data

The 2017 Center for Medicare and Medicaid Services 5% standard analytical sample of carrier claims data were queried, as previously described, for the 20 most prevalent medical conditions in elderly adults (56). Our previously described data extraction approach was modified as follows, in brief, the extraction followed the sequence illustrated in the population flow chart, Figure 1. The total 2017 CMS beneficiaries numbered approximately 3 million, these were initially limited to those aged 65–100 who numbered approximately 2.5 million. The beneficiaries with claims present in either the Carrier or the Outpatient files were included for a total of approximately 1.5 million. This was further limited to the population of those 75–80 years old, participating in Medicare Part B but not in Part C, and alive for all 12 months of 2017, and the population of those with claims near the median, i.e., 40th–60th percentile for claims (56–60). Age was limited as we observe marked increases in variation in Medicare program usage and mortality at the younger and older extremes of old age respectively (57). The age cohort selected for study does span the median age for U.S. older adults (over 65 years old). Claims were limited as we have observed that beneficiaries with lower claims per year have lower diagnostic rates for common conditions, and those with many claims per year may have higher rates. The claims cohort spanning the median was selected as we seek here to define the properties of a "median" older adult population (57). The final study population for this unadjusted appraisal of rates of common pain conditions and common pain comorbidities was just under 50,000.

Interprofessional advisory panel

Through directed invitation, we assembled a geographically and professionally diverse subject matter expert interprofessional advisory panel (IAP) consisting of eight nationally recognized experts in pain care, health professions education, and gerontology. Criteria for invitation included: established expertise in a relevant area: academic appointment, presentation at national meetings, and peer-reviewed publications; interest in interprofessional collaboration, and responsiveness. Eight professionals were invited initially; all except one accepted the invitation who provided a reference to another, like professional who accepted our invitation. All professionals remained

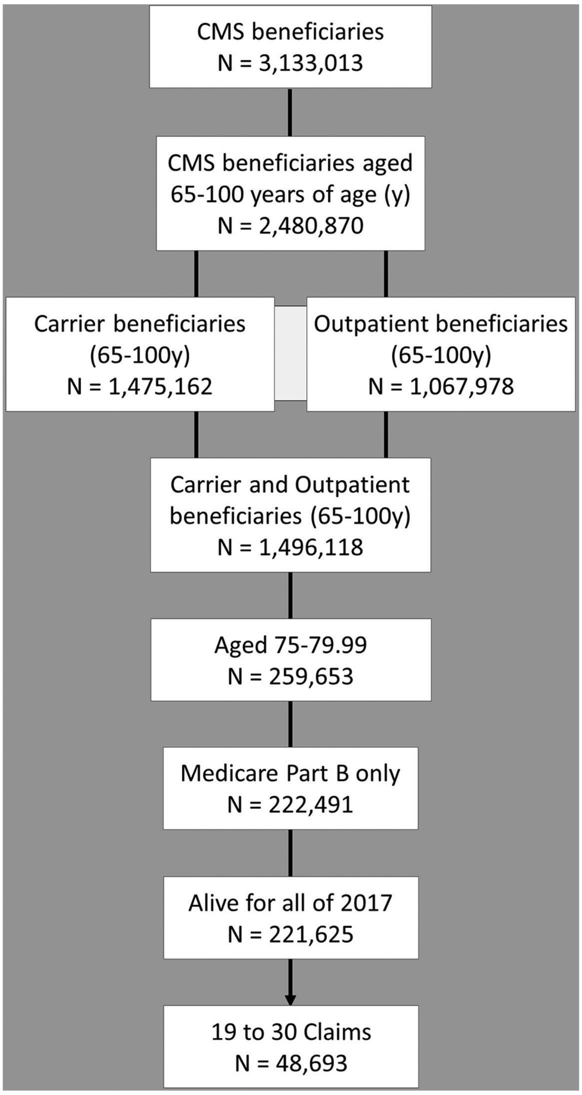

FIGURE 1
Population flow diagram for scoping data review. Medicare beneficiaries meeting study criteria were selected as illustrated.

in contact throughout the study development period except for one physician who stepped back midway in the context of a job change. The IAP included 4 physicians (internist, neurologist, psychiatrist, and rheumatologist), one registered nurse, one pharmacist, one clinical psychologist, and one physical therapist, Table 2. The group met virtually to discuss the potential questions of interest, evaluate and comment on extracts of clinical data and review results of the literature search. The goals of the IAP were to develop a list of "high value" pain comorbidities based on prevalence and potential impact on care, and to advise on survey instrument construction.

Integration of literature review and data extracts with input from advisory panel

These results were combined with a list of common medical conditions found through literature searches above. Using an iterative review process, a final list of 26 medical conditions and 13 chronic pain conditions were included in the final survey. The instrument prompt was presented to the interprofessional advisory panel and revised for clarity and concision.

Survey instrument pilot testing

An interprofessional and multi-disciplinary group of 8 board-certified healthcare practitioners, including clinically active physicians and nurse practitioners providing general medical or geriatrics care, from 2 affiliated institutions (University of Maryland Medical Center and the VA Maryland Health Care System) were invited to pilot the survey. No members of the IAP were included in this group. Respondents were asked to rate their agreement with: "This is a common condition in older adults and potentially impacts my decision-making regarding treatment of pain" using a 5-point Likert scale. Individual conditions were scored in terms of the percentage of respondents who agreed or strongly agreed with the prompt statement. Respondents were asked to provide demographic information on their specialty, practice setting, professional title, institution, and number of years in practice.

We scored the survey results as the percent of respondents selecting "agree" or "strongly" agree. Data were processed using Excel (Microsoft) and SAS (Cary, NC). Results are reported as average percent agreement. This pilot study was not powered to detect differences between conditions but was intended to test the instrument for feasibility of use.

This study was approved by the University of Maryland Medical Center IRB and the VA Maryland Health Care System Research and Development Committee.

Results

Literature review

Extensive literature review did not identify articles directly addressing the impact of common comorbidities on pain treatment decision-making in older adults. A small number of articles addressed the occurrence of medical and mental health comorbidities in those with pain-associated diagnoses or pain states (reporting chronic or acute pain), Table 3. Study methodologies were largely cross sectional, with information gathering through population-based survey or health system database analysis or both.

Population-based survey studies

Ohayon and colleagues, using population-based phone survey methods, evaluated comorbidities in relation to acute vs. chronic and neuropathic vs. non-neuropathic pain (61). Survey respondents reporting obesity, diabetes, hypertension, and diseases of the cerebrovascular system, nervous system or blood had increased risk for neuropathic pain (61). Those who reported depression were 3-fold more likely to have non-neuropathic pain

TABLE 2 PAEAN interprofessional advisory panel (IAP).

Clinical and research training	Current role	Region	Expertise
Internal medicine, Rheumatology, Medical education	Associate Professor, Clinician educator, Fellowship director[a]	Mid-Atlantic	Rheumatology, medical education, program building, clinical decision-making
Neurology, Clinical neurophysiology, pain, physiology, biomathematics	Associate Director for Education (Geriatrics), Associate Professor, Principal investigator[b]	Mid-Atlantic	Neuropathy, low back pain, pain education, geriatric data science, interprofessionalism
Internal medicine, Medical education	Dean, Professor[c]	Midwest	Medical education
Pharmacy, Education, Research	Professor, Principal investigator[d]	Midwest	Pain education, pharmacology
Physical therapy, Research	Professor, Principal investigator[e]	Midwest	Pain and physical activity, rehabilitation science, aging
Psychiatry, Geriatric psychiatry, Research	Professor, Geriatric psychiatrist, Principal Investigator[f]	Pacific Northwest	Geriatric psychiatry, mental health
Clinical psychiatry, Sleep medicine, Clinical research	Associate professor, Principal investigator[g]	Mid-Atlantic	Clinical psychology, sleep, pain
Nursing and Geriatrics, Behavior change research	Associate Director for Education and Evaluation (Geriatrics)[h]	South Central	Substance use and behavior change

Details of current roles:

[a] Attending physician and clinical preceptor, VAMHCS and University of Maryland Medical System; Program Director, Rheumatology Fellowship; Associate Program Director, Internal Medicine Residency; project co-PI.

[b] Associate Professor, Neurology, Johns Hopkins School of Medicine; Associate Director, Geriatric Research, Education, and Clinical Center, VA Maryland; Lead Site Investigator, SCEPTER study; Program director, Office of Research and Development Program Summer Research Program, VAMHCS; Attending clinician and clinical preceptor, VA Neurology inpatient consultation and outpatient clinic; project co-PI.

[c] Professor, Department of Medicine, Professor of Geriatrics, Department of Family Medicine and Community Health, Vice Dean of Medical Education, Case Western Reserve University School of Medicine.

[d] Professor, School of Pharmacy at Southern Illinois University Edwardsville, Associate Professor, Department of Family and Community Medicine, St. Louis University School of Medicine.

[e] Professor, Department of Physical Therapy and Rehabilitative Science, Physical Therapist, University of Iowa Carver College of Medicine.

[f] Professor, Department of Psychiatry and Behavioral Sciences, University of Washington.

[g] Associate Professor, clinical psychologist, Director, Behavioral Sleep Medicine Program, Department of Psychiatry and Behavioral Sciences, Johns Hopkins School of Medicine.

[h] Associate Director/Education and Evaluation, Geriatric Research, Education, and Clinical Center, Central Arkansas Veterans Healthcare System.

and 6-fold more likely to have neuropathic pain compared to those without depression. Häuser and colleagues, using population-based home visit methods, evaluated comorbidities in relation to cancer-related vs. non-cancer chronic pain and chronic disabling vs. chronic non-disabling pain (44). The investigators reported that depression was highly associated with chronic pain, as were stomach disease, rheumatic disease, obesity, and heart disease. Ramanathan and colleagues conducted a population-based ascertainment of participants consenting to survey and medical record review of persons reporting low back pain (32). The investigators observed that persons with low back pain had more medical comorbidities and those with more comorbidities described poorer health status. The presence of pain comorbidities increased the risk for provider non-compliance with 9 out of 10 quality indicators, including documentation of a medical history, performance of a physical or neurological examination, and assessment for infection or cancer (32).

Health records-based data analytics studies

Lamerato and colleagues extracted records for patients of a U.S.-based healthcare delivery system based on diagnosis with at least one of 24 chronic pain-associated conditions (45). Diabetes, chronic pulmonary disease, malignancy, and renal disease were the most prevalent comorbidities in those with chronic pain-associated diagnoses. In a companion paper, the authors present an unadjusted analysis suggesting that those with the highest healthcare costs have higher rates of comorbidities (65). Price-Haywood and colleagues extracted records for patients receiving primary care from a U.S.-based healthcare delivery system based on receipt of opioid prescriptions (66). A high Charlson comorbidity index was associated with a small decrease in the likelihood of providers prescribing opioids while substance use disorder diagnosis was associated with markedly increased likelihood of providers prescribing opioids (66). Higgins and colleagues extracted records for patients in a federal (nation-wide) U.S.-based healthcare delivery system based on participation in a national survey of U.S. veterans undergoing activity modification for weight management (46). The presence of multiple comorbid conditions increased the risks of low back pain and/or arthritis/joint pain with the likelihood of pain diagnoses increasing as the number of comorbid conditions increased, e.g., those veterans with 5 or more comorbid conditions had 7-fold likelihood of having both low back pain and arthritis/joint pain vs. having “no pain” when compared to those in the study with no comorbid conditions. The authors noted that pain comorbidities are likely to increase treatment complexity (46).

Clinical claims data scoping review

The data extraction for the purposes of this study included 48,693 Medicare beneficiaries 75–80 years old during 2017 meeting criteria for inclusion, 27,893 (57.3%) were recorded as female gender and 20,798 (42.7%) as male, Figure 1. The average age was 77.38 for females and 77.34 for males. The race and ethnicity distribution, utilizing the Research Triangle Index (%) was Undefined 0.18 and 0.12; White 83.46 and 85.83; Black 7.01

TABLE 3 Literature results summary.

Authors and year of publication	Methodology and ascertainment	Population	Pain conditions or states of interest	Comorbidities included	Number of study subjects	Study sponsorship
Ohayon MM, Stingl JC (61)	Prospective phone survey of a random, representative sample of the German national population.	National population, ≥15 years old	Prevalence of acute or chronic pain; neuropathic and non-neuropathic features	Psychiatric and medical comorbidities	3,011 (701 ≥ 65 years old (older adult data not reported separately)	Pfizer
Häuser W, et al. (44)	Prospective home visit survey of a randomly selected sample, designed to represent the German population in terms of age, sex, and education	National population including those willing to respond completely, ≥15 years old	Chronic Pain and Persistent Bodily Pain	"generic self-administered comorbidity questionnaire (SCQ)… to assess common diseases that might impact functioning (62). The SCQ asks about the presence, treatment, and functional limitations of 12 common diseases and 3 additional nonspecified medical problems."	2,850 [of 4,508 attempted (Mean age 49.7 years, older adult data not reported separately)]	Multiple sources including federal, academic and NGO sources. Two authors with multiple pharmaceutical funding disclosures
Ramanathan S, et al. (32)	Prospective study of a randomly selected sample, designed to represent the Australian population. Phone recruitment followed by phone surveys and consent to medical records review	National population including those willing to consent to phone surveys and medical records review, ≥15 years old.	Low back pain	22 "CareTrack" study comorbidities, through medical records review (primary outcome) and patient phone survey (secondary outcome) (63). Reported rates of 10 most common of these.	164 (medical records review) and 799 (phone survey) (of 15,292 initially contacted) [107 ≥ 55 years old (older adult data not reported separately)]	Federal sources
Lamerato LE, et al. (45)	Retrospective, observational study of electronic health records (EHR) records and claims in a large healthcare system in Detroit	Patients of a regional health care system "…identified based on the presence of ≥2 ICD-9-CM codes at least 30 days apart for the conditions of interest…."	"…derived from a [prior] study… supplemented by conditions addi-tionally identified… for a total of 24 chronic pain conditions."	Charlson comorbidity conditions (64). A companion paper examined healthcare utilization (costs) and number of Charlson comorbidities using unadjusted quartile analysis (65).	127,317 [4,950 ≥ 65 years old (older adult data not reported separately)]	Pfizer
Price-Haywood EG, et al. (66)	Prospective observation of convenience sample: patients of "…primary care providers (internal medicine or family medicine) practicing in 36 clinic locations across southeast Louisiana in an integrated delivery system" prescribed opioids for chronic noncancer pain during ascertainment period.	Patients of a regional health care system "…age 18 years and older… received opioid prescriptions for 3 of the previous 4 months (chronic opioid therapy), and no active diagnosis of cancer …"	Chronic noncancer pain: "…most common pain syndromes included neck/ back/knee pain, arthritis, and fibromyalgia…"	Charlson comorbidity index and comorbid mental health conditions, e.g., depression, anxiety, substance use disorder	14,221	Federal sources
Higgins DM, et al. (46)	Secondary analysis of a prospective convenience sample derived from a U.S. federal health system: "…national sample consisted of 45,477 overweight/ obese Veterans who received healthcare in VHA facilities and expressed interest in weight management."	Patients of a federal health system for military Veterans with "self-reported weight and height consistent with a BMI ≥25 and completed the MOVE! 23 survey in 2006."	Obesity/overweight was the exposure, rate of pain-associated conditions and rates of multimorbidity were the outcomes	"…20 possible responses for medical comorbidities … and 13 possible responses for mental health comorbidities…." (67).	32,743 reporting ≥1 pain-associated condition of 45,477 ascertained through the Move! 23 survey	None listed, likely received salary support from the Veterans Health Administration

NGO, Non-Governmental Organization; *ICD-9-CM*, International Classification of Diseases, 9th revision, clinical modification; *U.S.*, United States; *VHA*, (U.S.) Veterans Health Administration; *BMI*, body mass index; MOVE!23, a survey specific to a VHA health program.

Disclosures:

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and 5.45; Other 0.81 and 1.15; Hispanic 3.05 and 2.87; Asian American/Pacific Islander 5.05 and 4.18; Native American 0.45 and 0.40 for females and males respectively (68). The rates of common pain diagnoses are shown in Figure 2A. Elbow, wrist, hand, and ankle/foot pain are included to illustrate the relative rates of pain at anatomical sites but these were not included in the group of common conditions which comprised headache, neck pain, thoracic spine pain, low back pain, shoulder, hip, and knee pain; type 2 diabetic polyneuropathy, and fibromyalgia and myalgias (muscle pains). The most common pain code used was M54.5, indicating low back pain. The rates of common medical and mental health diagnoses (comorbidities) selected for study are shown in Figure 2B for females and males. The rates represent the rates of diagnosis based the most common code utilized for each specified condition and are not expected to equate to more systematic appraisals of prevalence, but rather represent a scoping appraisal of ICD-10 code utilization to represent common conditions associated with aging, in the population studied. The most common cardio-vascular-pulmonary condition code used was I10, for Hypertension, which was utilized for over 75% of the studied beneficiaries; the most common metabolic condition code use was E11.9, Type 2 diabetes mellitus, unspecified in males, and E03.9, hypothyroidism, unspecified in females, although hyperlipidemia, unspecified (grouped with cardio-vascular-pulmonary conditions) exceeded both E11.9 and E03.9; and the most commonly used neuropsychiatric/aging-related code was R42, indicating dizziness. The least commonly noted condition incorporated here was hepatic impairment, included due to having a major impact on pain treatment choices, i.e., strict avoidance of acetaminophen and other selected analgesic agents. The extracted data showed some conditions having indications of increased rates in the older adults diagnosed with one or more common pain conditions, e.g., depression, however this was not the focus of this study and further analysis was not pursued.

Interprofessional advisory panel

The interprofessional advisory panel met 6 times over two years to review and discuss the data obtained and to strategize for and advise the construction of the Pain in Aging, Educational Assessment of Need (PAEAN) survey instrument, Table 2. The inclusion of diverse professional and geographic perspectives increased the number of conditions viewed as comorbid with and potentially significant for pain clinical decision-making in older adults.

Survey instrument construction

The interprofessional advisory panel (IAP) reviewed and revised the list of conditions integrating literature review and clinical claims data scoping analysis, Table 3. Using a focus group process, respondents iteratively responded with potential comorbidity additions, omissions, and nomenclature until the list finalized. The final decision was to include 26 common clinical [19 medical and 7 neuropsychiatric (mental health)] conditions and 13 common pain-associated conditions in the pilot instrument, Tables 4, 5.

The draft survey instrument was presented to the IAP for final input and advice. The final version of the instrument consisted of a section for rating pain comorbidities, a section for rating prevalence of common pain conditions, and a section on respondent demographics, Figure 3. Questions about respondent demographics (not reported here) were placed at the end of the instrument in order to improve responder engagement. Respondents reported professional title, institution, years in practice, and primary specialty to validate inclusion.

Pilot testing

Eight clinically active healthcare practitioners were invited to participate in the pilot survey, all responded to the survey (100% response rate). The median time to complete the survey was 2 min and 45 s, with a range of 1 min and 28 s to 8 min and 34 s. All conditions received a rating from each participant (no missing data). Participants were more likely to select strongly agree than strongly disagree; three conditions had 4 of 8 participants selecting strongly agree, these were “Falls”, “Delirium”, and “Opioid Use Disorder” as impacting pain clinical-decision making. For visualization of the pilot survey results, conditions were grouped together according to main clinical categories as: (1) “Major medical”, i.e., cardio-vascular-pulmonary; (2) “Metabolic”, i.e., involving metabolism, vitamin deficiency syndromes, and endocrine-mediated conditions; and (3) “Neuropsychiatric/age-related”, e.g., falls, dementia. All neuropsychiatric/age-related conditions including dementia and opioid use; selected cardio-vascular-pulmonary conditions, e.g., hypertension and stroke; and selected metabolic conditions, e.g., renal impairment and diabetes mellitus, were rated as impactful (“Agree” or “Strongly Agree”) by most of the practitioners completing the survey, Figure 4.

Discussion

In this study, we demonstrate that there are many clinical conditions that potentially impact pain clinical decision-making by health care providers caring for older adults, and that this area requires additional study. The outcomes of this study are the pilot instrument as well as a demonstration of the comorbidity data for the study population, the literature review, and an appraisal of the instrument feasibility. The pilot instrument may be used by others, however, in current work we are using a revised stem version, replacing the “and” with “that”. The comorbidity data may be used by others to design pain education cases which incorporate the common and relevant comorbidities of pain in older adults aged 75–80 years. The literature review demonstrated that few articles address the importance of older adult pain comorbidities in clinical decision-

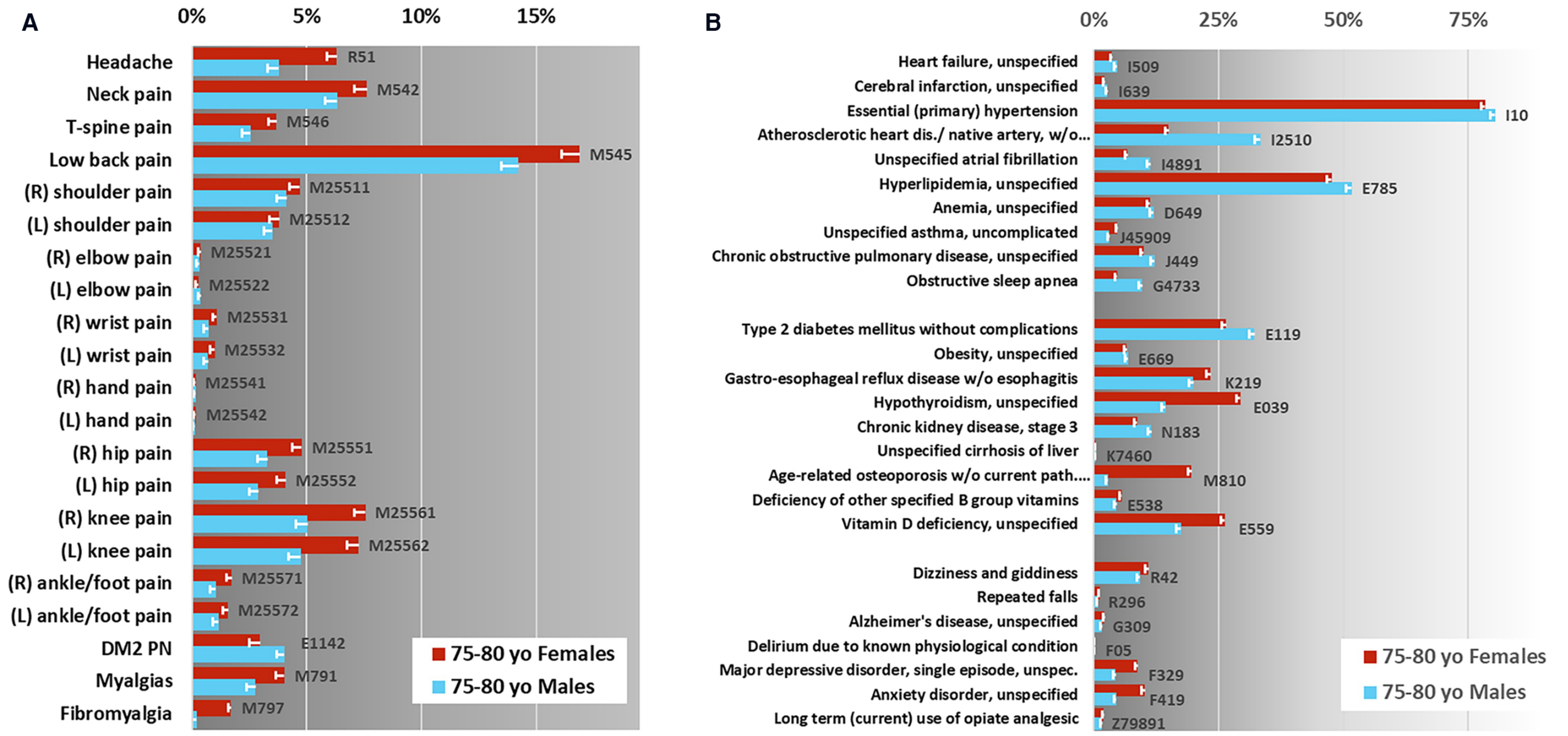


FIGURE 2
Claims data scoping review—identification of potential key elements. Diagnostic rate estimates for common condition ICD-10 codes in CMS Older adults 75–80 years old (yo). (A) Pain condition rate estimates, shown here are the most commonly utilized ICD-10 codes associated with these diagnoses. Pain-associated conditions marked with "*" were included in the assessment instrument. (B) Non-pain conditions selected for this study, shown here are the rate estimates for the most commonly used ICD-10 codes associated with each. Error bars indicate corrected 95% confidence interval, $n = 100$, *net* $p = 0.05$. The gray-scale background in each figure is to alert the viewer to the different x-axis scales.

TABLE 4 Initial and final pain-associated condition key element lists.

Initial pain list	Final pain list
Headache	Headache
Cervical spine pain	Cervical spine pain
Thoracic spine pain	Thoracic spine pain
Low back pain	Low Back pain
Fibromyalgia	Fibromyalgia
Myalgias	Myalgias
Diabetic peripheral neuropathy	Diabetic peripheral neuropathy
Focal joint pains	Shoulder pain (right and/or left)
	Hip pain (right and/or left)
	Knee pain (right and/or left)

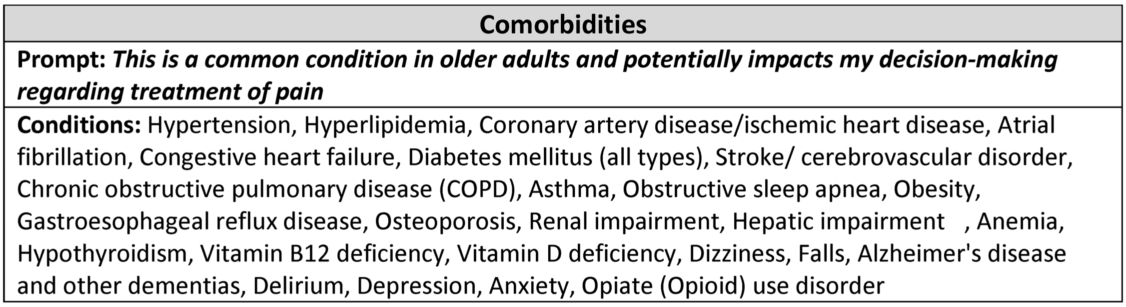
making, this was the primary impetus for our study. Finally, we included a demonstration of the type of data that could be obtained with this instrument. We note that this data is pilot data so that the error bars are wide and we do not draw summative conclusions from these values. The time to complete the survey was less than three minutes including demographics items and questions about overall pain condition prevalence. Taken together, we conclude that future studies using this PAEAN instrument are highly feasible and the knowledge gained will improve educational pain case development and ultimately strengthen pain clinical decision-making by those treating older adults. We postulate that medical and mental health comorbidities increase the cognitive burden of pain clinical decision-making, increasing the risk of harms and narrowing the scope of acceptable and feasible therapeutic options (69). The net impact of this cognitive burden remains unknown, but formal needs assessment is essential to the creation of more realistic and clinically useful pain education scenarios (39).

Improved preparation of healthcare providers is a high priority educational goal as the number of older adults is expected to increase (4, 70, 71). In addition to reporting on the conceptualization, development, and pilot testing of a pain clinical decision-making survey instrument, the data presented here are designed to increase awareness of and provide scoping-level data regarding those conditions most likely to increase the complexity of managing persistent pain in older adults (56, 70). Curriculum developers can use information gleaned in this study, together with other research findings, to take pragmatic steps towards improvements in evidence-based pain education initiatives (28, 39, 72–74). As a long-term goal, this study envisions better understanding of and preparation

TABLE 5 Initial, interim, and final common pain co-morbidity key element lists.

1st comorbidity list	Interim comorbidity list		Final comorbidity list		
HTN	HTN	HLD	Card/vasc/pulm	Metabolic	Neuropsych.
HLD	CAD	CHF	CHF	DM	*Dizziness*
DM	Atrial Fib.	COPD	Stroke	Obesity	*Falls*
Obesity	Asthma	OSA	HTN	GERD	*Dementia*
Depression	Anemia	Obesity	CAD/IHD	Hypothyroid.	*Delirium*
COPD	DM	GERD	Atrial Fib.	Renal Impair.	Depression
Anemia	Renal Failure	Hepatic Failure	HLD	*Hepatic Impair.*	Anxiety
CHF	Osteoporosis		Anemia	Osteoporosis	OUD
OSA	Depression	Anxiety	Asthma	*Vit. B12 Defic.*	
Renal Failure	Delirium	Dementia	COPD	*Vit. D Deficiency*	
Hepatic Failure	Mild Cognitive Impairment		OSA		

Italic font indicates conditions included on the basis on clinical impact based on IAP input. Abbreviations as in Table 1.


Comorbidities

Prompt: ***This is a common condition in older adults and potentially impacts my decision-making regarding treatment of pain***

Conditions: Hypertension, Hyperlipidemia, Coronary artery disease/ischemic heart disease, Atrial fibrillation, Congestive heart failure, Diabetes mellitus (all types), Stroke/ cerebrovascular disorder, Chronic obstructive pulmonary disease (COPD), Asthma, Obstructive sleep apnea, Obesity, Gastroesophageal reflux disease, Osteoporosis, Renal impairment, Hepatic impairment , Anemia, Hypothyroidism, Vitamin B12 deficiency, Vitamin D deficiency, Dizziness, Falls, Alzheimer's disease and other dementias, Delirium, Depression, Anxiety, Opiate (Opioid) use disorder

FIGURE 3
Pilot PAEAN instrument. Shown is the stem (Prompt) and list of conditions included in the final instrument. The instrument is constructed by placing the stem at the top of the page with the list of conditions along the left margin, each with a Likert scale to the right (one scale associated with each condition). The instruction for the instrument was: “Please rate your agreement with the following statement regarding each of the conditions below:” A 5-point Likert scale (strongly disagree to strongly agree) was used.

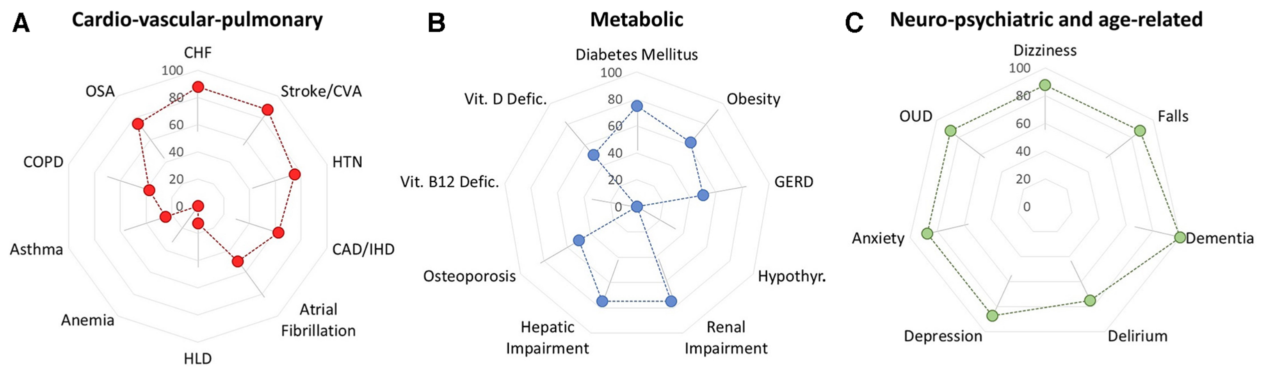


FIGURE 4
Preliminary assessment of respondent agreement that specified conditions impact pain-related clinical decision-making. (A) Cardio-vascular-pulmonary conditions may be viewed a variably impactful. (B) Metabolic conditions may be viewed as relatively less impactful although pilot data suggest that diabetes, renal impairment and hepatic impairment may have a strong impact on decision-making. (C) Pilot data suggest that neuro-psychiatric conditions have a major impact on pain-related clinical decision-making. Error bars represent the 95% confidence interval, corrected for multiple comparisons, $n = 26$, *net* $p = 0.05$. For clarity, error bars are shown in one direction only but pertain bidirectionally, with adjustments for floor (near zero) and ceiling (near 100%) effects.

for providers facing real-world challenges in managing pain in and with older adults.

Although it might be assumed that pain clinical decision-making for those treating older adults focuses primarily on pharmacological management, it is important to note that non-pharmacological therapies may result in substantive reductions in pain intensity and interference, although the data specifically, focusing on older adults is limited (23, 75–77). The benefits of nonpharmacological therapies, e.g., exercise, mindfulness-based stress reduction, yoga, and tai chi, may extend to other health benefits, such as improved mobility and balance, reduction of blood pressure, preservation of muscle mass, especially impactful for older adults (78–82). Because of the high prevalence of medical and mental health comorbidities in older adults with pain, a comprehensive approach to pain management, proactively incorporating nonpharmacological as well as pharmacologically based therapies, where appropriate, is often needed and comprehensive approaches should be widely incorporated into pain curricula (69, 83–86).

This study lays the groundwork for considering multi-morbidity in the treatment of chronic pain through an educational curricular development lens. We envision creating a clearer appraisal of the complexities of clinical practice by surveying healthcare professionals who regularly treat older adults many of whom experience persistent pain. These results will help to inform the development of clinical cases, accurately representing patients by accounting for real-world comorbidity and ultimately improving clinical skillfulness at entry to practice and beyond. Educational curricula which ignore the effect of comorbidities and multicomplexity cannot be expected to adequately prepare practitioners for real-world clinical challenges (4, 16, 28, 74, 87).

Comparison to existing literature

The existing literature on the effect of medical comorbidities and chronic pain conditions on treatment decisions for chronic pain conditions in older adults is sparse (32, 46). The literature suggests that practitioners have a limited understanding of the scale of this problem which is profound. There was no consensus regarding a standard set of comorbidities of relevance. Two studies cited the Charlson comorbidities list which was specifically developed for clinical prognostication in older adults, utilizing this list for the purpose of assessing comorbidities of pain in adults across a broad age-range may not be sufficiently expansive. We show here that there is a small number of studies addressing the co-existence of medical comorbidities and chronic pain conditions and very few examine this phenomenon comprehensively, and we did not identify any other studies that investigate how comorbidities affect pain clinical decision-making. Some studies have asked about comorbidities in other populations, not specifically focusing on older adults—a population where the multiplicity of comorbidities expands the challenge and risk of medication-based management (88, 89). This study offers an important addition in systematically developing a survey instrument designed to characterize the impact of pain comorbidities in older adults on treatment decisions.

Integrating literature, data, and expert opinion

We utilized a 3-pronged approach to survey instrument development and combined evidence-based methods with the subject-matter expertise of our interprofessional working group, aiming at a robust instrument with clinical and real-world contextual relevance. First, peer-reviewed literature provided the initial framework of comorbidities that was further refined by the professional experience of our advisory group. With their input, the terms *falls*, *dizziness*, and *delirium*, were added due to relevance in the context of our study aims (90–93). *Vitamin D deficiency*, *vitamin B12 deficiency*, and *hepatic impairment* have significant clinical relevance in the treatment of chronic pain-associated conditions, e.g., enthesiopathies, neuropathies, yet were not prominently included in the literature (94–98). When addressing conditions, such as pain, that impact a large percentage of older adults and have profound impacts on many domains of function, it is important to include a diverse range of healthcare professionals in projects which require appraisal and integration of complex data (4, 16). Finally, the utilization of real-world claims data codes provided statistical evidence and confirmation of the prevalence of comorbidities in the United States and further validated inclusion in our instrument (56, 60). A deliberate, interprofessional process led to the development of this research instrument (99).

Limitations

This is a pilot study describing the use of an intentional interprofessional process to develop a survey to assess pain clinical decision-making in older adults with single highly prevalent comorbidities. Some limitations are noted. The Medicare data which was reviewed by the interprofessional advisory panel was drawn from a demographically representative population of older adults, nonetheless, it is acknowledged that claims data may underestimate or overestimate the prevalence of certain conditions (100–102). Some "conditions" are defined by nonspecific terms, e.g., headache and hypertension, whereas others were more specific such as obstructive sleep apnea and opioid use disorder, so that the broader classes pertaining to these diagnoses, i.e., sleep disturbances and substance use disorders, may not be well captured by the survey (56, 103). This reflects the real world complexity of clinical practice wherein both detailed specification as well as the capacity to abstract to the more general are important skills (104). This data was useful in familiarizing non-medical providers with an estimate of condition prevalence from contemporary data and is intended in this article to provide the reader with actionable data to enhance pain education module development. We did select a "typical" population from the Medicare data focusing on the older adult aged 75–80 who was alive for all of the study year, was enrolled in Part B but not in Medicare Advantage (Part C), and who had between 19 and 30 claims. The latter restriction was included because we and others have noted that diagnostic rates vary widely with claim rates; the number of claims selected for this study included the median 20% of claims, e.g., claim rates ranging from the 40%ile to the 60%ile as our goal was to evaluate the "median" diagnostic rates for the population. It acknowledged that older adults vary tremendously in terms of health and morbidity so that no single number can capture the full flavor, we seek to present a single number that is representative of the typical morbidity burden in the age group studied. It was challenging to develop an effective literature search strategy. Much of the pain literature focuses on "complex pain", e.g., temporomandibular joint disorder, but does not address "medical complexity" and pain (105). Several meetings with the healthcare informationist were necessary to develop an effective strategy which ultimately included searching for pairs, i.e., a pain condition paired with a medical condition, for several of the high prevalence conditions. Although an effort was made to include several professions in the study group, the study team was led by two specialty physicians whereas the workforce for primary care is increasingly comprised of a broader range of healthcare providers including nurse practitioners, physical therapists, and physician assistants (106–108). This pilot study included a limited number of study subjects and a larger scale test of this instrument is underway, this report serves to explain the construction of the instrument and report feasibility (99). Finally, this study examines the impact of single comorbidities, however it is common for older adults, especially those of advanced age, to experience multiple serious health conditions simultaneously, i.e., multimorbidity, and to face health system challenges in coping with the medical instructions and treatments, i.e., multicomplexity (3, 46). We posit that clinical decision-making burdens likely increase as comorbidities multiply, thus it is important to examine the impact of multimorbidity and multicomplexity, it is our intention that this study provides an important foundation for that future work.

Conclusions

Comorbidities such as dementia, depression, anxiety, opioid use disorder, dizziness, falls, delirium, congestive heart failure, stroke, hypertension, diabetes, renal and hepatic impairment are likely to have a strong influence on clinical decision-making for healthcare providers working to address pain in older adults. Relatively understudied, the prevalence and impact of comorbidities present in older patients with pain should be proactively incorporated when creating educational curricula; in addition, the impact on clinical guidelines merits substantive consideration. Our survey instrument may be useful to those engaged in pain education research and content development, and improved understanding of pain-related clinical reasoning. We have provided the scoping Medicare data here so that educators can use this information to immediately begin to build more realistic cases incorporating the most common and impactful pain comorbidities. We conclude that further study is essential, and we propose the use of surveys, data analytics, focus groups, and literature reviews as well as systematic development and study of educational materials dedicated to improved clinical pain care, especially focusing on the question of how varying comorbid complexity impacts the decision-making processes of clinicians caring for older adults with pain.

Data availability statement

The data analyzed in this study is subject to the following licenses/restrictions: The dataset is restricted by an existing data use agreement. Requests to access these datasets should be directed to beth.hogans@va.gov.

Ethics statement

The studies involving humans were approved by University of Maryland Institutional Review Board. The studies were conducted in accordance with the local legislation and institutional requirements. The ethics committee/institutional review board waived the requirement of written informed consent for participation from the participants or the participants' legal guardians/next of kin because of Exempt status.

Author contributions

BS: Conceptualization, Formal Analysis, Investigation, Methodology, Project administration, Validation, Visualization, Writing – original draft, Writing – review & editing. BH: Conceptualization, Data curation, Formal Analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. LF-L: Conceptualization, Investigation, Methodology, Visualization, Writing – review & editing. LMB: Conceptualization, Investigation, Visualization, Writing – review & editing. CH: Conceptualization, Investigation, Methodology, Visualization, Writing – review & editing. LFB: Conceptualization, Investigation, Methodology, Visualization, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The handling editor JWW declared a past collaboration with one of the authors BH.

Publisher's note

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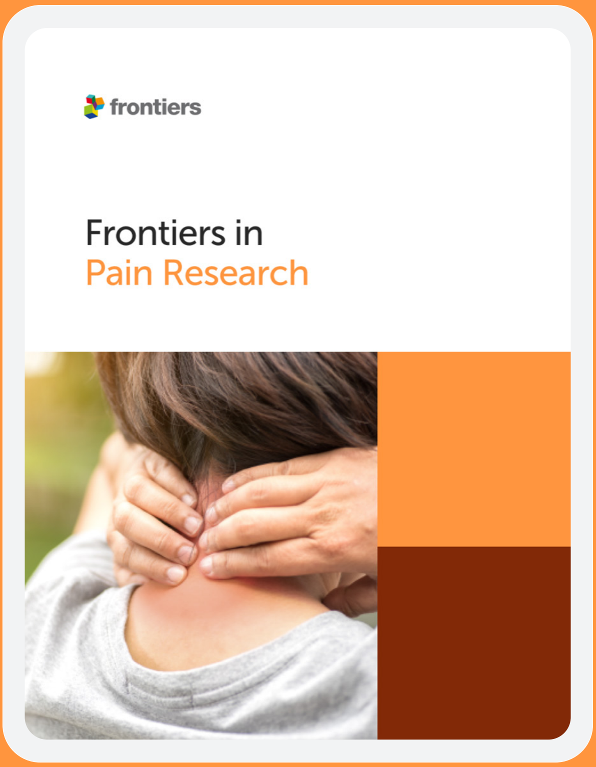
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