Title page

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ABSTRACT

The International Association for the Study of Pain (IASP) have designated 2018 as the global year for excellence in pain education. Despite advances in pain research, there remains an inadequate understanding and implementation of pain education that health professionals obtain in training prior to professional registration, licensure or certification. This paper reports on a synthesis of pain education research that has been conducted in this period of health professionals training. A scoping review framework by Arksey and O'Malley was used to guide a search of medical and education databases for records that have examined or evaluated pain education. Fifty-six reports were identified representing sixteen professions across twenty nine countries, published between 1992-2017. A descriptive account of the reports is provided which includes a timeline, geography, methods of evaluating and main purpose of the research. A narrative synthesis was undertaken to summarise and explain the results and main findings from reports of studies included in this review. Further to this a concept analysis was conducted to identify and map key concepts that can be used by stakeholders to develop or evaluate future pain education. Future directions for research are proposed which includes factors that are repeatedly reported to be important in advancing pain education and should underpin the campaign for environments that promote excellence in pain practice as the norm in healthcare.

1. INTRODUCTION

The International Association for the Study of Pain (IASP) Council have designated 2018 as the global year for excellence in pain education. Pain is recognised as a global health problem with significant impact on health and social care systems [15; 29; 40; 58; 76] . In response to this global crisis a number of countries produced national pain strategies or action plans which IASP analysed to produce 'Desirable Characteristics of National Pain Strategies: Recommendations by the International Association for the Study of Pain' [6]. Access to pain education for health professionals is one of the key recommendations to improve pain care, specifically that trainees are equipped with both the knowledge and skills to address all types of pain at an early stage of training. This is consistent with the Declaration of Montreal which states one of the reasons that pain management

is inadequate in most of the world is because there are major deficits in knowledge of health care professionals regarding the mechanisms and management of pain [1; 2]

Advancing pain education is complex because the range of knowledge and skills that a practitioner requires to be competent in pain management is broad and varied and the subject may be taught and evaluated from both a theoretical and practical aspect. Hence, pain education needs to include a variety of pedagogic approaches to facilitate learning including comprehension, interpretation, analysis and evaluation of knowledge and competence of practical skills. Despite the challenges there has been an increase in pain education research over recent years, however it remains unclear how pain education has progressed in terms of improving patient care.

Problems with pain education identified by surveys of multiple health science courses in higher education institutions across the USA, Canada and Europe include a lack of dedicated curriculum time, and that pedagogic approaches are thought to be ineffective in improving students pain knowledge and skills. Pedagogic approaches tend to be didactic and biomedically focussed which may not be optimal for developing knowledge and skills relevant to a pain practitioner [17; 22; 45; 79]. The Institute of Medicine (IOM) Report Relieving Pain in America identifies problems in pain education, but also provides a list of recommendations to improve curriculum and education for health care professionals [3].

We conducted a rapid scope of medical and education databases which revealed a large number of published reports of evaluations of pain education using a range of research methodologies. However, we did not find any reviews or syntheses of this research literature. The aim of this review is to scope the nature and synthesise the findings of research that has evaluated pain education for pre-registration/pre-licensure health professionals. A timeline of published reports will be provided, along with a synthesis of results and main findings, and an analysis of concepts that are key to the development and evaluation of pain education.

The findings presented in this manuscript formed part of a larger scoping review that examined both research and policy for pain education. The format of the review was informed by a conceptual framework which is available in the published protocol [71] . The methodology to identify reports

from medical and education databases, and findings from the review of research are presented in this manuscript. The findings from the review of policy are published elsewhere [70].

2. METHODS

A scoping review methodology was used to determine the breadth and depth of pain education literature which is briefly described in sections 2.1 to 2.5 of this manuscript [13].

2.1. Stage 1: Identifying the research question

One researcher (KT) conducted preliminary searches in Medline to pilot the search terms relevant to pain education research. A number of references were retrieved relevant to the examination or evaluation of pain education. These were subsequently discussed amongst the review team at which point the research question and search strategy were refined. Broad search terms were used to capture a wide variety of records and maintain breadth of coverage. Search terms were narrowed once a sense had been gained of the volume and scope of the literature.

2.2. Stage 2: Identifying relevant studies

An iterative approach was taken where the search strategy was revised with increasing familiarity with the literature and feedback from peer review. To locate reports that have examined or evaluated pain education search terms were combined using Boolean operators e.g. [pain] AND [curriculum OR education] AND [allied health occupations OR medicine OR nursing] in the following medical and education databases; MEDLINE, CINAHL, HMIC, AMED, EBM reviews and ERIC. Exploded MeSH or thesaurus search terms were used where possible along with keyword searches [pain education] OR [pain curriculum]. Subsequently reference lists of key papers were hand searched to identify any further relevant papers.

2.3. Stage 3: Study selection

The search strategy revealed a large number of citations (>3500) which were independently screened for eligibility by two authors (KT & JM). A third reviewer (MB) acted as arbiter where agreement could not be reached. The initial eligibility criteria was purposely broad to determine breadth of coverage. The eligibility criteria were; i) published in the English language, ii) directly

relevant to the pre-registration/pre-licensure pain curriculum (i.e. nursing, medicine, allied health professions), iii) human participants, iv) extractable data, iv) no date restriction.

Following the iterative nature of the methodology additional exclusion criteria were added after the first round of screening. Reports were excluded if i) they were not categorised as research in its broadest sense e.g. editorials/commentaries/opinion papers/letters to editors were excluded, ii) reports focussed on one specific health condition e.g. surgical/cardiac/cancer pain, iii) paediatric pain, and iv) published more than twenty five years ago. Reports that focussed on pain located to one area of the body e.g. chronic low back pain were included under the umbrella musculoskeletal pain. These exclusions were applied to maintain a broad approach to pain education that was not focussed to one patient group, and therefore the results would be applicable across the professions. The full text of all papers deemed eligible on title and abstract screening were put through to stage 4 of the review.

2.4. Stage 4: Charting the data

Author, year of publication, report location, type of report, health profession, purpose, methods of evaluating pain education, and main findings were extracted and charted by one author (KT). Any papers where data charting or eligibility were unclear were reviewed by another review team member (JM).

2.5. Stage 5: Collating, summarising and reporting the data

Results were collated and analysed in the following way.

i. A descriptive account providing the type, number, year of publication, location, methods of evaluating and the main purpose of pain education research.
ii. A narrative synthesis of key findings by research reports.
iii. An analysis of key concepts central to the design and evaluation of pain education.

3. RESULTS

3.1. OUTCOME OF THE SEARCH AND SUBSEQUENT SCREENING

The number of records identified by the search strategy, subsequent screening, eligibility and inclusion in the review is demonstrated in figure 1.

< Insert figure 1. Here >

3.2. DESCRIPTIVE ACCOUNT

Fifty-six reports of studies were located across twenty-nine countries ranging from 1992-2017, with just over forty percent (23/56) located in the USA (Table 1).

Participants identified in reports include health students, higher education faculty staff (e.g. lecturers, program directors, board members), and clinical staff (including new graduates). Only one out of fifty six reports included patients as participants. Sixteen health professions were referred to with the majority of research conducted in medicine, nursing, physiotherapy, and occupational therapy.

Scoping review methodology purposefully allows for a range of literature to be included in the review therefore the type of research in the reports identified and methods used to evaluate or examine pain education were varied and in some cases difficult to categorise where mixed methodology had been used.

Survey methodology was the most frequent approach to examine or evaluate pain education, followed by observational/cohort studies, experimental designs, course evaluations, qualitative approaches, and document analysis. The main purpose of each report was documented and coded by one author (KT), with five major categories emerging;

1. Analysis of student knowledge, skills, attitudes and beliefs regarding pain
2. Analysis of course curricula
3. Development of curricula
4. Evaluation & perception of education by faculty educators or students
5. Other factors reported to be relevant to pain education

Figure 2 demonstrates the timeline, geography, health profession, and main purpose of reports identified in each of these categories.

< Insert figure 2 here >

3.3. NARRATIVE SYNTHESIS

Understanding the results of large bodies of evidence is challenging when research uses a range of methods like those described in this scoping review. Hence, an approach to narrative synthesis described by the Cochrane Consumers and Communication Review Group was used to make sense of the results which summarise and explain findings primarily on the use of words rather than numerical results [63].

To provide initial structure to the narrative synthesis the results were analysed in the five categories described earlier by way of the main focus/purpose of the report. One author (KT) read the results of each study in their respective categories several times to identify key characteristics, similarities and differences between the results. These were reviewed and discussed until agreement was gained by all team members.

3.3.1 Analysis of student knowledge, skills, attitudes and beliefs regarding pain

This review found that student knowledge, skills, attitudes and beliefs regarding pain have been investigated for over twenty-five years. These reports appear to have been conducted for one of two reasons;

i) To examine or evaluate student knowledge, skill, attitude or beliefs regarding pain as a result of normal health curricula. In these reports students may have experienced pain education as part of their usual health training, but it was not reported as a focus within curricula.

ii) To examine or evaluate student knowledge, skill, attitude or beliefs regarding pain as a result of curricula that overtly incorporates or identifies pain into education. This is often referred to in the literature as dedicated pain education.

Reports that analysed student knowledge, skills, attitudes or beliefs regarding pain as a result of normal curricula were found across medicine [8; 11; 18; 46; 50; 54], nursing [9; 10; 20; 21; 23; 30; 31; 55; 57; 65], physiotherapy [8; 11; 25; 62], and occupational therapy [60; 68]. These reports frequently found that students lacked knowledge and skills, and that many had negative attitudes and beliefs regarding pain as a result of normal health curricula. Of those that did demonstrate some improvement throughout the educational process, pain knowledge was still often reported to be suboptimal.

Reports that analysed student knowledge, skills, attitudes or beliefs regarding pain as a result of curricula that overtly identified or incorporated pain into education were found across medicine [12; 53; 56; 66; 78; 81; 82], nursing [42; 78], physiotherapy [44; 67; 78], dentistry [78], occupational therapy [61; 67; 75; 78], and pharmacy [78]. Contrary to the results of the reports that evaluated normal curricula, these reports frequently found that pain knowledge, skill, attitudes and beliefs regarding pain significantly improve when students were exposed to this type of pain education.

Approaches to dedicated pain education were varied. They included: an elective chronic pain course [12], e-learning [42; 56; 81], a 4-day pain course [53], brief clinical and pain science seminars [82], a curriculum based on IASP core curricula outlines [67; 78], other pain curricula [59; 66; 75], and a teaching module on chronic pain [44].

A large number of studies reported the use of tools used to evaluate pain knowledge, skill, attitude or belief regarding pain, which included the Neurophysiology of Pain Questionnaire [8], the Knowledge and Attitudes Survey Regarding Pain (KASRP) [10; 20; 30; 42; 55; 57], the Revised Knowledge and Attitudes Survey Regarding Pain (RKASRP) [9; 23], the Schutte Emotional Intelligence Scale (SES) [20], Health Care Providers' Pain and Impairment Relationship Scale (HC-PAIRS) [25; 44; 50; 60; 62], Pain Attitudes and Beliefs Scale for Physiotherapists (PABS-PT) [11], 23-item Pain Knowledge Questionnaire [11; 21], City of Boston's Rehabilitation Professionals' Knowledge and Attitude Survey Regarding Pain (COBS) [61], Pain Knowledge and Attitude Questionnaire [75], Revised Pain Knowledge and Attitude Questionnaire [67; 68] and the Pain Knowledge and Beliefs Questionnaire [78].

Other methods of evaluating pain knowledge, skill, attitude or belief included clinical vignettes [65], interviews [47; 68], multiple choice questions (MCQ's) [56], clinical skills exams or checklists [46; 66], computer simulated or virtual patients [36; 37], and written assessment portfolios or assignments [53]

3.3.2. Analysis of curricula

This review also located studies that reported an analysis of the pain curricula across health professional courses by two distinct methodologies: i) faculty educators have been questioned about content and approaches, and ii) course curricula documents have been evaluated (table 1).

Analysis of pain curricula by surveys of faculty educators were found across nursing [17; 19; 22; 30; 45; 74; 79; 83] dentistry [17; 19; 22; 45; 79], medicine [17; 19; 22; 45], midwifery [17; 19],

occupational therapy [17; 19; 45; 79], pharmacy [17; 19; 22; 45; 79], physiotherapy [17; 19; 34; 45; 64; 79], veterinary science [17; 79], and social work [22].

Analysis of curricula by evaluation of written course curricula documents were found across medicine [16; 49; 80] dentistry [80], nursing [48; 80], pharmacy [80], occupational therapy [80], physiotherapy [80], psychology [80], and veterinary medicine [80].

Analysis of the pain curricula within and across the health professions indicated that there were only minimal standards relating to pain education from health regulators and quality assurance documents [17]. Traditional teaching methods such as lectures were most frequently used to teach pain [17; 22], yet pain education was lacking in total number of taught hours and was variable within and across the health professions in the UK [17], USA [22], Canada [79; 80] and Norway [45]. IASP curricula were poorly integrated [17; 22] and there were a lack of entry to practice pain competencies [80].

Reports that analysed curricula from professions on an individual basis were found across medical curricula in Europe [16] and the USA [49], nurse curricula in the UK [47; 74] and USA [83], and physiotherapy curricula in the USA [34; 64]. Again substantial variation was found [16; 34; 49] often with investigators concluding that there was minimal pain content [47; 64; 74], and IASP core curriculum received little or no coverage [49].

Qualitative methodology has been used to report the barriers and successes to implementing pain education with two major themes of successes and challenges emerging from the data. Successes included expanding pain education with a multidimensional curricula and teaching methods. Challenges include difficulties in identifying pain in the curricula, biomedical versus biopsychosocial definitions of pain, perceived importance, time, resources and staff knowledge, and responsibility for pain education [19].

3.3.3. Development of curricula

A number of reports were identified by this review that described studies that aimed to advance curricula by developing inter-disciplinary outcomes or competencies for pain education [28; 51; 69; 73]. These reports focussed on how curricula could or should be developed to improve graduates competence to practice pain management on graduation (table 1).

Recommendations for medical pain curricula were reported [51], along with curriculum content guidelines for educating medical students about the evaluation and management of chronic pain in older adults [73]. A comprehensive list of outcome based pain assessment and management competencies determined by interprofessional and international consensus building are available [28].

Only one report identified by this review included patients as participants. This report analysed qualitative data from patients, students and educators to identify gaps in pain management knowledge with five emergent themes making recommendations for medical curricula [69].

3.3.4. Faculty staff and student perspective on pain education

Faculty staff were reported to have variable satisfaction in relation to pain management in their courses [34; 64; 83].

Student evaluation of pain education was reported to be varied. Findings included reports of perceived gaps in knowledge and skills regarding pain in normal curriculum designs with some students reporting their pain education to be minimal [21]. Students also advocated the inclusion of additional pain teaching [68], and rated pain education highly in studies that report curricula with overt pain education [32; 53; 56; 78].

An electronic IASP questionnaire has been used by medical students to evaluate how the IASP pain curriculum had been covered during their studies [46].

3.3.5. Other factors reported to be relevant in pain education

The knowledge and attitudes, and previous experiences of nursing faculty are reported to be relevant and influential in pain education [23; 26; 30; 41; 77]. Other factors that are reported in the findings of studies that have examined or evaluated pain education include cultural differences in attitudes and beliefs about pain [25], emotional intelligence [20], emotional development needs [53], communication skills [46], frequency of pain care, gender, and interaction between educational level and religious faith [31], prior experiences and personal factors [37], sex and race [36]. These reports are heterogenous in their purpose and findings, therefore it is not possible to summarise the results. They do however provide concepts to be considered for pain education that are broader than the more frequently reported knowledge, skills, attitudes and beliefs about pain.

The results of reports included in this review identify many problems with pain education, but also provide models, approaches and tools for suggested improvements. A summary of the problems and solutions identified are provided in table 2.

3.4. Concept analysis

The results of this scoping review have provided a timeline, geography, inventory of included health professions, and synthesis of key findings in pain education research for pre-registration/pre-licensure health professionals

Further to this, a conceptual analysis was undertaken to identify and map key concepts relevant to the development or evaluation of pain education. The purpose of this was to develop a model that can be used as a reference tool to evaluate existing pain education, or to plan and develop future pain education for health professionals. Concepts, notions, and ideas were identified by reading all reports included in the scoping review several times to make sense of and gain understanding of the full dataset. Characteristics relevant to the design and evaluation of pain education along with key stakeholders in pain education were extracted and coded. Four overall key components of the educational process emerged relevant to the development or evaluation of pain education;

1. Student characteristics.
   Student knowledge, skill, attitudes and beliefs are measurable by a range of quantitative and qualitative methodologies. The 'success' of pain education is commonly determined by these outcomes. Personal characteristics and prior experiences that students have encountered are also identified, and are possibly relevant in the design and evaluation of pain education. Students have provided useful insight when asked to evaluate their learning experience.
2. Educator characteristics.
   Knowledge, skill, attitudes and beliefs of educators and leaders in pain education are reported as part of the educational process. Similar to students, individual characteristics and experiences of educators are possibly relevant and influential in the design and evaluation of pain education. Educators and pain leaders are used as experts regarding the design, content and delivery of pain education, and can provide insight when asked to

evaluate education. Educators can take on the role of pain champion in an educational setting.

3. Content and Delivery – when, how, and what to teach about pain.

   Dedicating increased hours of pain education in curricula structured with core guidelines such as IASP pain curricula, are recommended. Increasing the number of taught hours using pedagogic approaches has shown to improve pain education (e.g. dedicated pain education such as e-learning modules/ inter-professional education). Providing and locating pain education in curricula to facilitate graduates that are confident to practice and bridging the gap into competent clinical practice is advised.

4. Outcomes: patient and education.

   The outcome of education (e.g. what has been learned), and the effect in clinical practice (e.g. patient outcome) is increasingly reported as being critical in pain education. Pain competencies are published and endorsed by IASP. Recipients of healthcare are key stakeholders that have provided significant contribution when they have been included in research.

A conceptual model has been developed to aid stakeholders in the evaluation or development of pain education, and is provided in figure 3.

4. DISCUSSION

This scoping review demonstrates the considerable amount of research that has been conducted to evaluate pain education for health professionals. There has been a significant increase in the number of published reports over recent years that have not only identified the problems leading to poor pain education but have also provided practical solutions.

Unfortunately, in practice the implementation of these solutions appears to be poor. Explanations for this are discussed in the literature. They include the need for greater implementation of core competencies for pain education, and for organisations that accredit/regulate health professions to take more responsibility for mandating and ensuring standards of pain education with health education programmes [27]. This review synthesis supports these findings and furthers the discussion by providing the context of problems and solutions to pain education based on twenty-five years of research.

This review located a large body of evidence indicating that student knowledge, skill, attitudes or beliefs about pain are mostly inadequate across the health professions. The problems with pain education were clearly articulated and consistent in their findings that pain often lacks attention in health curricula, and that pedagogic approaches do not necessarily facilitate the knowledge and skills that health professionals require to manage patients in pain. Delivering pain education within a biopsychosocial model was repeatedly reported as a critical approach to the assessment and management of pain, however education models often focus on educating health professionals in the biology and physiology of pain with the psychosocial aspects of pain gaining less attention. This is inadequate when patients living with chronic pain as a long term condition report that the psychosocial aspects of pain are what they struggle with the most [72]. The importance of managing the human side of illness and patient care has been reported in the literature for decades, and while this probably does feature in health professionals education, in many cases it still does not appear to be explicitly part of pain education [24].

There are resources available to improve the design of pain education. The IASP Education Initiatives Working Group developed interprofessional and uniprofessional pain curriculum outlines to be implemented in pre-registration/pre-licensure health courses. The curricula, which were updated in 2017, are based on the four components of the IASP Core Curricula: i) multidimensional nature of pain, ii) pain assessment and measurement, iii) management of pain, and iv) clinical conditions, and are intended to instil the knowledge and skills necessary to advance the science and management of pain [2]. The increased uptake of these curricula in health courses is a foundation to building a biopsychosocial approach to pain education that meets the needs of patients living with pain.

Reports identified in this review demonstrated a variety of pedagogic approaches that can be used to improve outcomes for students, and are therefore suggested as options for the design of pain education in health professional courses. These include inter-professional workshops, e-learning modules, and short courses on pain that demonstrated improved outcomes for students [12; 42; 44; 53; 56; 61; 66; 67; 75; 78; 81; 82]. This is supported by a qualitative analysis of faculty educators comments regarding pain education where successes were attributed to expansion of pain content in the curricula, explicitly integrating pain into curricula, and diversity of teaching methods where an innovative array of teaching approaches were used e.g. including service users in education, incorporating e-learning, and problem based learning [19]. In particular, interprofessional education has been advocated, often featuring as a major recommendation in reports on pain education across the health professions [4] [17].

Further to this, this review highlighted that other factors such as cultural beliefs, prior experiences, emotional intelligence, and the impact of sex and race, that may be influential in pain education. Again, some of these factors may feature in health professionals education, but there is little evidence that they form part of education specifically about pain. Considering these potentially influential factors may be important in the design and development of pain education as part of the concept of patient centred care [43]. A blueprint for integrating cognitive and affective dimensions of pain experience into health professionals education is provided in the literature that incorporates the emotional development of clinical trainees [52]. A description of the framework is provided which has been applied to the development and implementation of two new courses in pain.

The role of faculty educators in pain education was identified by several reports in this review. In addition to knowledge and skill, the concept of attitudes and beliefs about pain and the influence this can have on the success and outcome of pain education is discussed. Having a team of people involved in teaching and a local champion, team or network of people influencing curriculum change has been proposed as way of improving successful delivery of pain education for health professionals [19].

The outcome of pain education has gained more attention in recent literature by the development of pain competencies and outcomes for healthcare students. In these reports the focus has shifted from what students have been taught, to what they have learned in order for them to become competent and confident health practitioners in pain practice [28; 33; 35]. Following the consensus on the development of core competencies a group of interprofessional faculty provided a follow-up of how to implement learning tools within teaching and curricula in pre-licensure health care. Suggestions and exemplars in applying core competencies for pain management are provided which include providing multiple opportunities for learners to overlap concepts for better depth of understanding, and to include learning concepts through visual metacognition where visual concepts create improved mental thinking or 'meta-cognition' [14]. The focus is to improve the application of knowledge and skills in 'practice settings' i.e. real-client situations. Profession specific recommendations to incorporate, apply and assess core competencies are provided for nurse [33], and physical therapy curricula in the USA [35].

In the UK, the Royal College of Nurses (RCN), and the Physiotherapy Pain Association (PPA) have developed profession specific pain knowledge and skills frameworks for different staff grades working with people in pain. The RCN pain knowledge and skills framework is designed to guide and

support the demonstration of competence by nurses when caring for people with pain [39]. The content of this document is split to meet the different needs of unregistered and registered nurses, therefore each group has its framework summary based on Benner's 1982 novice to expert levels of practice. The PPA framework entry level graduate to expert physiotherapists describes the values, behaviours, knowledge and skills of physiotherapists working with people in pain [7]. This document describes domains at four levels on a continuum from graduate entry level (newly qualified physiotherapist) to expert. It is described as a resource that will be used to develop descriptors of competence. The British Pain Society have recently published 'A Practical Guide to Incorporating Pain Education into Pre-registration Curricula for Healthcare Professionals in the UK' [5], which includes a comprehensive section on core curriculum outcomes for pain education.

It is well documented that there is a gap between knowledge and practice in pain [38]. Wider uptake of pain competencies from the pre-registration/pre-licensure stage of training through to registered clinical staff aims to bridge the gap between knowledge and practice with greater focus on producing healthcare staff that are competent in pain practice. This model of education also facilitates a more natural step into continuing education that graduates have to undertake as part of a clinical career.

This review identified a variety of methodologies used to examine or evaluate pain education. The most significant advancement of methodologies are the reports that have shifted the focus towards educational outcomes, however there is still a lack of research that has been conducted to evaluate how effective pain education is in influencing patient outcomes. There is also a significant lack of patient involvement in pain education research: incorporating patients in the design and evaluation of pain education, and pain education research is necessary to further develop curricula and to advance research methodologies so that meaningful outcomes for patients are evaluated.

To achieve better pain care a conceptual shift needs to occur where graduates are expected to have excellent pain knowledge and skills, that they can communicate with and listen to the needs of patients experiencing pain, and that they are confident in their pain practice.

Future recommendations

To develop methodologies in pain education research that map the causal pathways from pain education to patient outcomes.

To incorporate patients in developing the design, delivery and outcome of pain education curricula and research.

To advance pain education by shifting the delivery from a theory dense, to a clinical environment where contextual decision making in practice is encouraged.

Limitations of the review

It is not within the scope of this review to report on the methodological quality of included reports, rather to provide a timeline, synthesis of, and map concepts within pain education research.

This review identified many reports across the health professions. Others may exist that were not identified by the search strategy employed in this review. The health professions identified in the reports are bias to medicine, nursing and the allied health professions as these were the professions that formed part of the initial search strategy. Other professions such as veterinary science and dentistry were identified when they featured in larger studies that investigated pain education across the health sciences.

Acknowledgments

This work was supported by a Health Education England (HEE) PhD Studentship.

Conflict of interest statement

The authors have no conflict of interest to declare.

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Figure legends

Figure 1. Search strategy.

Figure 2. Timeline of reports that have examined or evaluated pain education.

Figure 3. Conceptual model.

Figure 3

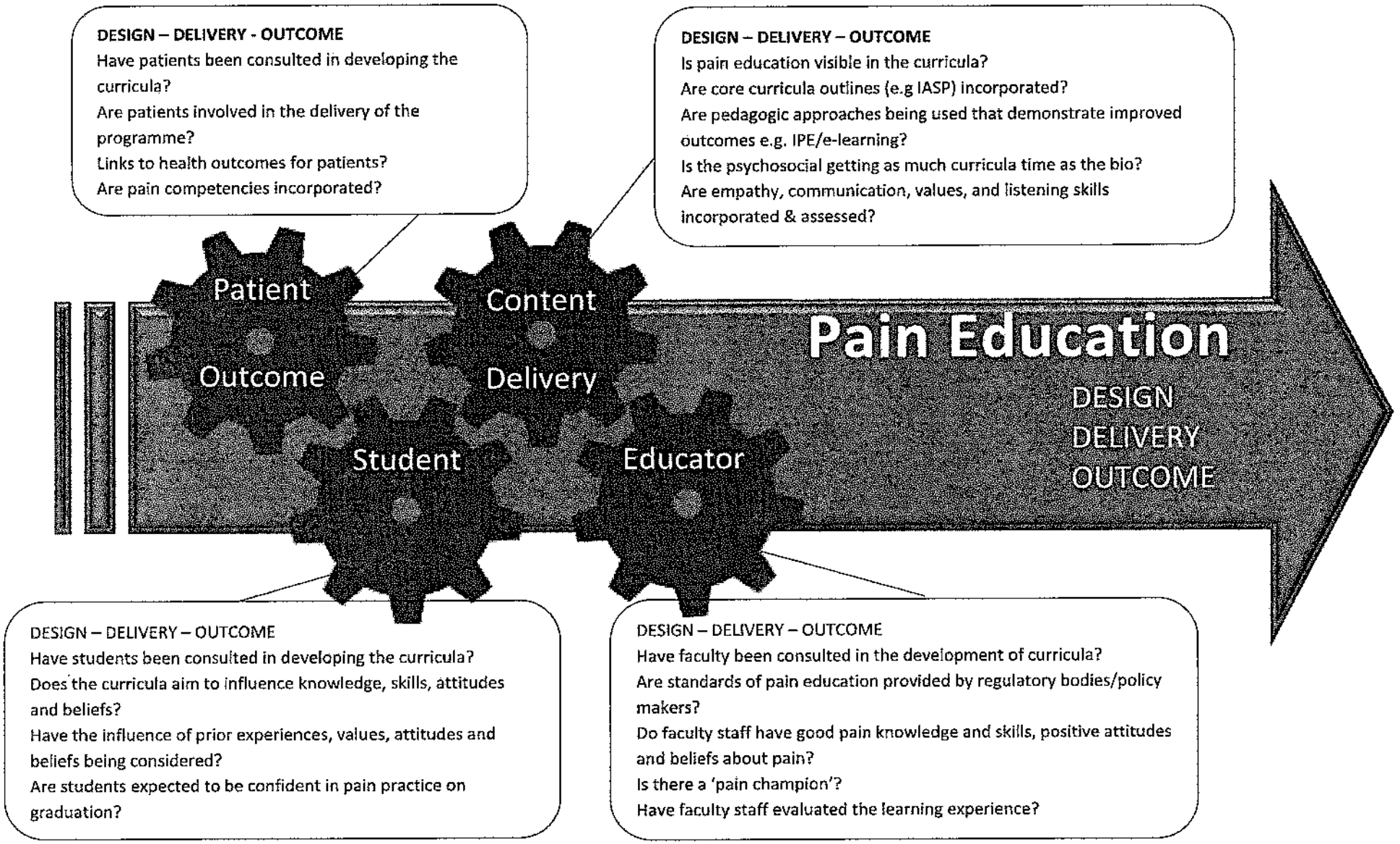
DESIGN – DELIVERY - OUTCOME
Have patients been consulted in developing the curricula?
Are patients involved in the delivery of the programme?
Links to health outcomes for patients?
Are pain competencies incorporated?
DESIGN – DELIVERY – OUTCOME
Is pain education visible in the curricula?
Are core curricula outlines (e.g IASP) incorporated?
Are pedagogic approaches being used that demonstrate improved outcomes e.g. IPE/e-learning?
Is the psychosocial getting as much curricula time as the bio?
Are empathy, communication, values, and listening skills incorporated & assessed?
Patient
Content
Outcome
Delivery
Student
Educator
Pain Education
DESIGN
DELIVERY
OUTCOME
DESIGN – DELIVERY – OUTCOME
Have students been consulted in developing the curricula?
Does the curricula aim to influence knowledge, skills, attitudes and beliefs?
Have the influence of prior experiences, values, attitudes and beliefs being considered?
Are students expected to be confident in pain practice on graduation?
DESIGN – DELIVERY – OUTCOME
Have faculty been consulted in the development of curricula?
Are standards of pain education provided by regulatory bodies/policy makers?
Do faculty staff have good pain knowledge and skills, positive attitudes and beliefs about pain?
Is there a 'pain champion'?
Have faculty staff evaluated the learning experience?

Figure 1

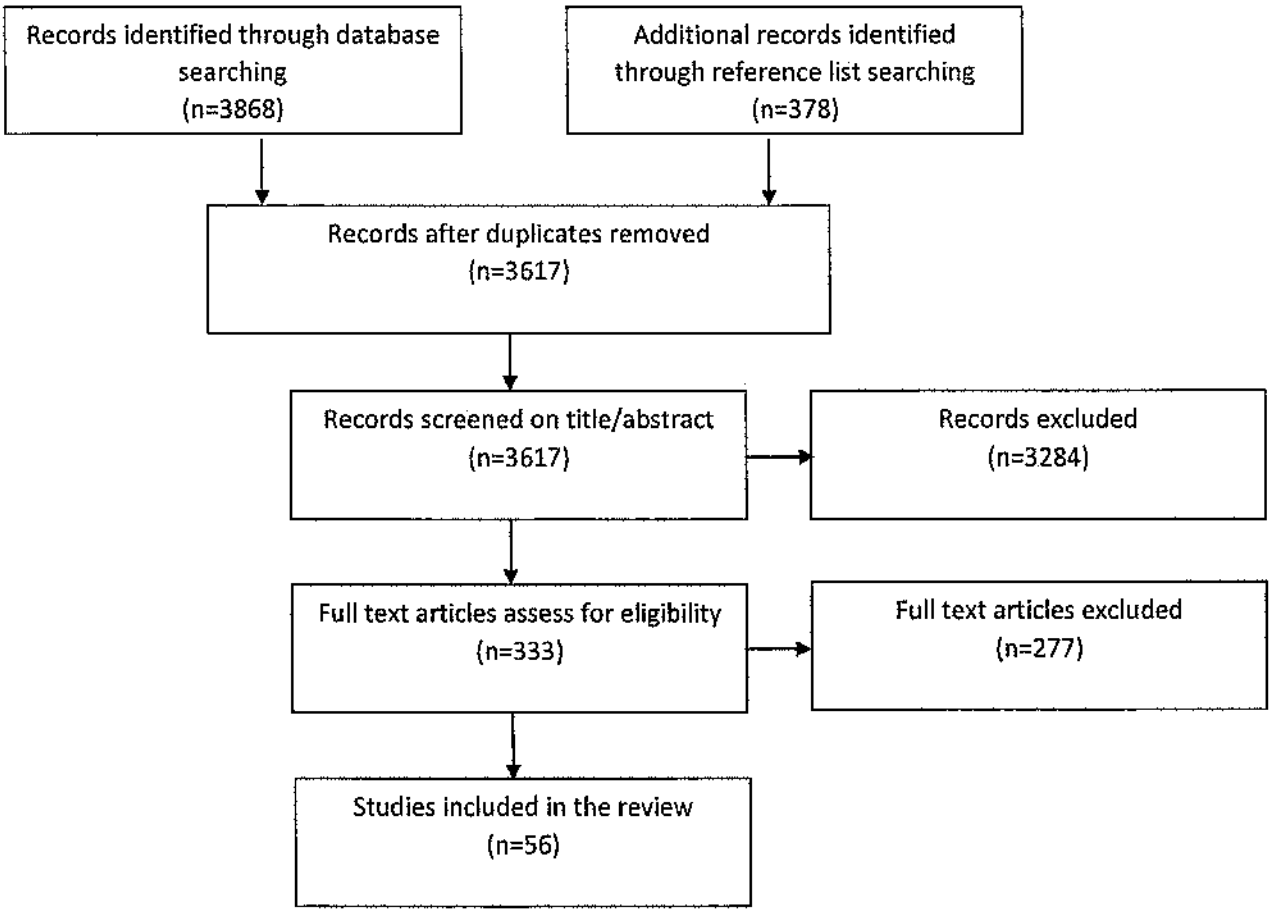
Records identified through database searching (n=3868)
Additional records identified through reference list searching (n=378)
Records after duplicates removed (n=3617)
Records screened on title/abstract (n=3617)
Records excluded (n=3284)
Full text articles assess for eligibility (n=333)
Full text articles excluded (n=277)
Studies included in the review (n=56)

Figure 2

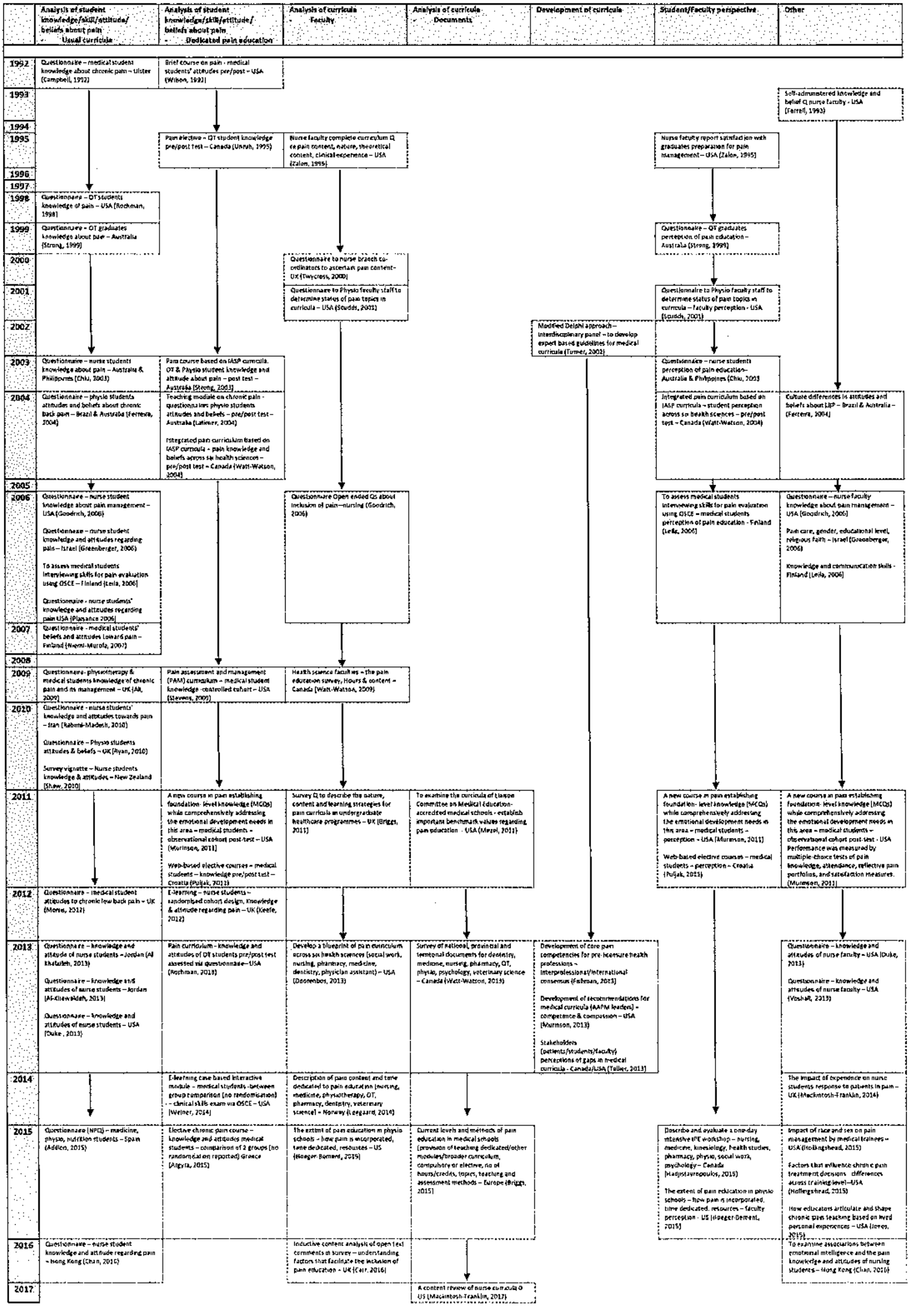
Analysis of student knowledge/skill/attitude/ beliefs about pain - Usual curricula
Analysis of student knowledge/skill/attitude/ beliefs about pain - Dedicated pain education
Analysis of curricula - Faculty
Analysis of curricula - Documents
Development of curricula
Student/Faculty perspective
Other
1992
Questionnaire – medical student knowledge about chronic pain – Ulster (Campbell, 1992)
Brief course on pain - medical students' attitudes pre/post – USA (Wilson, 1992)
1993
Self-administered knowledge and belief Q nurse faculty - USA (Ferrell, 1993)
1994
1995
Pain elective – OT student knowledge pre/post test – Canada (Unruh, 1995)
Nurse faculty complete curriculum Q re pain content, nature, theoretical content, clinical experience – USA (Zalon, 1995)
Nurse faculty report satisfaction with graduates preparation for pain management – USA (Zalon, 1995)
1996
1997
1998
Questionnaire – OT students knowledge of pain – USA (Rockman, 1998)
1999
Questionnaire – OT graduates knowledge about pain – Australia (Strong, 1999)
Questionnaire – OT graduates perception of pain education – Australia (Strong, 1999)
2000
Questionnaire to nurse branch co-ordinators to ascertain pain content– UK (Twycross, 2000)
2001
Questionnaire to Physio faculty staff to determine status of pain topics in curricula – USA (Scudds, 2001)
Questionnaire to Physio faculty staff to determine status of pain topics in curricula – faculty perception - USA (Scudds, 2001)
2002
Modified Delphi approach – interdisciplinary panel – to develop expert based guidelines for medical curricula (Turner, 2002)
2003
Questionnaire – nurse students knowledge about pain – Australia & Philippines (Chiu, 2003)
Pain course based on IASP curricula. OT & Physio student knowledge and attitude about pain – post test – Australia (Strong, 2003)
Questionnaire – nurse students perception of pain education– Australia & Philippines (Chiu, 2003)
2004
Questionnaire – physio students attitudes and beliefs about chronic back pain – Brazil & Australia (Ferreira, 2004)
Teaching module on chronic pain - questionnaires physio students attitudes and beliefs – pre/post test – Australia (Latimer, 2004)
Integrated pain curriculum based on IASP curricula – student perception across six health sciences – pre/post test – Canada (Watt-Watson, 2004)
Culture differences in attitudes and beliefs about LBP – Brazil & Australia – (Ferreira, 2004)
Integrated pain curriculum based on IASP curricula - pain knowledge and beliefs across six health sciences – pre/post test – Canada (Watt-Watson, 2004)
2005
2006
Questionnaire – nurse student knowledge about pain management – USA (Goodrich, 2006)
Questionnaire – nurse student knowledge and attitudes regarding pain – Israel (Greenberger, 2006)
To assess medical students interviewing skills for pain evaluation using OSCE – Finland (Leila, 2006)
Questionnaire - nurse students' knowledge and attitudes regarding pain USA (Plaisance 2006)
Questionnaire Open ended Qs about inclusion of pain—nursing (Goodrich, 2006)
To assess medical students interviewing skills for pain evaluation using OSCE – medical students perception of pain education - Finland (Leila, 2006)
Questionnaire – nurse faculty knowledge about pain management – USA (Goodrich, 2006)
Pain care, gender, educational level, religious faith – Israel (Greenberger, 2006)
Knowledge and communication skills - Finland (Leila, 2006)
2007
Questionnaire - medical students' beliefs and attitudes toward pain – Finland (Neemi-Murola, 2007)
2008
2009
Questionnaire- physiotherapy & medical students knowledge of chronic pain and its management – UK (Ali, 2009)
Pain assessment and management (PAM) curriculum – medical student knowledge -controlled cohort – USA (Stevens, 2009)
Health science faculties – the pain education survey, Hours & content – Canada (Watt-Watson, 2009)
2010
Questionnaire - nurse students' knowledge and attitudes towards pain – Iran (Rahimi-Madiseh, 2010)
Questionnaire – Physio students attitudes & beliefs – UK (Ryan, 2010)
Survey vignette – Nurse students knowledge & attitudes – New Zealand (Shaw, 2010)
2011
A new course in pain establishing foundation- level knowledge (MCQs) while comprehensively addressing the emotional development needs in this area – medical students – observational cohort post-test – USA (Morinson, 2011)
Web-based elective courses – medical students – knowledge pre/post test – Croatia (Puljak, 2011)
Survey Q to describe the nature, content and learning strategies for pain curricula in undergraduate healthcare programmes – UK (Briggs, 2011)
To examine the curricula of Liaison Committee on Medical Education-accredited medical schools - establish important benchmark values regarding pain education - USA (Mezei, 2011)
A new course in pain establishing foundation- level knowledge (MCQs) while comprehensively addressing the emotional development needs in this area – medical students – perception – USA (Morinson, 2011)
Web-based elective courses – medical students – perception – Croatia (Puljak, 2011)
A new course in pain establishing foundation- level knowledge (MCQs) while comprehensively addressing the emotional development needs in this area – medical students – observational cohort post-test - USA Performance was measured by multiple-choice tests of pain knowledge, attendance, reflective pain portfolios, and satisfaction measures. (Morinson, 2011)
2012
Questionnaire - medical student attitudes to chronic low back pain – UK (Morris, 2012)
E-learning – nurse students – randomised cohort design, knowledge & attitude regarding pain – UK (Keefe, 2012)
2013
Questionnaire – knowledge and attitude of nurse students – Jordan (Al Khatatneh, 2013)
Questionnaire – Knowledge and attitudes of nurse students – Jordan (Al-Alawi-Mdah, 2013)
Questionnaire – knowledge and attitudes of nurse students – USA (Duke , 2013)
Pain curriculum - knowledge and attitudes of OT students pre/post test assessed via questionnaire—USA (Rothman, 2013)
Develop a blueprint of pain curriculum across six health sciences (social work, nursing, pharmacy, medicine, dentistry, physician assistant) – USA (Doorenbos, 2013)
Survey of National, provincial and territorial documents for dentistry, medicine, nursing, pharmacy, OT, physio, psychology, veterinary science – Canada (Watt-Watson, 2013)
Development of core pain competencies for pre-licensure health professions - interprofessional/international consensus (Fishman, 2013)
Development of recommendations for medical curricula (AAPM leaders) - competence & compassion – USA (Morrison, 2013)
Stakeholders (patients/students/faculty) perceptions of gaps in medical curricula - Canada/USA (Fuller, 2013)
Questionnaire – knowledge and attitudes of nurse faculty – USA (Duke, 2013)
Questionnaire – knowledge and attitudes of nurse faculty – USA (Voshall, 2013)
2014
E-learning case based interactive module – medical students -between group comparison (no randomisation) - - clinical skills exam via OSCE – USA (Weiner, 2014)
Description of pain content and time dedicated to pain education (nursing, medicine, physiotherapy, OT, pharmacy, dentistry, veterinary science) – Norway (Leegaard, 2014)
The impact of dependence on nurse students response to patients in pain – UK (Mackintosh-Franklin, 2014)
2015
Questionnaire (NPQ) – medicine, physio, nutrition students – Spain (Addor, 2015)
Elective chronic pain course – knowledge and attitudes medical students – comparison of 2 groups (no randomised on reported) Greece (Argyra, 2015)
The extent of pain education in physio schools – how pain is incorporated, time dedicated, resources – US (Boeger-Bement, 2015)
Current levels and methods of pain education in medical schools (provision of teaching dedicated/other modules/broader curriculum, compulsory or elective, no of hours/credits, topics, teaching and assessment methods – Europe (Briggs, 2015)
Describe and evaluate a one-day intensive IPE workshop – nursing, medicine, kinesiology, health studies, pharmacy, physio, social work, psychology – Canada (Madjstavropoulos, 2015)
The extent of pain education in physio schools – how pain is incorporated, time dedicated, resources – faculty perception - US (Boeger-Bement, 2015)
Impact of race and sex on pain management by medical trainees – USA (Hollingshead, 2015)
Factors that influence chronic pain treatment decisions - differences across training level—USA (Hollingshead, 2015)
How educators articulate and shape chronic pain teaching based on lived personal experiences – USA (Jones, 2015)
2016
Questionnaire – nurse student knowledge and attitude regarding pain – Hong Kong (Chan, 2016)
Inductive content analysis of open text comments in survey – understanding factors that facilitate the inclusion of pain education – UK (Carr, 2016)
To examine associations between emotional intelligence and the pain knowledge and attitudes of nursing students – Hong Kong (Chan, 2016)
2017
A content review of nurse curricula – US (Macintosh-Franklin, 2017)

Table 1

Table 1. Table of included reports

Adillón C, Lozano È, Salvat I. Comparison of pain neurophysiology knowledge among health sciences students: a cross-sectional study. BMC Research Notes 2015;8:592-592.
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Table 2. Proposed problems, and suggested solutions to improve pain education

	PROPOSED PROBLEMS	SUGGESTED SOLUTIONS
DESIGN	There is a lack of time spent on pain education. It is not always visible in health curricula or explicit where pain is being taught.	Redesign curricula with increased focus on pain. Make it explicit where pain education features in curricula. Use profession specific or interprofessional curricula outlines.
	There is often poor stakeholder engagement in curricula design with a lack of standards from policy makers and health regulators.	Where possible include patients, students, and educators in the design of pain education. Ask health regulators to mandate pain education.
	The psychosocial aspect of the biopsychosocial model is not as well covered as the bio aspect. Student attitudes and beliefs about pain, and 'other' factors such as prior experience with pain is often not considered or incorporated into pain education.	Challenge student attitudes and beliefs. Consider incorporating education on values, empathy and ethics. Include education on interpersonal skills such as listening and communication when educating students about pain.
DELIVERY	Traditional pedagogic approaches such as lectures may not be effective in improving pain knowledge and skills, or influencing attitudes and beliefs about pain.	Use pedagogic approaches with proven outcomes e.g. interprofessional, e-learning, short courses. Locate pain education in real clinical practice settings.
	Knowledge, skills, attitudes and beliefs about pain in faculty educators are not always considered.	Challenge attitudes and beliefs. Educate the educators. Identify local pain champions.
OUTCOME	Translating pain education into pain practice is challenging. Health professionals are not always thought to be competent or confident in pain practice on graduation.	Increase the uptake of competency based outcomes and frameworks at both the pre-registration/pre-licensure stage of training, and in continuing professional development.
	There is lack of research that incorporates patients, or focusses on patient outcomes.	Expand methodologies to advance pain education research. Where possible include patients, students, educators in the evaluation of pain education.