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Complete List of Authors:	Ilhan, Emre; Macquarie University Davies, Luke; Macquarie University, Department of Health Sciences; Monash University Pacey, Verity; Macquarie University Faculty of Medicine and Health Sciences Smith, Mitchell; Monash University Munro, Jane; Royal Children's Hospital Melbourne Department of General Medicine Munns, Craig; The University of Queensland Sturgiss, Elizabeth; Monash University - Peninsula Campus Williams, Nicole; The University of Adelaide, Centre for Orthopaedic and Trauma Research; Women's and Children's Hospital Adelaide, Department of Orthopaedic Surgery Tofts, Louise; Macquarie University, Department of Health Sciences Locke, Vance; Edith Cowan University Haines, Terry; Monash University School of Primary and Allied Health Care Brennan, Sue E.; Monash University Maloney, Stephen; Monash University - Peninsula Campus Sarkies, Mitchell N; The University of Sydney, School of Health Sciences Clavisi, Ornella; Musculoskeletal Australia Miles, Dan; Australian Podiatry Association Nissen, Lisa; The University of Queensland, Centre for the Business & Economics of Health Williams, Dr Cylie; Monash University
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The breadth and visibility of children's lower limb chronic musculoskeletal pain: A scoping review.

Emre Ilhan,[1] Luke Davies,[1,2] Verity Pacey,[1,2] Mitchell Smith,[2] *Kids' Leg Pain Steering Committee*: Jane Munro,[3] Craig Munns,[3,4,5] Elizabeth Sturgiss,[2] Nicole Williams,[7] Louise Tofts,[1] Vance Locke,[8] Terry Haines,[2] Sue Brennan,[9] Stephen Maloney,[2] Mitchell Sarkies,[10] Ornella Clavisi,[11] Dan Miles,[12] Lisa Nissen;[2] Cylie M. Williams[2]

1. Department of Health Sciences, Faculty of Medicine, Health and Human Sciences, Macquarie University, Sydney, NSW, Australia
2. School of Primary and Allied Health Care, Monash University, Melbourne, VIC Australia
3. Rheumatology Unit, Royal Children's Hospital, Arthritis and Rheumatology Murdoch Children's Research Institute, Melbourne, VIC, Australia.
4. Faculty of Medicine, The University of Queensland, Brisbane, QLD, Australia.
5. Child Health Research Centre, The University of Queensland, Brisbane, QLD, Australia.
6. Department of Endocrinology and Diabetes, Queensland Children's Hospital, Brisbane, QLD, Australia
7. Adelaide Medical School, Faculty of Health and Medical Sciences, The University of Adelaide, Adelaide, SA, Australia.
8. Western Kids Health, WA, Australia.
9. School of Public Health & Preventive Medicine, Monash University, Melbourne Australia.
10. Sydney School of Health Sciences, Faculty of Medicine and Health, The University of Sydney, Sydney, NSW, Australia.
11. Musculoskeletal Australia, Melbourne, VIC, Australia.
12. Australian Podiatry Association, Melbourne, VIC, Australia.

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Corresponding author: Cylie Williams, e-mail: cylie.williams@monash.edu; address: Monash University, School of Primary and Allied Health Care, 47-49 Moorooduc Hwy, Frankston, VIC, 3199, Australia. Ph: +61(3)99044344

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ABSTRACT

Objective

To identify the types of conditions reported in peer-reviewed literature that result in chronic musculoskeletal lower limb pain in children and adolescents and explore alignment of these conditions with the chronic pain reporting codes indexed in the International Classification of Diseases 11th Revision (ICD-11).

Methods

This scoping review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. Five electronic databases were searched (Medline, EMBASE, PsycINFO, CINAHL, and the Cochrane library) for articles involving children under 18 years and reporting on chronic musculoskeletal pain of the lower limb. We assigned an ICD-11 code to each condition based on details reported in the study. We recorded whether any of the presenting conditions were linked to an ICD-11 chronic pain manifestation code.

Results

From 10,951 records, 384 papers were included. There were 124 unique conditions associated with chronic lower limb pain, the most common being chronic widespread musculoskeletal pain (21 studies) and juvenile idiopathic arthritis (24 studies). Only 11.1% of presenting conditions were linked to an ICD-11 chronic pain manifestation code.

Conclusion

Most presenting conditions associated with chronic pain in the lower limb do not have a chronic pain manifestation code in the new global standard for recording health information. This means, chronic pain associated with common lower limb conditions may remain invisible in global statistics.

Trial registration: The protocol for this scoping review was registered with the Open Science Framework

Strengths and limitations

- We used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews and a registered protocol to guide this review
- The global standard for recording diagnostic health information to classify conditions and chronic pain
- Only studies published in English were included
- One reviewer extracted data due to the breadth of data collected
- No studies had a risk of bias or quality assessment

INTRODUCTION

Chronic pain, defined as pain lasting for more than 3 months, can occur in a median of 18% (range 5-27%) of children and adolescents [1 2]. Children and adolescents face difficulties as a result of chronic pain including reduced participation in daily activities, such as attending school, playing with their peers, and engaging in physical activity [1]. Chronic pain negatively impacts quality of life and increases the risk of psychological disturbances such as anxiety and depression in adulthood [3 4]. The lower limb (foot, ankle, leg, knee, thigh, and hip) is one of the most common sites of chronic musculoskeletal pain in children and adolescents, accounting for almost 40% of all childhood chronic disease pain patterns [1 5]. The onset of chronic lower limb pain in childhood tends to occur before children enter formal schooling [6], but diagnoses vary considerably. It is likely to persist for up to four years following their first episode [7].

Children commonly experience chronic pain for 12 months prior to seeing a professional with additional experience in managing chronic pain such as a pain medicine specialist or allied health professional such as a physiotherapist, psychologist, or occupational therapist [7]. Adequate education, identification, and assessment at early stages in the pain journey is pivotal in minimising any pain chronification risk. This is because children and their families initially present to primary care or community based health professionals such as allied health, well before specialist consultation [8 9]. To enable adequate care from the outset, primary care clinicians and community-based healthcare professionals may benefit from specific evidence-based guidelines to provide optimal and early diagnosis and treatment of chronic pain in children and adolescents prior to engaging with specialist services [10].

Population-level research conducted in Australia shows that children and adolescents' musculoskeletal lower limb presentations to general practice are twice as common as spinal and trunk problems [10]. The authors of the study [10], however, noted that they could not distinguish presentations that were acute or chronic in nature, highlighting the need for a

standardised system to collect such data. Recently, the *International Classification of Diseases* (ICD) framework (https://icd.who.int/en) was revised to include chronic pain as a separate disease category [11 12]. Incorporating chronic pain classifications into the ICD-11 allows capture of health statistics, hence making chronic pain more visible as a public health issue [13]. This is an important goal to address the under-recognition of chronic pain in children and adolescents and improve health outcomes [14]. While the ICD-11 may better highlight the burden of chronic pain in children and adolescents, its usefulness is yet to be explored in the context of chronic musculoskeletal pain in the lower limb of children and adolescents [15].

The primary aim of this scoping review was to identify the breadth and types of conditions reported in peer-reviewed literature that may result in chronic lower limb pain in children and adolescents. The secondary aim was to explore the alignment of these conditions with the new chronic pain reporting codes indexed in the *International Classification of Diseases 11th Revision* (ICD-11). This secondary aim served as an exercise to field test the usefulness of the ICD-11 in capturing cases in which certain health conditions are associated with chronic musculoskeletal pain of the lower limb. Scoping review methodology was chosen to ensure a broad approach guided data capture.

METHODS

This scoping review was conducted in accordance with the Joanna Briggs Institute methodology for scoping reviews [16]. We reported the review in line with Preferred Reporting Items for Systematic Reviews and Meta-Analyses reporting guidelines for scoping reviews (PRISMA – ScR). A protocol for this scoping review was registered on Open Science Framework on 3rd of March 2023 (https://doi.org/10.17605/OSF.IO/2RYV6).

This scoping review was overseen by a steering group of 15 paediatric and methodological experts assembled by the research team. The group comprised 10 paediatric healthcare

professionals who routinely support children who experience chronic musculoskeletal lower limb pain. These included a rheumatologist, endocrinologist, general practitioner, orthopaedic surgeon, paediatrician, psychologist, pharmacist, two physiotherapists/clinical researchers, and a podiatrist/clinical researcher. We also were supported by three methodology experts, and two consumer representatives with an interest in chronic lower limb pain in children and adolescents. The role of the steering group was to provide input into the search strategy and resolve disagreements in the categorisation of conditions according to the ICD-11. This steering group also established which conditions included in this review were musculoskeletal in nature which aligned with the funding directions and aims.

Eligibility criteria

Studies were eligible for inclusion if they were available in English, sampled a paediatric population (< 18 years of age or mean or median population < 18 years of age) and reported on the presence of chronic or persistent musculoskeletal pain in the lower limb. Chronic or persistent musculoskeletal pain was defined as studies describing pain lasting for longer than 3 months that originates in the joints, bones, muscles, tendons, and related soft tissues [17]. For the purposes of this review, the lower limb included the hip, thigh, knee, leg, ankle, and foot, but excluded the pelvis, pubic symphysis, and sacroiliac joints. This review included randomised controlled trials, observational studies, and case reports and series to ensure study conclusions were based on the primary analysis of human data. This eligibility criteria were chosen to ensure only conditions relevant to chronic musculoskeletal pain were included and aligning to the overall research aim of the funder. Therefore, pain that was dermatological or neuropathic/potentially neuropathic in nature were excluded (e.g. chronic regional pain syndrome), work-related pain or articles describing a region of pain without a diagnosis name or term were excluded. Papers that were trial protocols, editorials, opinion pieces, or where no data were presented were excluded. In studies with mixed populations

(e.g., in terms of age, location of pain, mechanisms of pain such as neuropathic pain), only data from participants that met this review's eligibility criteria were included.

Information sources and search strategy

An initial, limited search of PubMed and Google Scholar were conducted to identify any papers on the topic of "chronic lower limb pain", "musculoskeletal pain", and "paediatric pain". To ensure a comprehensive search of the literature, a clinical research librarian assisted in the development of a systematic search strategy for each of the databases. Five electronic databases were then searched, including Medline, EMBASE, PsycINFO, CINAHL, and the Cochrane library using keywords such as "chronic pain", "lower extremity", and "paediatric". The full electronic search strategy for Medline is presented in Table 1, which was adapted for the each of the included databases. No limitations were placed on publication date or status. The search was conducted from database inception until the 4th of May 2022. Studies meeting the eligibility criteria were uploaded onto EndNote Version X9 (Clarivate Analytics, PA, USA) then exported to Covidence Systematic Review Software (Veritas Health Innovation, Melbourne, Australia) for de-duplication and screening.

Selection of sources of evidence

Two reviewers (CW and VP) independently screened titles and abstracts of papers based on the eligibility criteria. In the event of disagreements, a third reviewer (EI) was consulted to reach consensus. Full texts were screened independently by two of five reviewers (CW, VP, EI, LD, MS). Any concerns regarding the eligibility of a study were resolved by consensus among the authors first, and then by the steering group in cases where the musculoskeletal nature of the conditions reported was unclear. Extensive efforts were made to retrieve full-text records through multiple physical and digital sources including two university libraries and a hospital library. Due to the data capture strategies, and volume of data, we did not use any citation chaining methods.

Data charting process and data items

Data from eligible studies were extracted into a purpose-built spreadsheet in Microsoft Excel. Data items included first author, year of publication, type of study design, the country/countries in which the study was conducted, the age groups researched, duration of pain described in the study, lower limb location of pain, and the specific condition(s) that were reported to be associated with chronic musculoskeletal pain of the lower limb.

Data were extracted by one reviewer. Following extraction, one reviewer (EI, LD, VP, CW, or MS) independently used the *International Classification of Diseases 11th Revision* (ICD-11) (https://icd.who.int/en) to assign a code to each of the conditions presented in the studies. The ICD-11 browser version 2022.02 release (https://icd.who.int/en) was used for coding. All codes were then discussed during a regular meetings between reviewers (EI, LD, VP, CW, MS) to ensure coding consistency and agreement, where several cases or diagnoses were independently coded differently by reviewers and all similar condition codes were checked to ensure correct alignment and decisions. We did not record the number of disagreements in coding. Coding was done to the level at which the paper provided sufficient detail about the condition. Given the scope of this review, we did not contact authors of papers with the necessary missing information. Disagreements were resolved through discussion, and adjudication by a third reviewer or steering group experts if a resolution could not be found. Using the ICD-11, each study was assigned a 'parent' code (a two-digit code) to facilitate hierarchical organisation of the data. In studies which reported more than one condition, multiple codes were assigned to reflect the number of conditions reported. We also recorded cases which had multiple parent codes. Where a presenting condition was aligned with a secondary chronic pain manifestation code, this was also recorded within the spreadsheet. Only codes that reflected the primary condition/s and, if different, the pain conditions, were recorded. For example, *FB82.00: Chondromalacia patellae* is linked to the manifestation code *MG30.31: Chronic secondary musculoskeletal pain associated with structural changes*. Manifestation codes in the ICD-11 refer to the manifestation of the disease (e.g., chronic

pain), not the disease itself. Therefore, all chronic pain manifestation codes refer to chronic secondary pain conditions, not chronic primary pain conditions.

Data synthesis

Data were summarised descriptively using frequencies and percentages to characterise the published literature (e.g., country, study design, sample size, age, and sex of participants). To address the review aims, data were also summarised descriptively to determine types and percentage of conditions associated with chronic lower limb pain in children and adolescents. This was achieved by analysing the ICD-11 parent codes of the relevant conditions, which were then categorised into primary and secondary chronic pain groups, according to the definitions provided by Treede et al. [5] In addition, conditions relating to the same anatomical structure or physiological process were grouped under a single broad heading. For example, joint instability of the hip, patella, ankle was merged and grouped under "joint instability of the lower limb". Finally, the alignment of these conditions with the new chronic pain classification system was explored by determining whether any presenting conditions (where pain was not a result of chronic primary pain) were indexed with a chronic pain manifestation code in the ICD-11.

Patient and public involvement

There were two consumer representatives. One who had lived experience of a child with chronic lower limb pain and supporting families with chronic lower limb pain. The other provided support and education to health professionals who provide services to children who have chronic lower limb pain.

RESULTS

Characteristics of included studies

A total of 10,951 records were identified through the database searches. After duplicates were removed and titles and abstracts screened, 1,330 papers were downloaded for full text

screening, with a final 384 studies (from 387 articles where three reported the same population) included in the review (Figure 1). A common reason for exclusion was that studies did not report on participants with chronic and/or persistent pain.

Of the 384 studies included in this review (Supplementary Table 1), the majority were case reports (n = 212 studies) or retrospective medical record reviews (n = 48) which were published in the 2010's (n = 216/384), conducted in the United States of America (n = 139/384 studies), and sampled adolescents between 11 and 17 years of age (n = 170/384 studies). Of those studies that reported sex (308 studies), studies sampled more females (n = 4,062) than males (n = 2,188) in total. No paper included in this review sampled infants less than a year old (Table 2).

Conditions related to chronic musculoskeletal pain of the lower limb

Discounting duplicate conditions, this review found 124 unique conditions that were associated with chronic musculoskeletal lower limb pain in children and adolescents (Supplementary file 2). The most commonly presented health conditions identified resulting in chronic lower limb pain in children and adolescents were juvenile idiopathic arthritis (n = 24/384 studies), chronic widespread musculoskeletal pain (n = 21/384 studies), spasticity-related musculoskeletal pain in cerebral palsy (n = 19/384 studies), post-surgical pain (n = 13/384 studies), osteoid osteoma (n = 14/384 studies), and post-fracture (n = 14/384 studies) (Table 3).

The most common description of pain was having pain for at least 3 months (n = 135/384 studies) or for longer than a year (n = 109/384 studies). Most commonly, studies reported on pain related to the knee only (n = 104/384 studies), mixed cases of various locations of the lower limb (n = 85 studies), or the hip only (n = 70/384 studies) (Table 3).

Conditions related to chronic musculoskeletal pain of the lower limb based on the ICD-11

All records could be assigned an ICD-11 code. Out of the 27 parent codes available on the ICD-11 classification system (ICD-11 codes: 01-26, V and X), 18 codes were associated with chronic lower limb pain (ICD-11 codes: 1-8, 11-15, 20-23, X) (Table 3). In total, 432 parent codes were assigned to the conditions of participants in the studies (Figure 2). The parent codes that were used most frequently were *15: Diseases of the musculoskeletal system or connective tissue* (n = 165 conditions), *20: Developmental anomalies* (n = 54 conditions), *21: Symptoms, signs, or clinical findings, not elsewhere classified* (n = 43 conditions), *X: Extension codes* (n = 34 conditions), *8: Diseases of the nervous system* (n = 32 conditions), and *22: Injury, poisoning, or certain other consequences of external causes* (n = 24 conditions). Several other parent codes (ICD-11 codes: 6, 7, 11-14, 23) were used for less than 5 conditions.

Alignment of the chronic pain classification with the ICD-11 or condition linked with chronic pain manifestation code

Chronic pain was reported as the presenting condition in 41 conditions in this review and assigned the parent code *21: Symptoms, signs, or clinical findings, not elsewhere classified,* and then the code *MG30: Chronic Pain.* These included the codes *MG30.2: Chronic post-surgical or post-traumatic pain* (n = 13 conditions), *MG30.0: Chronic primary pain* (n = 9 conditions), and *MG30.Y: Other specified chronic pain* (n = 9 conditions).

For cases in which chronic pain was not the presenting condition (n = 389 conditions, i.e., chronic secondary pain), only 43 conditions (11.1% of 389 conditions, or 13.7% of the 124 unique conditions once duplicates were removed) were linked to a chronic pain manifestation code (MG30) (Additional file 2). These 43 conditions included chronic secondary musculoskeletal pain associated with structural changes (n = 19), chronic secondary musculoskeletal pain (n = 9), chronic cancer pain (n = 7), chronic secondary musculoskeletal pain from persistent inflammation (n = 6), and chronic musculoskeletal pain due to disease of the nervous system (n = 2) (see Figure 2).

DISCUSSION

This scoping review identified 124 unique conditions reported in the literature that may be associated with chronic musculoskeletal pain of the lower limb in children and adolescents. Most studies reported chronic pain as a symptom (e.g., chronic secondary musculoskeletal pain from juvenile idiopathic arthritis) rather than a disease in its own right (e.g., chronic primary pain such as chronic widespread musculoskeletal pain). The findings of this review suggest that there is considerable variability in the cause of secondary chronic lower limb pain investigated in the peer reviewed literature [18]. The ICD-11 coding system aligned with the plethora of chronic pain conditions presented. However, only 11.1% of all presenting conditions in the review had a manifestation code linked to chronic pain. This highlights the possibility that the global burden of chronic musculoskeletal pain of the lower limb in children and adolescents may not be adequately captured by the ICD-11 due to the under-utilisation of manifestation codes.

The number of conditions that result in lower limb musculoskeletal chronic pain was extensive. As a result, this breadth will result in diversity in health professionals who may be involved in care. This highlights that health professionals require training specific to paediatric musculoskeletal health conditions that may result in chronic pain[19]. This is currently an international focus[19]. This finding also lends itself to consistency in guidelines that are multi-disciplinary and not just focused on a single health profession. These opportunities are in place for conditions such as Juvenile Idiopathic Arthritis, the most common condition identified. This condition has a number of guidelines on medication management with limited consideration to chronic musculoskeletal lower limb pain [20].

The under-recognition of chronic musculoskeletal pain in children and adolescents [14] may have far-reaching detrimental impacts on children and adolescents [21], families [22], and society [14] including the under -assessment and -management of chronic pain. Making chronic

musculoskeletal pain of the lower limb in children and adolescents visible first requires capturing the burden in order to facilitate the adequate allocation of funding and resources. While the ICD-11 offers a potential solution for health systems to enable the evaluation of the burden, the problem of chronic pain needs to be made more visible by incorporating manifestation codes in all potential conditions that could lead to chronic pain. Because manifestations codes are linked to primary health conditions, ensuring that chronic pain manifestation codes exist for those health conditions that are associated with pain may ensure that health professionals, researchers, and policy makers are able to select these manifestation codes when inputting data. This presents opportunities for future data capture and practice reform.

Limitations of this review arise from the result of the large number of studies included in this review, data from studies were extracted by one reviewer only. We also acknowledge that only English-language papers were included in this review. This may mean that a large number of region-specific conditions resulting in chronic musculoskeletal lower limb pain in children and adolescents were not captured. Lastly, the assignment of ICD-11 codes was based on what was reported in papers included in this review and while we extensively consulted with our steering committee, the reported information may have not covered all the required criteria of the that diagnosis.

Conclusion

Many conditions may be associated with chronic musculoskeletal lower limb pain in children and adolescents as investigated in the peer reviewed literature. While the ICD-11 captures chronic pain classifications related to primary and secondary pain conditions, chronic secondary pain must be made more visible by having the ability to link conditions to chronic pain manifestation codes. This may allow clinicians, researchers, and policy makers to better estimate the burden of chronic musculoskeletal pain of the lower limb in children and

adolescents. Increasing the visibility of chronic musculoskeletal pain in children and adolescents will allow a more equitable distribution of funding and resources for the development of strategies for the appropriate identification of children and adolescents with chronic musculoskeletal lower limb pain.

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Data availability statement

The dataset generated analysed during the current study are available from the corresponding author on reasonable request. An abbreviated version of the data used for analysis in this review is available in the Additional files 1 and 2.

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Figure legends

Figure 1: PRISMA flowchart of records screened and included in the scoping review.

Figure 2: The coding of primary and secondary chronic pain conditions of the lower limb in children and adolescents using the ICD-11 in the peer reviewed literature. N is the number of codes assigned within each category. Parent codes 6 (Mental, behavioural, or neurodevelopmental disorders, n = 1), 14 (Diseases of the skin, n = 1 relating to malformations involving cutaneous blood vessels, Code EF2Z), and 23 (External causes of morbidity and mortality, n = 2) were omitted from this figure for brevity.

Table 1: Full search strategy for Medline

Search	Query
1	Lower Extremity/ or Leg/ or Hip/ or Knee/ or Ankle/ or Foot/
2	(leg* or hip* or knee* or ankle* or foot or feet or lower limb* or lower extremit*).mp.
3	1 or 2
4	Chronic Pain/ or arthralgia/ or musculoskeletal pain/ or nociceptive pain/ or pain, postoperative/ or neuralgia/
5	((persistent or chronic or ongoing or long-term or nociceptive or musculoskeletal or post-operative or joint or neuropathic or nerve) adj3 pain).mp.
6	arthralgia.mp.
7	4 or 5 or 6
8	3 and 7
9	Infant/ or Child/ or Child, Preschool/ or Adolescent/
10	(baby or babies or neonate* or newborn or child* or infant* or toddler* or paediatric* or pediatric* or teen* or adolesc* or pre-pubesc* or prepubesc* or youth* or juvenile).mp.
11	9 or 10
12	8 and 11
13	exp animals/ not humans.sh.

Table 2: Characteristics of included studies

Type of study design	N = 384	%
Case report	212	55.2
Case series	29	7.6
Prospective cohort	32	8.3
Prospective cross-sectional	45	11·7
Longitudinal	8	2.1
Randomised controlled trial	8	2.1
Retrospective medical record review	48	12.5
Review	2	0.5
Country of data collection		
Australia	11	2.9
Canada	8	2.1
China	8	2.1
Denmark	10	2.6
France	9	2.3
Germany	12	3.1
Greece	5	1.3
India	19	4.9
Italy	16	4.2
Japan	15	3.9
Korea	6	1.6
Spain	8	2.1
Turkey	20	5.2
United Kingdom	19	4.9
United States of America	139	36.2
*Other**	79	20.6
Decade of publication		
1980's	2	0.5
1990's	27	7.0
2000's	76	19.8
2010's	216	56.3
2020-2022	63	16.4
Age groups[1]		
Infancy (0-1 years)	0	0.0
Childhood (2-10 years of age)	72	18.8
Adolescence (11-17 years)	170	44.3
Mixed age groups (0-17 years)	141	36.7
Sex		
Males (total N)	2,188	35.0
Females (total N)	4,062	65.0
Studies in which sex was not reported	76	-

* Austria (1), Belgium (1), Bolivia (1), Bosnia (1), Brazil (1), Bulgaria (1), Croatia (2), Czech Republic (1), Egypt (1), Finland (4), Hong Kong (1), Hungary (2), Indonesia (1), Iran (2), Ireland (2), Israel (2), Kenya (1), Lebanon (1), Libya (1), Macedonia (1), Malaysia (4), Mexico (1), Nepal (1), Netherlands (5), New Zealand (1), Nigeria (2), Norway (4), Oman (1), Pakistan (3), Poland (3), Portugal (3), Qatar (2), Saudi Arabia (2), South Africa (2), Sri Lanka (1), Sweden (4), Switzerland (3), Taiwan (3), Thailand (4), Ukraine (2)

[1] Based on the *American Academy of Pediatrics*; Adolescence is divided into 3 groups according to this classification but was collapsed into one category for the purposes of this review (>10 years of age). Late adolescence, being 18-21 years of age, was excluded from this study.

Table 3: Chronic musculoskeletal pain of the lower limb

	N = 384 studies	%
Most common conditions reported		
Juvenile idiopathic arthritis	24	6.3
Chronic widespread musculoskeletal pain	21	5.5
Spasticity-related musculoskeletal pain from cerebral palsy	19	4.9
Osteoid osteoma	14	3.6
Fracture	14	3.6
Post-surgical pain	13	3.4
ICD-11 Parent codes	N = 432 cases	
1: Certain infectious or parasitic diseases	10	2.3
2: Neoplasms	19	4.4
3: Diseases of the blood or blood-forming organs	10	2.3
4: Diseases of the immune system	18	4.2
5: Endocrine, nutritional, or metabolic diseases	13	3.0
6: Mental, behavioural, or neurodevelopmental disorders	1	0.2
7: Sleep-wake disorders	1	0.2
8: Diseases of the nervous system	32	7.4
11: Diseases of the circulatory system	1	0.2
12: Diseases of the respiratory system	2	0.5
13: Diseases of the digestive system	2	0.5
14: Diseases of the skin[a]	1	0.2
15: Diseases of the musculoskeletal system or connective tissue	165	38.2
20: Developmental anomalies	54	12.5
21: Symptoms, signs, or clinical findings, not elsewhere classified	43	10.0
22: Injury, poisoning, or certain other consequences of external causes	24	5.6
23: External causes of morbidity and mortality	2	0.5
X: Extension codes	34	7.9
Presence of a chronic pain manifestation code in cases where chronic was not the primary condition	43/389 cases	11.1
Duration of pain	N = 384 studies	%
Pain at least ≥3 months	135	35.2
Pain at least ≥6 months	61	15.9
Pain at least ≥12 months	109	28.4
Chronic, but not specified	79	20.6
Location of pain	N = 384	
Hip	70	18.2
Thigh/groin	7	1.8
Knee	104	27.1
Lower leg	7	1.8
Ankle	42	10.9
Foot	29	7.6
Widespread lower limb	40	10.4
Mixed cases	85	22.1

[a]This referred to one case related to “malformations involving cutaneous blood vessels” (Code EF2Z).

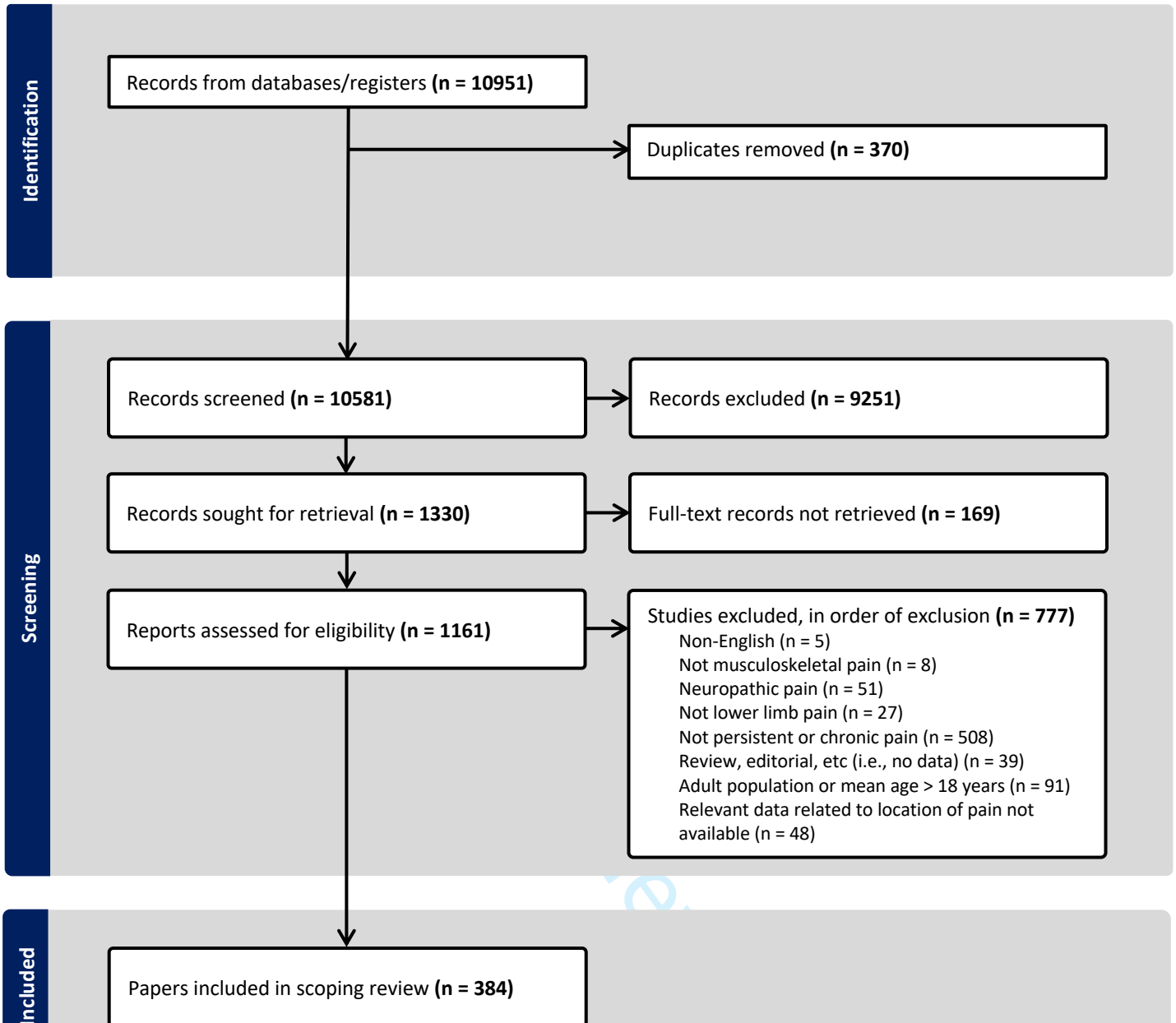

Figure 1: PRISMA flowchart of records screened and included in the scoping review.

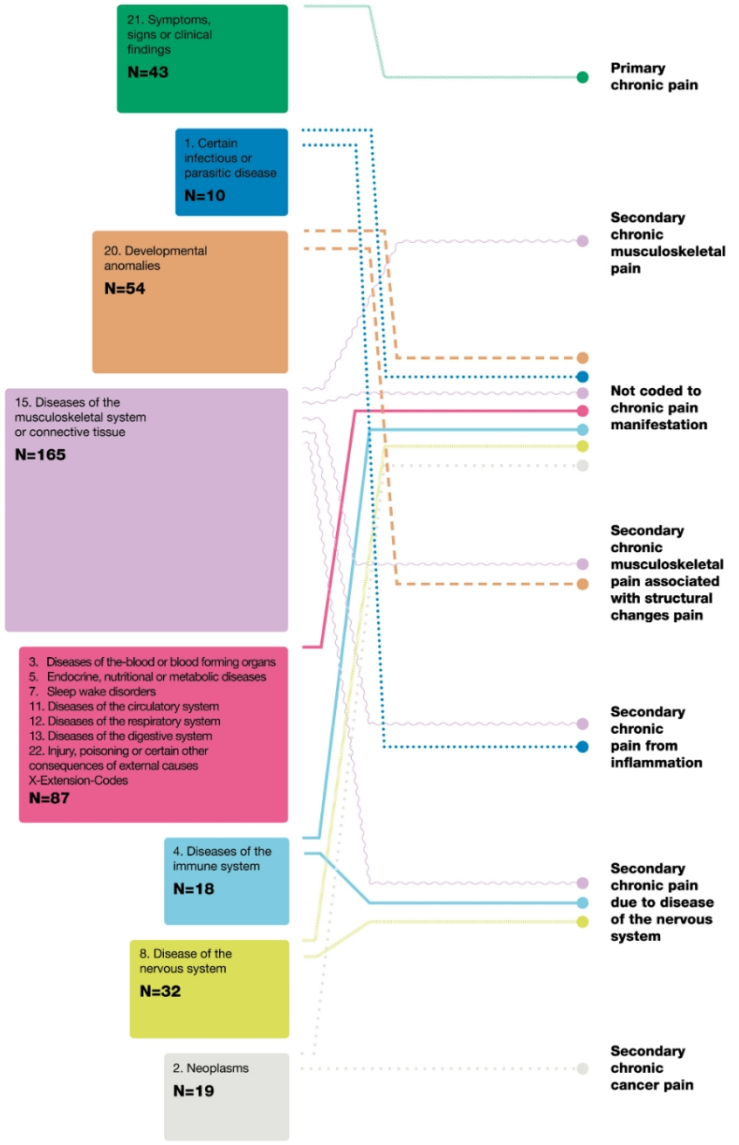

Figure 2. The coding of primary and secondary chronic pain conditions of the lower limb in children and adolescents using the ICD-11 in the peer reviewed literature. N is the number of codes assigned within each category. Parent codes 6 (Mental, behavioural, or neurodevelopmental disorders, n = 1), 14 (Diseases of the skin, n = 1 relating to malformations involving cutaneous blood vessels, Code EF2Z), and 23 (External causes of morbidity and mortality, n = 2) were omitted from this figure for brevity.

159x256mm (144 x 144 DPI)

S1 Table: Expanded characteristics of studies included in the review

First author	Country	Study type	Definition and average length of chronic pain	Included sample size*	Age (measure of central tendency, range, and measure of variance (SD)	Sex	Primary condition described as resulting in chronic lower limb pain	Location(s) of pain in the lower limb
Abdullah (1)	Malaysia	Case report	Pain (>2 years)	1	17 years	Male	Pachydermoperiostosis	Knee, Ankle
Abe (2)	Japan	Case report	Chronic (3months or longer)	1	14 years	Female	al navicular stress fracture	Foot
Abiodun (3)	Ukraine	Cross-sectional	Chronic (3 years)	84	2-18 years	51 Female 33 Male	venile idiopathic arthritis	Hip, Knee, Ankle
Abousamra (4)	USA	Cross-sectional	Chronic (at least 1-year post op)	13	3-15 years	6 Female 4 Male	Hip instability	Hip
Abramowicz (5)	USA	Cross-sectional retrospective	Average 4.6 years	65	Mean 11.7 (SD 3.8)	48 Female 17 Male	emic Arthritis (, psoriatic arthritis, enthesitis)	Knee, Ankle
Abushhaiwia (6)	Libya	Abstract (case report)	Chronic pain >3 years	1	14 years	Male	ronic recurrent multifocal osteomyelitis	Leg
Accadbled (7)	France	Case report	Pain >2 years	1	13 years	Male	- surgical Subtotal lateral meniscectomy	Knee
Adba (8)	Qatar	Case report	Chronic Pain (>1 year)	2	3 and 6	Male	venile idiopathic arthritis	Knee
Adiguzel (9)	Turkey	Case report	8 months	1	14 years	Female	Traumatic brain injury (heterotrophic ossification associated)	Knee
Agarwal (10)	India	Case report	Pain 4 months	1	15 years	Male	venile-onset ankylosing spondylitis	Hip
Agrawal (11)	India	Case report	Pain (>6 months)	1	13 years	Male	Pachydermoperiostosis	Hip/knee/Large joints
Aiyer (12)	India	Case report	Pain for 3 months	1	14 years	Female	Dysplasia / Tuberculous infection	Hip
Alkadumi (13)	USA	Case report	Pain >12months	1	16 years	Male	Chondroblastoma	Knee
Allessandrella (14)	Spain	Case report	Chronic (5 years)	1	17 years	Male	Pachydermoperiostosis (genetic)	Knee, Ankle
Alpigiana (15)	Italy	Case report	Chronic (>1 year)	1	15 years	Male	venile idiopathic arthritis	Hip
Alqanatish (16)	Saudi Arabia	Case report	Chronic pain (>3 months)	1	12 years	Male	Scurvy	Lower limb
Anderson (17)	Switzerland	Case series	Chronic (Undefined)	4*	Mean 16.3 years	4 Female	Pseudotumor	Ankle
Andias (18)	Portugal	Cross-sectional	Chronic (3months or longer)	1249*	Mean 16.4 years	819 Female	Musculoskeletal pain	Lower Limb/multiregional
Anghelescu (19)	USA	Retrospective review	Pain (>6 months)	129*	Mean 14 years (range 6-21)	63 Female	Post surgical pain	Thigh, shin
Arici (20)	Turkey	Case report	Chronic (3 months or longer)	1	11 years	Female	ronic recurrent multifocal osteomyelitis	Legs
Assafiri (21)	USA	Case report	Pain (>3 months)	1	13 years	Male	Osteoid osteoma	Ankle
Auvinen (22)	Finland	Cohort (two year follow up)	Pain in last 6 months	86*	15-18 years	43 Female 43 Male	Musculoskeletal pain	Knee, Ankle
Awan (23)	USA	Case report	Chronic (6 months)	1	17 years	Male	uboid-navicular coalition	Foot
Azabagic (24)	Bosnia	Longitudinal study	Chronic pain (>1 year)	310	Mean 11.3 years (range 7-14)	NR	Musculoskeletal pain	Knee, Ankle
Baghdadi (25)	Iran	Retrospective medical record review	Chronic pain (>1 year)	13	1-18 years of age	7 Female 6 Male	Septic Arthritis	Hip
Baima (26)	USA	Case report	Chronic pain (>3 months)	1	6 years	Male	Prosthesis-related pain (post chopart amp)	Knee, Ankle
Bakkaloglu (27)	Turkey	Case report	Persistent pain 8 months	1	8 years	Female	Familial Mediterranean fever arthritis	Knee

Banskota (28)	Nepal	Retrospective case series	Pain (>12 months)	30	Mean 8.5 years (range 2-16)	9 Female 21 Male	Traumatic hip dislocation	Hip
Barfield (29)	USA	Case report	Chronic pain (no time frame mentioned)	1	17 years	Female	Celiac disease	Achillies tendon/bilateral thigh and calf
Bari (30)	Pakistan	Case report	Pain (condition gradually worsened over a few months)	1	4 years	Female	Scurvy	Lower limbs
Barut (31)	Turkey	Cross-sectional observational	Chronic	168	16 years (IQR 9)	87 Female 81 Male	Juvenile idiopathic arthritis	Hip, Knee, Ankle, Foot
Bauer (32)	France	Case series	Chronic pain (15 months)	1*	16 years	Male	Impingement from bimalleolar fracture	Ankle
Baydogan (2012, 2015) (33, 34)	Turkey	RCT	Chronic pain (no definition provided)	30	9.3 (1.4) years 6-18 years	21 Female 9 Male	Juvenile idiopathic arthritis	Knee
Bazette-Jones (35)	USA	Cross sectional survey	Pain frequency (ranges from daily to rarely)	437*	10-18 years	NR	Musculoskeletal pain	Hip, Knee, Ankle
Behzadi (36)	Norway	Case report	> 2 years	1	14	Female	Femoroacetabular impingement	Hip
Belke (37)	Germany	Case report	Chronic (at least 3 months)	1	12 years	Male	Rhabdomyolysis (diabetic ketoacidosis)	Lower leg, Foot
Benaroch (38)	USA	Case series	> 6 years	7*	15.5 years	Male	Post operative pain	Knee
BenEliyahu (39)	USA	Case report	Chronic (Undefined)	1	17 years	Female	Exertional compartment syndrome	Calf
Berend (40)	USA	Case series	Chronic pain (>3 months)	8	14.9 years	NR	Legg-calve-perthes-disease	Hip
Bettin (41)	Germany	Case report	Persistent pain	1	12 years	Male	Femoral neck stress fracture	Hip
Bica (42)	Brazil	Case report	Chronic pain (>1 year)	1	10 years	Male	Osteochondrosis	Knee
Biddeci (43)	Italy	Cross-sectional observational	Persistent pain (Undefined)	19*	10+ years (all paediatric)	10 Female 9 Male	Avascular osteonecrosis secondary to treatment for acute lymphoblastic leukaemia	Hip, Knee, Ankle
Blackman (44)	USA	Retrospective case series	Persistent pain (Undefined)	71	Mean 15.5 years (range 11.7-19.8)	66 Female 5 Male	Medial patellofemoral ligament	Knee
Blatnik (45)	USA	Case report	Persistent pain (Undefined)	1	12 years	Female	Bilateral distal femur salter-harris type 1 fracture / persistent osgood-schlatter disease	Knee
Bloch (46)	USA	Case report	Chronic (Undefined)	1	2 years	Male	Recurrent cervical lymphadenopathy	Bilateral leg
Bonfiglio (47)	USA	Case report	Chronic pain	1	13 years	Female	Hematogenic bone abscess / osteomyelitis (brodies abscess)	Ankle
Boulter (48)	Australia	Retrospective medical review	Chronic pain (>3 months)	26	3-17 years	14 Female 12 Male	Cystic fibrosis, reactive arthropathy, widespread musculoskeletal pain, chondromalacia patellae osteochondrosis, osteonecrosis, osteochondritis dissecans	Lower limb
Bout-tabaku (49)	Qatar	Prospective cohort	Chronic pain	219	Mean 17 years (SD 1.6 years)	167 Female 52 Male	Musculoskeletal pain	Hip, Knee, Ankle, Feet
Boyer (50)	USA	Retrospective cohort	Chronic (at least 9 months)	86	10 years (range 4-17 years)	41 Female 45 Male	Cerebral palsy (post operative)	Hip, Knee, Ankle, Feet
Brix (51)	Denmark	Retrospective cohort	Chronic pain (Undefined)	53*	3-10 years of age	30 Female 23 Male	Acute lymphoblastic leukaemia	Hip, Knee, Ankle

Broström (52)	Sweden	Cross-sectional observational study	Chronic pain (>1 year)	18	Mean 10 years (SD 3.1)	15 Female 3 Male	Juvenile idiopathic arthritis	Hip, Knee, Ankle
Bueso (53)	USA	Case report	Chronic pain (>6 months)	1	7 years	Male	Juvenile idiopathic arthritis	Knee
Buoncristiani (54)	USA	Case series	Chronic pain	8	3-10 years	3 Female 2 Male	Injury to tarsometatarsal joint	Foot
Burgos-Vargas (55)	Mexico	Secondary analysis of RCT	Chronic pain (mean 4.2 years)	33	11 years	6 Female 27 Male	Enthesopathy due to spondyloarthropathy	Hip, Knee, Ankle
Busconia (56)	USA	Case report	Chronic pain (Undefined)	10*	13 years (range 10-17)	6 Female 4 Male	Chronic ankle instability	Ankle
Caldonazzi (57)	Italy	Cross-sectional observational study	Persistent pan (Undefined)	7	Mean 11 years	6 Female 1 Male	Vitamin D deficiency	Foot
Cappuccio (58)	Italy	Case report	Chronic pain	1	10 years	Female	PLA2GA-related disorder (genetic)	Lower limb
Castle (59)	Australia	Phenomenological study	Chronic pain (>3months)	4*	Mean 17.6 years	4 Male	Cerebral palsy	Hip
Catli (60)	Turkey	Case report	Pain for 6 months	1	8 years	Female	Osteopetrosis tarda	Ankle
Ceglie (61)	Italy	Case report	Chronic pain (>7 months)	1*	4.5 years	Male	Scurvy	Leg
Ceroni (62)	Switzerland	Case report	Chronic pain (Undefined)	1	13 years	Female	Accessory ossicle of foot	Ankle
Champion (63)	Australia	Cross-sectional questionnaire	Chronic (3 months or longer)	104*	3-18 years	NR	Restless leg syndrome	Leg
Chang (64)	Taiwan	Case report	Persistent pain (>2 months)	1	14 years	Male	Juvenile idiopathic arthritis	Hip
Chaturvedi (65)	India	Retrospective medical record review	Chronic pain (Undefined)	17*	4-14 years	14 Female 5 Male (whole sample)	Arthritis due to bancroftian filariasis (Filarial arthritis)	Knee, Ankle
Chollet (66)	USA	Prospective cohort	Chronic pain (Undefined)	10*	2-14 years	NR	Osteonecrosis due to chemotherapy for ALL or non-hodgkins lymphoma	Ankle
Chua (67)	Malaysia	Case report	Chronic pain (>3 months)	1	7 years	Female	Melorheostosis (Mesenchymal dysplasia)	Hip, Knee
Cibulka (68)	USA	Case report	Chronic pain (>8 months)	1	15 years	Female	Cellofemoral pain syndrome	Knee
Cilliers (69)	South Africa	Case series	Chronic pain (since infancy)	NR	NR	NR	Walkes familial hip dysplasia (autosomal dominant condition)	Hip
Cirakli (70)	Turkey	Cross-sectional observational	Chronic (> 12 months)	16*	Mean 11 years (2-17 years)	NR	Brucellosis	Leg
Clohisy (71)	USA	Prospective cohort	Persistent pain (Undefined)	NR	17.6 years (range 13-31.8)	NR	Acetabular dysplasia	Hip
Colgan (72)	Ireland	Case report	Persistent pain (>3 months)	1	14 years	Male	Slipped upper femoral epiphysis	Knee
Constantinou (73)	Australia	Case report	Chronic pain (>3 months)	1	16 years	Male	Non-union distal fibula avulsion fracture	Ankle
Corominas (74)	Spain	Case report	Pain (18 months)	1	14 years	Male	Osteochondritis dissecans	Foot
Craig (75)	USA	Case report	Chronic pain (Undefined)	1	9 years	Male	Activated phosphoinositide 3-kinase (PI3K) delta syndrome	Hip
Crosby (76)	USA	Retrospective review	Pain (>12 months)	4*	Mean 12.9 years (range 8-17)	NR	Femoral shaft fracture	Hip

Curtin 2005 (77)	Ireland	Case report	Pain (18 months)	1	12 years	Male	Osteochondritis of medial lallucial sesamoid	Foot
Curtin 2010 (78)	USA	Case report	Pain (3 months)	1	16 years	Male	Bucket handle medial plica	Knee
Dagher (79)	Lebanon	Case report	Chronic (>1 year)	1	5 years	Female	Juvenile idiopathic arthritis	Knee, Ankle
Dartnell (80)	UK	Review	Persistent pain (Undefined)	4*	Mean 14.7 years	NR	Hip dislocation or subluxation in cerebral palsy	Hip
Das (81)	India	Cross-sectional observational	Chronic pain (Follow up 1.6-3 years)	14	11-16 years	3 Female 11 Male	Post operative cerebral palsy	Knee
de Rooy (82)	Netherlands	Case report	Chronic pain (6 months)	14	14 years	Female	Growth arrest at secondary growth plate	Knee
Deere (83)	UK	Longitudinal study	Pain (>3 months)	845	Mean 17.8 years	550 Female 295 Male	Musculoskeletal pain	Hip, Thigh, Knee, Ankle, Foot
Demir (84)	Turkey	Case series	Pain 2 years	3	<18 years	NR	Takayasu arteritis	Knee
Demir (85)	Turkey	Case report	Chronic (undefined)	1	11 years	Female	Juvenile idiopathic arthritis	Ankle
Den Hoed (86)	Netherlands	Prospective evaluation	Persistent pain (Undefined)	30*	> 4 years osteonecrosis subgroup (range 4-18 years)	16 Female 14 Male	Osteonecrosis	Hip, Knee, Ankle
Deniz (87)	Turkey	Case report	Pain 6 months	1	10 years	Female	Iselins disease	5th metatarsal
DePhillipo (88)	USA	Case report	Persistent pain (Undefined)	1	11 years	Male	Osteochondral defect	Knee
Derfalvi 2022/2014 (89, 90)	Hungary	Cross-sectional observational	Persistent pain (Undefined)	82	Mean 13.7 years (SD 3.2)	37 Female 45 Male	Crohn's disease	Hip, Knee, Ankle
DiCaprio (91)	USA	Case report	Persistent pain (>4 months)	1	14 years	Female	Osteosarcoma	Knee
Dimitrovska (92)	Macedonia	Case series	Chronic	49	3-14 years	23 Female 26 Male	Brucellosis	Big joints of lower limb
Doyle (93)	USA	Case series	Pain (>4 months)	3	2.5 years, 14 years, 8 years	3 Female	Talonavicular coalition	Foot
Duan (94)	China	Case report	>2 year history of pain	1	11 years	Female	Talonavicular coalition	Foot
Duckers (95)	Germany	Case report	Chronic pain (8 years)	1	11 years	Female	Purpura schoenlein hennoch	Ankle
Ece (96)	Turkey	Follow up	Chronic pain (Undefined)	111*	Mean 10 years (Range 1.5-18 years)	NR	Juvenile idiopathic arthritis	Hip, Knee, Ankle, Foot
Eichenbaum (97)	USA	Case report	Pain (>12 months)	2	14 years 16 years	2 Male	Talus partitus	Ankle
Eisenstein (98)	USA	Case report	Chronic pain (6 months)	1*	12 years	Female	Chronic recurrent multifocal osteomyelitis	Hip, Ankle, Foot
Ekinci (99)	Turkey	Case report	Chronic pain (3months or longer)	1	13 years	Female	Multifocal AVN (neuropsychiatric SLE)	Knee
Eliasberg (100)	USA	Case report	Persistent pain (Undefined)	1	17 years	Male	Meniscal ossicle	Knee
Emad (101)	Saudi Arabia	Case study	Chronic pain (3 years)	1	12 years	Male	Lipsynovitis prepatellaris (Hoffa's syndrome)	Knee
Encinas (102)	Bolivia	Case report	Pain (15 months)	1	12 years	Female	Bechet's disease	Knee
Endo (103)	Japan	Case report	Chronic pain (12 months)	1	16 years	Female	Chondroblastoma	Knee
Eng (104)	USA	RCT	Pain (> 6months)	20	13-17 years	20 Female	Patellofemoral pain syndrome	Knee
Engel (105)	USA	Cross-section observational	Chronic (>3 months)	23*	8-20 years	NR	Neuromuscular disease (e.g., DMD)	Leg, Feet

Ergen (106)	Turkey	Case report	Pain (5 months)	1	13 years	Male	Seruse injury – triradiate cartilage	Hip
Farsetti (107)	Italy	Case report	Chronic pain (>3 months)	1	11 years	Female	Osteochondrosis	Ankle
Fellas (108)	Australia	RCT	Chronic pain (>3 months)	66	Mean 12 years	45 Female 21 Male	Juvenile idiopathic arthritis	Foot
Ferguson (109)	Canada	Case report	Chronic pain (>3 months)	1	13 years	Female	Chronic recurrent multifocal osteomyelitis	Ankle
Ferrada (110)	USA	Cross-sectional Survey	Persistent pain (Undefined)	NR	Mean 14.6 years	NR	Relapsing polychondritis	Knee, Ankle
Ford (111)	USA	Case report	Chronic pain (2 years)	1	9 years	Female	Autoimmune polyendocrinopathy candidiasis ectodermal dystrophy	Knee, Ankle
Ford (112)	USA	Case report	Chronic pain (Undefined)	1	16 years	Female	Patellar sleeve fracture	Knee
Foxen-craft (113)	USA	Cross-sectional survey	Chronic pain (>6 months)	21	Mean 14.3 years	NR	Musculoskeletal pain	Hip, Knee, Ankle
Fuglkjaer (114)	Denmark	Prospective longitudinal study	Chronic pain (>12 weeks)	NR	8-17 years	NR	Musculoskeletal pain (traumatic/non traumatic)	Thigh, Knee, Lower leg, Ankle, Foot
Funk (115)	USA	Case report	Chronic pain (Undefined)	1	12 years	Male	Type 3 von willebrand disease	Ankle
Gallagher (116)	USA	Case report	Chronic pain (>4 months)	1	3 years	Female	Avoidant restrictive intake disorder	Hip, Knee
Gamble (117)	USA	Cross-sectional	Chronic pain (Undefined)	77	0-19 years	48 Female 28 Male	Pseudoachondroplasia	Hip, Knee
Garg (118)	UK	Case report	Pain (>7 months)	1	15 years	Female	Primary diaphyseal tuberculosis	Leg
Geiduschek (119)	USA	Cross-sectional observational study	Persistent pain (Undefined)	55	3-22 years (Median 5 years)	20 Female 25 Male	Spasticity related to cerebral palsy	Lower extremity
Gemulla (120)	Germany	Case series	Pain (5 months)	1*	15 months	Female	Norovirus or influenza virus	Ankle
George 2019 (121)	India	Case report	Pain (> 12 months)	1	15 years	Male	Slipped capital femoral epiphysis in hyperparathyroidism	Hip
George 2008 (122)	UK	Case report	Persistent pain (undefined)	2	14-16 years (Mean age 15 years)	1 Female 1 Male	Benign lesion of proximal femur	Femur
Georgoulis (123)	Greece	Case series	Persistent pain (Undefined)	NR	13-24 years of age (mean 18 years)	NR	Osteoid osteoma	Knee
Gerberg (124)	USA	Case report	Chronic pain	1	8 years	Male	Legg-calve-perthes disease	Hip
Gerbino (125)	USA	Cross-sectional observational	Chronic pain (3 months)	NR	Mean age 16.9 years	NR	Patellofemoral pain syndrome	Knee
Gibbons (126)	Canada	Case series	Chronic pain (unspecified)	1*	NR	NR	Chronic ankle pain following lateral ankle sprain	Ankle
Glard (127)	France	Retrospective review	Pain (>10 months)	4	11-17 years	4 Female 1 Male	Os trigonum	Ankle
Gokhale (128)	UK	Case report	Pain (>7 months duration)	1	9 years	Female	Ganglion	Hip/groin
Goraya (129)	India	Case report	Chronic pain (3 months or >)	1	9 years	Female	Arteriovenous malformation of the knee	Knee
Gottesman (130)	USA	Case report	Chronic pain (Undefined)	1	16 years	Female	Spondyloepimetaphyseal dysplasia	Knee
Greenberg (131)	USA	Case report	Chronic Pain (>3 months)	1	15 years	Male	Fibular stress fracture	Lower leg
Gupta (132)	India	Cohort study	Pain (>12 months)	1*	Mean 12.6 years	NR	Protusio acetabulae / septic arthritis	Hip
Gutierrez (133)	Spain	Retrospective medical record review	Chronic pain (>2 years)	22*	Mean 9.4 years (SD 0.3)	NR	Flat foot	Foot

Hanna (134)	UK	Case series	Pain (12 months)	2	13 years 17 years	Male	condylar osteochondritis dissecans	Knee
Haelewijn (135)	Belgium	Case report	Pain (> 6 months)	1	14 years	Male	Haemophilic A	Foot
Hashkes (136)	USA	Cross-sectional observational	Chronic pain (mean 1.4 years)	11	4-15 years	3 Female 8 Male	Growing pains	Lower leg (shin, calf)
Hayat (137)	UK	Case report	Pain (>12 months)	1	16 years	Male	Ohiofemoral impingement	Groin
Hayyun (138)	Malaysia	Case report	Persistent pain (>5 months)	1	10 years	Male	moral neck stress fracture	Hip
Heinemann (139)	Germany	Longitudinal	Chronic pain (>3 months)	10	<15 at age of diagnosis	NR	Ewing sarcoma	Lower limb
Heinen (140)	Germany	Prospective cohort	Chronic pain (Undefined)	278*	2-17 years		ral palsy (spasticity related pain)	Hip, Knee, Ankle, Foot
Helenius (141)	Finland	Case series	Chronic pain (undefined)	28*	15.7 years (Range 3.7 - 32.8 years)	NR	vascular bone necrosis, d capital femoral epiphysis, ochondritis dissecans of the edial femoral condyle, coarthritis, meniscal tear,	Hip
Hensley (142)	USA	Case report	Chronic pain (>6 months)	1	15 years	Male	N ular fracture (non-displaced)	Foot
Hetsroni (143)	USA	Retrospective office chat review	Chronic pain (>3 months, >1 year)	6	Range 14-18 years	5 Female 1 Male	M meniscocapsular separation	Knee
Hevesi (144)	USA	Retrospective geographic database review	Persistent pain (Undefined)	4*	Mean 12.5 years	NR	steochondritis dissecans	Knee
Higuchi 2016 (145)	Japan	Case report	Persistent pian (>5 months)	1	14 years	Female	l neurofibromatosis type 1	Hip, Leg
Higuchi 2019 (146)	Japan	Case report	Persistent pain (3 months)	1	14 years	Male	Osteoid osteoma	Knee
Ho (147)	USA	Case report	Pain (>8 years)	1	15 years	Male	Skeletal dysplasia and open physes	Knee
Holden (148)	Denmark	Prospective longitudinal	Persistent pain (Mean 24 months)	220*	Median 17 years	NR	Musculoskeletal pain	Knee
Holm (149)	Norway	Cohort	Pain (2.5 years)	21*	Mean 11.7 (range 5.5-22.4)	NR	Hip Dysplasia	Hip
Holzheimer (150)	Germany	Case report	Chronic pain (Undefined)	1	10 years	Female	Inguinal hernia	Groin
Hori (151)	Japan	Case series	Chronic pain (>4 years)	1*	10 years	Female	-adipose vascular anomaly	Thigh
Hosny (152)	Egypt	Cohort	Consistent pain (Undefined)	3*	8-14 years	NR	egg-calve-perthes disease	Hip
Houx (153)	France	Cross-sectional observational	Chronic pain	33*	NR	NR	opyrin-associated periodic syndrome	Lower limb
Howe (154)	USA	Case report	Chronic pain (>3 months)	1	9 years	Female	Discoid lateral meniscus	Knee
Huppertz (155)	Germany	Cross-sectional	Chronic (3 months or >)	2	Median 11 years (Range 3-16 years)	NR	Lyme arthritis	Hip, Knee, Ankle
Huynh (156)	USA	Case series	Pain (4 month and 2-year history)	2	3 years 4 years	2 Male	Tenosynovitis, Juvenile idiopathic arthritis	Lower limb, Knees, Ankle
Ifedic (157)	USA	Case report	Chronic pain (at least 3 months)	1	11 years	Male	Chronic recurrent multifocal osteomyelitis	Knee

Iliev (158)	Bulgaria	Case report	Pain (several months)	1	18 years	Male	Os subtibiale	Ankle
Ismail (159)	USA	Case report	Chronic pain (>2 years)	1	14 years	Female	Osteochondroma	Ankle
Issever (160)	Germany	Case report	Chronic pain (>1 year)	1	10 years	Female	Accessory navicular bone	Ankle, Foot
Iwaasa (161)	Japan	Case report	Persistent pain (>6 months)	1	16 years	Female	Plica syndrome	Knee
Jain (162)	India	Case report	Pain (6 months)	1	13 years	Female	Primary sjogrens syndrome with distal renal tubular acidosis and metabolic disease	Hip, Knee
James 2017 (163)	USA	Case report	Pain (7 years)	1	11 years	Female	Recurrent ankle sprain	Ankle
James 2015 (164)	Australia	Cross-sectional	Paim (mean10 months)	124	Mean 10.8 years	52 Female 72 Male	Calcaneal apophysitis	Heel
Jasiexicz (165)	Poland	Retrospective medical record review	Persistent pain (5.6 years)	1*	Mean 14 years (range 9-22 years)	NR	Accessory navicular bone	Foot
Jiang (166)	China	Care report	Persistent pain (Undefined)	1	16 years	Female	Hoffa's fracture	Knee
Jimenez (167)	USA	Prospective cohort	Chronic pain (>2 years)	39*	Mean 16 years	35 Female 4 Male	Femoroacetabular impingement	Hip
Johnson (168)	USA	Retrospective medical record review	Chronic pain (>7 months)	7*	Mean 12 years (Range 2-23)	2 Female 5 Male	Klippel-trenaunay syndrome (vascular malformation)	Knee
Kalra (169)	UK	Case report	Chronic pain (5 years)	1	9 years	Female	Recurrent rhabdomyolysis	Calves
Kamal (170)	Indonesia	Case report	Persistent pain (>2 years)	1	10 years	Female	Osteofibrous dysplasia	Tibia
Kaplan (171)	USA	Case report	Chronic pain (Undefined)	1	16 years	Female	Chondrolysis	Hip
Karadag (172)	Turkey	Case report	Pain (>3 months)	1*	3 years	Female	Hyperimmunoglobulin D syndrome	Leg
Kaser (173)	USA	Case report	Chronic pain (>3 months)	1	11 years	Female	Chondroblastoma	Knee
Kaspiris (174)	Greece	Retrospective	Chronic pain (Undefined)	130*	Mean 8.6 years (SD 2.5)	69 Female 63 Male	Growing pain	Leg
Kawaji (175)	Japan	Case report	Chronic pain (>3 months)	1*	16 years	Female	Autosomal dominant precocious osteoarthropathy	Hip
Kawakami (176)	Japan	Case report	Chronic pain (>2 years)	1	9 years	Male	Extraskeletal para-articularosteochondroma	Ankle
Kaymaz (177)	Turkey	Case report	Pain (3 months)	1	16 years	Male	Patella chondroma	knee
Keeratisiroj (178)	Thailand	Cross-sectional observational	Pain (7days, 12 months)	270*	Range 10-19 years	NR	Musculoskeletal pain	Hip, Knee, Ankle
Kehoe (179)	USA	Case series	Chronic pain (>11 months)	1*	11 years	Male	Sustentaculum tali fracture adjacent to talocalcaneal tarsal coalition Kempert	Foot
Kempert (180)	USA	Cross-sectional observational	Chronic pain (at least 3 months)	109	8-19 years	73 Female 15 Male	Musculoskeletal pain	Lower limb
Kernbach (181)	USA	Case series	Chronic pain (>16 months)	6	12-17 years	NR	Middle facet talocalcaneal coalition	Ankle
Khan 2014 (182)	UK	Case report	Chronic pain (10 months)	1	14 years	Male	Iliacus haematoma after apophyseal injury	Hip
Khan 2019 (183)	USA	Case report	Chronic pain (several months)	1	11 years	Female	Septic arthritis	Hip

Knaus & Terjesen (184)	Norway	Retrospective medical record review	Chronic pain (>3 months)	4*	Mean 15 years (Range 3-27)	Male	Postoperative proximal femoral resection arthroplasty	Hip
Kramer (185)	USA	Case series	Chronic pain (>3 months)	14	9-18 years	NR	Osteochondritis dissecans	Knee
Kreetapirom (186)	Thailand	Case report	Pain (>3 months)	1	15 years	Male	Hyperthyroidism	Hip
Krishnamoorthy (187)	USA	Case report	Severe pain (2 years)	1	17 years	Female	Primary hyperthyroidism	Knee
Krutzke (188)	Germany	Case report	Chronic pain (>3 months)	1	15 years	Female	COPA syndrome	Knee, Ankle, Foot
Kumar (189)	India	Retrospective study	Pain (9 months)	7	Mean 15 years	NR	Undifferentiated spondyloarthropathy	Hip, Knee, Ankle
Kumar (190)	India	Cross-sectional observational	Chronic pain (>3 months)	94*	5-16 years	NR	Primary chronic musculoskeletal pain	Lower limb
Labotka (191)	USA	Observational	Pain (undefined)	49	Mean 18 years	NR	Sickle cell disease	Leg
Lager (192)	Sweden	Cross-sectional	Chronic (3 months or >)	38*	15 years	NR	Spinal muscular atrophy, duchenne and becker muscular dystrophy	Leg
Lambrechts (193)	USA	Case report	Chronic pain (>12 months)	1	15 years	Male	Heterotopic ossification of rectus femoris post AIIS avulsion fracture	Hip
LaMont (194)	USA	Retrospective chart review	Persistent pain (>12 months)	19	Mean 15 years (range 9.5-17)	5 Female 14 Male	Inverted discoid meniscus segment	Knee
Larson (195)	USA	Cross-sectional	Chronic (>1 year)	28*	Mean 13 years (range 6-17)	NR	Slipped capital femoral epiphysis	Hip, Knee
Lavoie (196)	USA	Case report	Chronic (4 years)	1	11 years	Male	Philadelphia chromosome-positive CML	Leg
Lee 2015 (197)	Korea	Cross-sectional observational	Chronic (6 months)	20	Mean 11 years (SD 2)	8 Female 12 Male	Symptomatic flexible flat foot	Foot
Lee 2015 (198)	Korea	Cross-sectional observational	Chronic (6 months)	20	Mean 9.1 years (SD 2.32)	13 Female 7 Male	Growing pain	Lower limb
Lefkir (199)	Algeria	Case series	Pain (>3 months)	1*	14 years	Female	Juvenile angio-bechet's disease	Knee
Lepore (200)	Canada	Case report	Persistent pain (5 months & >3 years)	2*	9 years 14 years	Female	Polyarticular juvenile arthritis	Groin, Knee
Lequang (201)	USA	Case report	Pain (>3 years)	1	15 years	Female	Factor I type A variant	Knee
Li (202)	China	Case report	Pain (6 months)	1	13 years	Female	Wilson disease	Knee
Liu (203)	Taiwan	Case report	Chronic pain (>4 months)	2	2 months & 2 years	Male	Spinal meningioma	Knee
Logan (204)	USA	Retrospective review	Pain (11 months)	51*	Mean 11 years	NR	Symptomatic discoid meniscus	Knee
Logan (205)	USA	Case report	Pain (>3 years)	1	8 years	Female	Bone length secondary to ABI	Hip
Lolekha (206)	Thailand	Prospective cohort	Chronic pain (>3 months)	4*	Range 4-11 years	NR	Human immunodeficiency virus	Lower limb
Lu (207)	China	Case report	Pain (3 years)	1	9 years of age	Male	Pyogenic arthritis	Knee, Ankle
Luhmann (208)	USA	Retrospective review	Chronic pain (>12 months)	9	Mean 14.6 years (range 10.3-19.9)	1 Female 8 Male	Painful idiopathic rigid flatfoot	Foot
Luthi (209)	Switzerland	Case report	Chronic pain (>3 months)	1	16 years	Male	Complication of oral retinoids	Knee
Lyback (210)	Finland	Cross-sectional observational	Chronic pain (>3 months)	15*	Range 1.5-16 years	NR	Juvenile rheumatoid arthritis	Knee
Macdonald (211)	USA	Case report	Chronic pain (Undefined)	1	7 years	Female	Post fibular fracture	Ankle

Maj (212)	Malaysia	Case report	Chronic pian (>6 months)	1	11 years	Female	rior horn deficient discoid meniscus	Knee
Majumder (213)	India	Case report	Chronic pain (>3 months)	1	5 years	Male	nted villonodular synovitis	Knee
Malec (214)	USA	Case report	Persistent pain (several months)	1	14 years	Female	FVII deficiency	Knee
Mardanpour (215)	Iran	Case report	Pain (4 month history)	1	11 years	Female	alcaneus osteosarcoma	Ankle
Mariani (216)	Italy	Retrospective review	Chronic pain (>1 year)	1*	Mean 15 years	Male	ronic patella instability	Knee
Maru (217)	Japan	Case report	Chronic pain (>3 months)	1	12 years	Female	Chondroblastoma	Hip
Masiero (218)	Italy	Cohort	Persistent pain (>3 months)	2584	Mean 15 years (SD 1.21)	NR	Musculoskeletal pain	Hip, Knee, Ankle
Maslon (219)	Poland	Observational	Permanent pain (Undefined)	11*	Mean 9.6 years	NR	Cerebral palsy	Hip
Matava (220)	USA	Retrospective review	Pain (4 months, 12months)	3*	Mean 12.7 years	NR	S ed capital femoral epiphysis	Hip, Leg, Knee
Mattila (221)	Finland	Retrospective review	Chronic pain (>2 years)	14	Mean 6 years	6 Female 8 Male	Intra-articular venous alformation of the knee	Knee
Mauro (222)	Italy	Case report	Chronic pain (6 months)	1	16 years	Female	nted villonodular synovitis	Knee
Mauro (223)	Italy	Case series	Chronic pain (several months)	1	7 years	Female	eta thalassemia minor	Hip, Knee, Ankle
May (224)	USA	Retrospective review	Chronic pain (>6 months)	52	Mean 12.5 years (range 3-19)	NR	Osteoid osteoma	Hip, Thigh, Knee
McKinnon (225)	Australia	Cross-sectional observational	Chronic pain (>3 months)	75	Range 5-18 years	NR	Cerebral palsy	Lower limb
Mehdinasab (226)	Pakistan	Case report	Chronic pain (1.5 years)	1	15 years	Female	Osteoid osteoma patella	Knee
Menge (227)	USA	Case reports	Chronic pain (>3 months)	1	14 years	Male	al malleolar stress fracture	Ankle
Messia (228)	Italy	Case report	Chronic (>1 year)	1	4 years	Female	g associated vasculopathy (SAVI)	Knee, Ankle
Messner (229)	Sweden	Case series	Chronic pain (>12 months)	1	18 years	1 Female 1 Male	ondral damage due to trauma	Knee
Miettunen (230)	Canada	Prospective	Chronic pain (>3 months)	40	Range 0-18 years	NR	Osteonecrosis related to chemotherapy (ALL)	Hip, Knee
Miltner (231)	Germany	Prospective cohort	Chronic pain (>6 months)	27	Range 13-18 years	24 Female 3 Male	tellar hypertension syndrome	Knee
Mir (232)	India	Case report	Chronic pain (2 years)	1	17 years	Male	eoblastoma of talus body	Ankle
Miro (233)	Spain	Cross-sectional	Chronic pain (Undefined)	115	Mean 14 years (SD 3)	44 Female 56 Male	Chronic pain in context of physical disability (Cerebral palsy, Neuromuscular disease, Spina bifida),	Hips, Leg, Feet
Miyazaki (234)	Japan	Case report	Chronic (9 months)	1	16 years	Female	Chondroblastoma	Knee
Moore (235)	Canada	Case report	Chronic (3 years)	1	8 years	Male	Lyme arthritis	Knee
Morris (236)	USA	Case report	Chronic pain (>6 months)	1	11 years	Male	Osteoid osteoma	Ankle, Foot
Mortensen (237)	USA	Case report	Chronic pain (6 months)	1	15 years	Male	schial osteoid osteoma	Hip

Motsis (238)	Greece	Case report	Chronic pain (2 years)	1	16 years	Female	Intra-articular synovial lipoma	Knee
Moukoko (239)	France	Cohort	Chronic pain (>12 months)	36	Mean 8 years	26 Female 10 Male	Subfibular ossicle	Ankle
Muramastsu (240)	Japan	Case series	Chronic pain (>3 months)	8*	Range 0-17 years	3 Female 5 Male	Synovial hemangioma	Knee
Muschol (241)	USA	Case report	Pain (5 months)	1	5.5 years	Male	Hypertrophic medial plica / medial femoral condyle damage	Knee
Naranje (242)	India	Case report	Chronic pain (>6 months)	1	10 years	Male	Cirsoid aneurysm	Knee
Nayak (243)	USA	Case report	Chronic pain (Undefined)	1	12 years	Female	Chronic dislocated hip	Hip
Nemcova (244)	Denmark	Retrospective medical record review	Chronic pain 2-84 months)	21	Mean 10.5 years	12 Female 9 Male	Chronic recurrent multifocal osteomyelitis	Lower extremities
Nevins (245)	USA	Case report	Pain (>6 months)	1	10 years	Male	Lipoma arborescence	Knee
Ningegowda (246)	India	Case report	Chronic pain (>1 year)	1	13 years	Male	Chondroblastoma	Ankle
Novaczyk (247)	USA	Retrospective cohort	Chronic (months or >)	265	Range 9-11 years	NR	Cerebral palsy	Hip, Knee, Ankle, Foot
Novais (248)	USA	Prospective cohort	Chronic (Undefined)	13*	Range 9-18 years	2 Female 11 Male	Osteonecrosis of femoral head	Hip
Nwachukwu (249)	USA	Retrospective medical record review	Chronic pain (post-op, >6 months f/u)	11*	Mean 16.2 years (range 13-18)	NR	Cyclofibrosis following ACL reconstruction	Knee
Nwankwo (250)	Nigeria	Case report	Chronic pain (>3 months)	1	11 years	Female	Dermatomyositis	Lower limbs
Oh (251)	Korea	Retrospective with single follow up	Chronic (6 months)	10	Mean 15.6 years (range 10-22)	5 Female 5 Male	Idiopathic flat foot	Ankle, Foot
Oshlyanska (252)	Ukraine	Case report	Chronic pain (>3 months)	1	14 years	Male	Paraneoplastic arthritis	Knee
Pacey 2014 (253)	Australia	Intervention	Chronic pain (Undefined)	9*	Mean 11.6 years	NR	Joint hypermobility syndrome	Knee
Pacey 2013 (254)	Australia	RCT	Chronic pain (Undefined)	265	Mean 12.04 years (SD 2.93)	18 Female 8 Male	Generalised joint hypermobility	Knee
Padeh (255)	Israel	Cross-sectional observational	Chronic pain (Undefined)	61	Mean 9.4 years	47 Female 24 Male	Juvenile rheumatoid arthritis	Hip, Knee, Ankle
Padhye (256)	Australia	Retrospective medical record review	Persistent pain (undefined)	20	Mean 13 years	NR	Osteonecrosis	Hip, Knee, Ankle
Paluska (257)	USA	Case report	Persistent pain (3 months)	1	11 years	Male	Osteomyelitis	Thigh
Papakonstantinou (258)	Greece	Retrospective review	Persistent pain (Undefined)	5	Median 12 years	3 Female 2 Male	Osteonecrosis	Hip, Knee
Park (259)	Korea	Case report	Chronic pain (>1 year)	1	16 years	Male	Recurrent macrophage activation syndrome	Ankle
Paruk (260)	South Africa	Case series	Chronic pain (>3 months)	2	13 years 17 years	Male	Primary hyperthyroidism	Knee, Ankle
Patel (261)	India	Case report	Chronic pain (>3 years)	1	12 years	Male	Wilsons disease	Knee
Perez (262)	Spain	Case report	Pain (>3 years)	1	7 years	Male	Haploinsufficiency of A20 with new mutation p.W365R	Lower limbs
Pietrzak (263)	Australia	Case report	Chronic pain (>6 months)	1	16 years	Female	Patellofemoral pain syndrome and iliotibial band syndrome	Knee
Pilbury (264)	UK	Case report	Pain (>4 years)	1	12 years	Male	Cystic fibrosis	Knee

Pill (265)	USA	Retrospective case series	Chronic pain (Undefined)	23	Mean 10.4 years (range 8-13)	15 Female 8 Male	Symptomatic os subfubare	Foot
Pinto (266)	Portugal	Cross-sectional	Chronic pain (3 months or >)	18*	Range 10-17 years	NR	Haemophilia	Knee, Ankle
Poirot (267)	France	Cohort study	Pain (Long duration)	65*	Mean 6.79 (SD±1.93)	NR	Cerebral palsy	Hip, Knee, Feet
Porter-Bishop (268)	New Zealand	Case report	Chronic pain (Undefined)	1	12 years	Male	Von Willebrand disorder	Ankle
Portin (269)	USA	Case report	Chronic (3 months or >)	1	7 years	Male	Juvenile idiopathic arthritis	Ankle
Pouliquen (270)	France	Retrospective medical record review	Chronic pain (>2 years)	25	Range 6-16 years	20 Female 5 Male	Anatomical variant "Too long" supromedial calcaneal process	Foot
Pountney (271)	UK	Randomised trail	Chronic pain (>6 months)	6	Mean 12.1 years	2 Female 4 Male	Cerebral palsy	Hip
Pourbordbari (272)	Denmark	Cross-sectional population	Chronic pain (median pain 5 months)	56*	Median 13 years (IQR 12-16.5)	NR	Musculoskeletal pain	Knee, Ankle, Foot, Heel
Poutoglidou (273)	Greece	Case report	Chronic Pain (4 months)	1	10 years	Male	Pigmented villonodular synovitis	Knee
Powell (274)	USA	RCT	Persistent pain (>1 month, less than 24 months)	25*	Mean 12.4 years	NR	Juvenile idiopathic arthritis	Foot, Ankle
Prakash (275)	India	Case report	Chronic pain (>6 months)	1	8 years	Male	Metatarsal tubercular osteomyelitis	Foot
Prigent (276)	France	Case report	Chronic pain (>18 months)	1	13 years	Male	Traumatic lower limb amputation	Foot
Pybus (277)	UK	Case report	Chronic pain (>3 months)	1	4 years	Female	Takayasu arteritis	Lower limbs
Rao 2021(278)	USA	Case report	Chronic pain (>6 months)	1	13 years	Female	Osteochondroma	Knee
Rao 2020 (279)	USA	Case report	Persistent pain (6 months)	1	13 years	Male	Ewings sarcoma	Hip, Thigh, Knee
Rathleff 2013 (280)	Denmark	Cross-sectional population based	Chronic pain (>36 months)	57*	Mean 17.2 years	Female	Patellofemoral pain syndrome	Knee
Rathleff 2013 (281)	Denmark	Cross-sectional	Chronic pain (>18 months)	57*	Mean 17 years (SD ±1.1)	Female	Patellofemoral pain syndrome	Knee
Rathleff 2019 (282)	Denmark	Prospective longitudinal	Chronic pain (>2 years)	169*	Mean 17 years	Female	Musculoskeletal pain	Knee
Rathleff 2016 (283)	Denmark	Prospective longitudinal	Chronic pain (>2 years)	180*	Mean 17 years	Female	Patellofemoral pain syndrome	Knee
Raza (284)	UK	Case report	Chronic pain (>1 year)	1	12 years	Female	Synovial chondromatosis	Hip
Remesal (285)	Spain	Case report	Chronic pain (>1 year)	1	9 years	Female	Chronic infantile neurologic, cutaneous, and articular syndrome (CINCA)	Knee
Rethlefsen (286)	USA	Retrospective medical record review	Chronic pain (>3 years)	46*	Mean 10.5 years (SD±2.1)	NR	Post-op calcaneal sliding/lengthening osteotomy	Foot
Riaz (287)	UK	Case report	Chronic pain (>9 months)	1	15 years	Male	Osteochondral lesion	Ankle
Richard (288)	USA	Prospective longitudinal	Chronic pain (>12 months)	51	Mean 17.6 years (range 12-21)	32 Female 19 Male	Post-operative hip preservation surgery	Hip
Rodrigo (289)	Sri Lanka	Case report	Chronic pain (>3 months)	1	17 years	Male	Tuberculosis infection	Knee

Roth (290)	Germany	Case report	Pain (12 months)	1	7 years	Female	Oligoarticular juvenile idiopathic arthritis	Leg
Rukavina (291)	Croatia	Case report	Chronic pain (>3 months)	1	13 years at onset	Female	Primary OA w/ spondyloepiphyseal involvement (mutation of type II collagen gene COL2AI)	Hip, Knee, Ankle
Ryan (292)	USA	Case report	Pain (1.5 years)	1	15 years	Female	Sacral osteoid osteoma	Leg, Knee
Sahin (293)	Turkey	Case report	Chronic pain (14 years)	1	17 years	Female	Synovial haemangioma	Knee
Salvati (294)	Italy	Case series	Chronic pain (>6 months)	1	17 years	Male	Osteonecrosis femoral head	Hip
Salzman (295)	USA	Case report	Chronic pain (Undefined)	1	3 years	Female	Tuberculous osteomyelitis	Hip
Sams (296)	USA	Case report	Persistent pain (>12 months)	1	13 years	Male	Developmental dysplasia & dislocation of the patella	Knee
Sanchis-Alfonso (297)	Spain	Case report	Persistent pain (several months)	1	16 years	Female	Localised Pigmented Villonodular Synovitis	Ankle
Santora (298)	USA	Case report	Persistent pain (Undefined and 9 months)	1	11 & 12 years	Female	Intraarticular loose body	Hip
Santos-Pereira (299)	Portugal	Case report	Chronic pain (>6 months)	1	13 years	Female	Tillaux Fracture	Ankle
Sarage (300)	USA	Case series	Chronic pain (>4 months)	1	15 years	Female	Talo-navicular tarsal coalition	Foot
Sasapu (301)	USA	Case report	Persistent pain (5 months)	1	10 years	Female	Osteoid osteoma	Leg
Schejbalova (302)	Czech Republic	Retrospective medical record review	Chronic pain (>3 months)	4*	Ramge 9-18 years of age	NR	Cerebral palsy	Hip
Schils (303)	USA	Review	Pain (several months)	2*	Range 16-34 years	NR	Medial malleolar stress fracture	Ankle
Schuett (304)	USA	Retrospective medical record review	Chronic pain (>3 months)	32*	Mean 14.4 years (SD ±1.4)	NR	Pelvic apophyseal avulsion fracture	Hip
Scott (305)	USA	Case report	Chronic pain (>3 months)	1	7 years	Female	Multiple epiphyseal dysplasia	Lower limbs
Sekiya (306)	USA	Case report	Chronic pain (>1 year)	1	17 years	Male	Acetabular impingement	Hip
Shabir (307)	Pakistan	Retrospective medical record review	Chronic pain (>6 months)	5*	Range 2-5 years	NR	Congenital dislocation of hip	Hip
Shah (308)	USA	Case report	Pain (4 months)	1	6 years	Male	Vitamin D deficiency	Lower limb
Shah (309)	USA	Case report	Persistent pain (several years)	1	13 years	Female	Intra-adipose vascular anomaly	Thigh
Sharma (310)	USA	Case report	Persistent pain (>2 years)	1	12 years	Male	Musculoskeletal pain syndrome	Hip, Knee
Shetty (311)	USA	Case report	Chronic pain (>7 months)	1	7 years	Female	Osteoid osteoma	Hip
Shiner (312)	USA	Case report	Pain (3 months)	1	9 years	Female	Acute lymphoblastic leukemia	Knee, Ankle
Shore (313)	USA	Retrospective chart review	Pain (12 months)	29*	Mean 17 years	NR	Legg-calve-perthes	Hip
Shtarker (314)	Israel	Retrospective medical record review	Chronic pain (Undefined)	4*	11,12,13,16 years	NR	Angular and rotational deformities of the lower limb	Lower limb
Shukla (315)	UK	Case series	Chronic pain (>3 months)	4*	11, 14,15	1 Female 3 Male	Osteoid osteoma	Foot

Singh 2003(316)	USA	Case report	Pain (2 years)	2	13 & 15 years	Female	Talo-patello-scaphoid osteolysis	Knee, Ankle
Singh 2010 (317)	USA	Case report	Chronic pain (>5 months)	1	16 years	Female	Chronic synovitis	Knee
Sink (318)	USA	Retrospective review	Chronic pain (>3 months)	35	Mean 16 years (range 13-18)	30 Female 5 Male	Femoroacetabular impingement	Hip
Sitati (319)	Kenya	Case report	Pain (1 year)	1	10 years	Male	Sever disease	Heel
Skelley (320)	USA	Case report	Chronic pain (Undefined)	1	13 years	Male	Slipped capital femoral epiphysis with vitamin D deficiency	Hip
Smedbraten (321)	Norway	Cross-sectional	Bodily pain (undefined)	569	Mean age 10.4 (4th from); 15.5 (9th form)	NR	Musculoskeletal pain	Knee
Somorjai (322)	Netherlands	Case report	Persistent pain (>3 years)	1	16 years	Male	Intra-articular plica	Ankle
Sornay-Soares (323)	France	Retrospective	Pain (12 months)	10	Mean 14.9 years	Female	Juvenile idiopathic arthritis	Knee
Speirs (324)	USA	Case series	Chronic pain (>1 year)	1	14 years	Female	Focal periphyseal oedema	Knee
Spencer (325)	USA	Retrospective review	Chronic pain (>3 months)	10	Mean 18 years	NR	Ischial tuberosity apophyseal fracture	Hip
Sperotto 2013/2015 (326, 327)	Italy	Cohort	Chronic pain (>3 years)	38*	Mean 14 years (range 8-16)	NR	Benign joint hypermobility / idiopathic musculoskeletal pain	Hip, Lower limb
Stanton (328)	USA	Retrospective medical record review	Chronic (3 months or >)	36*	Mean 13.4 years (range 8-19)	24 Female 12 Male	Complex Sympathetic Dystrophy	Hip, Knee, Ankle
Steel (329)	UK	Case series	Chronic pain (Undefined & 4 years)	2	10 & 11 years	Male	Iliac/pelvic mass (NF1 and lymphoma - both leading to hip dislocation)	Hip
Stein 2010 (330)	USA	Case report	Chronic (Undefined)	1	13 years	Male	Cerebral palsy	Hip
Stein 2005 (331)	USA	Case report	Chronic (Undefined)	1	13 years	Male	Cerebral palsy	Hip
Styles (332)	USA	Case series	Chronic pain (Undefined)	9*	Range 9-21 years	3 Female 5 Male	Sickle cell disease	Hip
Su (333)	Taiwan	Prospective cohort	Pain (>6 months)	11*	Mean 14.4 years (Range 10-25)	NR	Hip dysplasia	Hip
Suh (334)	Korea	Case report	Persistent pain (7 months)	1	9 years	Male	Osteonecrosis	Foot
Sulko (335)	Poland	Case report	Pain (>12 months)	1	17 years	Male	Osteomyelitis and lymphoma	Hip, Knee
Suzuki (336)	Japan	Cohort	Persistent pain (Undefined)	NR	Mean 8 years (range 5-13)	NR	Perthes disease	Hip
Syu (337)	USA	Case report	Chronic pain (>3 months)	1	11 years	Female	Chronic recurrent multifocal osteomyelitis	Hip, Knee, Ankle
Szer (338)	USA	Cross-sectional observational	Chronic pain (>3 months)	12*	Range 2-15 years	NR	Lyme arthritis	Hip, Knee, Ankle
Tanir (339)	Turkey	Retrospective medical record review	Chronic pain Symptoms ranging from 2 to 900 days	69*	Mean 9.02 (SD 3.59)(range 1-16)	NR	Brucellosis	Hip, Knee, Ankle
Tenuta (340)	USA	Retrospective medical record review	Chronic pain (12-120 months)	10*	Mean 14 years	NR	Cerebral palsy	Hip
Tezel (341)	Turkey	Case report	Chronic pain (>5 years)	1	10 years	Female	Rickets	Lower limb

Thomas (342)	UK	Case report	Chronic pain (>3 months)	1	17 years	Male	Juvenile osteochondritis dissecans	Knee
Timm (343)	USA	Prospective cohort	Chronic pain (at least 6 months)	76*	Mean 13.9 years	NR	Ankle sprain	Ankle
Tippett (344)	USA	Case report	Chronic pain (>3 months)	1	8 years	Male	Perthes disease	Knee
Tiwara (345)	India	Prospective observational	Persistent severe pain (>6 months)	25	Mean 9.08 years (range 4-12)	NR	Legg-calve-perthes	Hip
Tobias (346)	UK	Prospective cohort study	Chronic pain (>3 months)	1299	Mean 13.8 years	776 Female 523 Male	Joint hypermobility	Lower limb
Tompkins (347)	USA	Case series	Chronic pain (>3 months)	3*	15 and 17 years	2 Female 1 Male	Chondral defects of patella	Knee
Tonsoline (348)	USA	Case report	Pain (>6 months)	1	16 years	Male	Adductor tendinitis	Groin
Toro (349)	Italy	Case report	Persistent pain (>3 months)	1	15 years	Male	Femoral neck fracture	Hip
Trager (350)	USA	Case report	Chronic pain (>3 months)	1	15 years	Male	Juvenile osteochondritis dissecans	Knee
Tripathy (351)	UK	Case report	Pain (>4 months)	1	12 years	Male	Hoffa fracture	Knee
Tripathy (352)	India	Case series	Chronic pain (>3 months)	3*	Mean 9 years (range 4-17)	2 Female 1 Male	Fibrous dysplasia (mono-ostotic polyostotic)	Hip, Leg, Tibia
Tsimicalis (353)	Canada	Prospective cohort	Chronic pain (>4 months)	25*	Mean 12 years (8-19 years)	NR	Osteogensis imperfecta	Hip, Ankle
Turati (354)	Italy	Case report	Chronic pain (undefined)	1	11 years	Female	Osteochondroma	Foot
Tuzuner (355)	Turkey	Case report	Chronic pain (>1 year)	1	14 years	Female	Osteoid osteoma	Ankle
Ukarapong (356)	USA	Case report	Chronic pain (Undefined)	1	13 years	Male	Homozygous mutation of ALPL and mild form of hypophosphatasia	Knee
Ulu (357)	Turkey	Prospective cohort	Chronic pain (3 months or >)	8*	Median 12 years (range 3-17)	NR	Chronic non-bacterial osteomyelitis	Ankle
Umrani (358)	Oman	Case report	Persistent pain (>4 months)	1	8 years	Male	Osteosarcoma	Hip
Unadkat (359)	Africa	Case series	Chronic pain (>5 months)	1	2 years	Female	Acute lymphoblastic leukemia	Lower limb
Uwaezuoke (360)	Nigeria	Case report	Chronic pain (3 years)	1	14 years	Male	Osgood-schlatter's disease	Knee
Van straalen (361)	Netherlands	Prspective cohort	Chronic pain (>3 months)	196	Range 5-16 years	149 Female 47 Male	Juvenile idiopathic arthritis & chronic musculoskeletal pain	Hip, Knee, Ankle
Vijayan (362)	USA	Case report	Pain (6 months)	1	9 years	Female	Juvenile idiopathic arthritis	Knee
Villalba (363)	Spain	Prospective cohort	Pain (>6 months)	5	Mean 15.2 years (range 12-18)	1 Female 4 Male	Osteochondritis dissecans	Knee
Vukic (364)	Croatia	Case report	Chronic pain (>3 months)	1	15 years	Female	Juvenile fibromyalgia	Hip
Waisel (365)	USA	Case report	Chronic pain (Undefined)	1	13 years	Female	Ehlers-Danlos	Knee, Ankle
Wang 2020 (366)	USA	Prospective cohort	Chronic pain (>12 months)	22*	Mean 12.3 years (SD±6.8)	NR	Fibroadipose vascular anomaly (FAVA)	Hip, Knee, Ankle, Foot
Wang 2021 (367)	China	Retrospective medical record review	Chronic pain (post-op follow up 10-71 months)	6 (feet)	Mean 12.8 years (range 11-20)	NR	Sinus tarsi pain following subtalar arthroereisis	Foot
Ward (368)	Canada	Case report	Chronic pain (Undefined)	1	12 years	Female	Osteopathia striata with cranial sclerosis	Hip, Knee

Washington (369)	Thailand	Case report	Pain (10 months)	1	5 years	Male	Miliary & osteoarticular tuberculosis	Hip
Watanabe (370)	Japan	Case report	Persistent pain (>6 months)	1	3 years	Female	Synovial hemangioma	Knee
Watters (371)	USA	Case report	Chronic (3 months or >)	1	12 years	Male	Ewings sarcoma	Hip
Wei (372)	USA	Case report	Persistent pain (Undefined)	1	17 years	Female	Gorham-stout syndrome	Hip
Wells (373)	USA	Retrospective medical record review	Chronic pain (follow up 6 months op)	6*	11,13,14,17 years	4 Female 2 Male	Osteonecrosis	Hip
Westbom (374)	Sweden	Retrospective medical record review	Chronic pain (>6 months)	185*	Range 4-19 years	80 Female 105 Male	Cerebral palsy	Hip, Knee, Ankle
Widhalm (375)	Austria	Cohort	Permanent pain (Undefined)	20*	Mean 14.2 years (SD±2.7)	9 Female 11 Male	Cartilage lesion	Knee
Wiegerinck (376)	Netherlands	RCT	Chronic pain (4 months)	101	Mean 10.6 years (SD±1.6)	25 Female 76 Male	Calcaneal apophysitis	Ankle
Wobma (377)	USA	Case series	Persistent pain (12 months)	1	10 years	Female	Chronic recurrent multifocal osteomyelitis	Hip
Wong (378)	Hong Kong	Case report	Pain (3 months)	1	7 years	Female	Neuroblastoma	Hip
Wong 2009 (379)	USA	Case report	Chronic pain (>3 months)	1	12 years	Male	Patellofemoral pain syndrome & bipartite patella	Knee
Wong 2022 (380)	Denmark	Prospective cohort	Chronic pain (Undefined)	22	Mean 9.1 years (range 2- 17 years)	8 Female 14 Male	Cerebral palsy	Hip, Knee, Ankle
Yi (381)	China	Case report	Pain (>12 months)	1	6 years	Male	Synovial chondromatosis	Hip
Yokouchi (382)	Japan	Case report	Chronic pain (3 months)	1	10 years	Male	Osteoid osteoma	Mid tibia
Yoshida (383)	Japan	Case report	Persistent pain (Undefined)	1	8 years	Female	Osteosarcoma	Knee
Yuill (384)	Canada	Case report	Persistent pain (>4 months)	1	14 years	Male	Hallis posterior tendonopathy	Foot
Yuldashev (385)	Korea	Retrospective medical cord review	Chronic pain >10 years)	1*	9 years	Male	Type I camuratingelmann	Tibia
Zhang (386)	China	Cohort	Chronic pain (Undefined)	*6	Mean 14.3 years (range 13-17)	Male	Haemophilic arthropathy	Knee
Zhu (387)	China	Case report	Chronic pain (>12 months)	4*	Range 12-14 years	1 Female 3 Male	Metaphyseal chondrodysplasia type schmid	Knee

* This is the population that each study described as meeting the inclusion criteria of having chronic lower limb pain

NR – Sex breakdown not reported for subpopulation of the full study

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S2 Table: The 124 conditions found in this review, and whether or not they were associated with the ICD-11 chronic pain manifestation code

Condition	Was there an ICD-11 manifestation code for chronic pain available?
Acute lymphoblastic leukaemia	Yes
Persistent ankle pain subsequent to a strain or sprain	No
Coeliac disease	No
Cerebral Palsy. This also includes pain subsequent to surgical interventions relating to Cerebral Palsy	No
Cystic Fibrosis	No
Persistent hip pain due to femoroacetabular impingements	Yes
Fibrous dysplasia. This includes both mono-ostotic and polyostotic.	No
Haemophilia including FVII deficiency	No
Persistent hip pain due to developmental (congenital) hip dysplasia	No
Inflammatory arthropathies. These include Ankylosing Spondylitis or undifferentiated Spondyloarthropathy	No
Inguinal hernia	No
Joint instability, including hip, knee, patella or ankle	Yes
All types of Juvenile idiopathic arthritis. This includes oligoarthritis, polyarthritis, systemic, psoriatic arthritis, enthesitis-related and undifferentiated	Yes
Lyme Arthritis	Yes
All types of Muscular Dystrophy. This includes Duchene, Becker, fascioscapulohumeral, limb girdle, myotonic.	No
Musculoskeletal pain. This includes primary, idiopathic and chronic widespread pain (Juvenile fibromyalgia).	No
Neurofibromatosis Type 1	No
Dysplasia. This includes conditions such as osteoarthritis with spondyloepiphyseal involvement (mutation of type II collagen gene, COL2AI, Skeletal dysplasia and open physes, Protusio acetabulae Multiple epiphyseal dysplasia Spondyloepimetaphyseal dysplasia, BUT EXCLUDES High or low bone mass or low bone dyspasias"	Yes
Osteomyelitis, including brodies abscess	No
Persistent anterior knee pain due to patellofemoral pain syndrome and chondromalacia patellae	Yes
Henoch-Schoenlein Purpura	No
Spinal Muscular Atrophy	Yes
Persistent lower limb pain subsequent to limb amputation	No
Von Willebrand disorder	No
Stress fracture	No
Arteriovenous Malformation	No
Talipes Equinovarus	No
Brucellosis	No
Hyperimmunoglobulin D Syndrome	No
Hyperparathyroidism, including primary hyperparathyroidism	No
High bone mass dysplasia. This includes Osteopetrosis tarda, Melorheostosis (mesenchymal dysplasia), Camurati-Engelmann (Type I), Osteopathia striata but EXCLUDES general Dysplasia or low bone mass	No
Philadelphia chromosome-positive CML	No
PIK3CA-related disorder	No
Scurvy	No
Slipped capital femoral epiphysis	No
Spina Bifida	No
Cryopyrin-associated periodic syndrome	No
Dermatomyositis	No
Ewing Sarcoma	No

Fibroadipose vascular anomaly (FAVA)	No
Ganglion	No
Klippel-Trenaunay syndrome (vascular malformation)	No
Legg-Calve-Perthes Disease	No
Liposynovitis prepatellaris (Hoffa's syndrome)	No
Myopathy	No
Osteogenesis imperfecta	No
Osteoid osteoma	No
Restless leg syndrome	No
Disorders of the meniscus. This includes symptomatic discoid meniscus, meniscocapsular separation and meniscal ossicle.	Yes
Auto-immune polyendocrinopathy candidiasis ectodermal dystrophy	No
Chondroblastoma	No
Chronic granulomatous disease	No
Coalition. This includes any location in the foot for example talocalcaneal or talonavicular	No
Exertional compartment syndrome	No
Arthritis related to Crohn's disease	No
Enthesopathy	No
Familial Mediterranean fever arthritis	No
Flat foot. Consider only paediatric flexible flat foot, not rigid relating to spasticity or coalition	No
Fracture of the lower limb. This includes femur, ischial tuberosity, pelvis, tibia, fibula, ankle, foot	No
Generalised joint hypermobility syndrome	Yes
Human immunodeficiency virus	No
Hypophosphatasia as a result of Homozygous mutation of ALPL	No
Iliotibial band syndrome	Yes
Ischiofemoral impingement	Yes
Osteochondral lesion & Osteochondritis Dissecans	No
Osteosarcoma	Yes
Pigmented villonodular synovitis	Yes
Persistent lower limb pain post surgery.	No
Septic (pyogenic) arthritis	No
Relapsing Polychondritis	No
Sickle Cell Disease	No
Tuberculosis infection	No
Vitamin D deficiency	No
Wilson disease	No
Beta thalassemia minor	No
Growing pains	No
Pseudotumor (idiopathic intracranial hypertension)	No
Sjogren's syndrome	No
Spinal meningioma	No
Rhabdomyolysis	No
Heterotrophic Ossification	No
Neuroblastoma	No
Metaphyseal Chondrodysplasias type Schmid	No
Accessory bone. This includes Os Subfibulare, navicular, Os subtibiale, Os trigonum, ossicle, subfibular ossicle	No
Activated phosphoinositide 3-kinase (PI3K) delta syndrome	No
Anatomical variants of lower limb. This includes 'Too long' anteromedial calcaneal process, Limb length secondary to ABI, Angular and rotational deformities, Retroversion of acetabular dome	No
Apophysitis	No
Arthritis due to Bancroftian filariasis (Filarial arthritis)	No

Autosomal dominant precocious osteoarthropathy	No
Avascular necrosis (also known as Osteonecrosis)	No
Behcet's disease	No
Benign bone tumour/lesion. This includes osteochondroma, chondroma benign and benign lesion of proximal femur	No
Chondral defects & cartilage pain disorders of the lower limb	No
Chondrolysis	No
Chronic infantile neurologic cutaneous and articular syndrome (CINCA)	No
Cirsoid aneurysm	No
Epiphyseal arrest	No
COPA Syndrome (genetic)	No
Focal periphyseal oedema	No
Gorham-stout syndrome	No
Haploinsufficiency of A20 with new mutation p.W365R	No
Persistent lower limb pain resulting from complications arising post fracture. For example, ankle impingement resulting from bimalleolar fracture.	No
Tarsometatarsal interval injury	No
Intraarticular loose body	Yes
Intra-articular venous malformation of the knee	No
Post infective arthritis including Noro or influenza virus	No
Nuclear factor I type A variant	No
Osteoblastoma	No
Osteochondrosis	No
Osteofibrous dysplasia (ossifying fibroma)	No
Pachydermoperiostosis	No
Paraneoplastic arthritis	No
Patellar Hypertension Syndrome	No
Reactive arthropathy	No
Sting-Associated Vasculopathy (SAVI)	No
Benign tumours of synovium. This includes Synovial chondromatosis, Synovial haemangioma, Intra-articular synovial lipoma	No
Synovitis. This includes both chronic and transient.	Yes
Takayasu arteritis	No
Talo-patello-scaphoid osteolysis	No
Talus Partitus	No
Tendon disorders of the lower limb. This includes tibialis posterior and flexor hallucis longus tendinopathy and adductor tendinitis.	No
Tenosynovitis, inflammatory arthritis	Yes
Traumatic Joint dislocation	No
Recurrent macrophage activation syndrome	No

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The breadth and visibility of children's lower limb chronic musculoskeletal pain: A scoping review.

Emre Ilhan,[1] Luke Davies,[1,2] Verity Pacey,[1,2] Mitchell Smith,[2] Jane Munro,[3] Craig Munns,[3,4,5] Elizabeth Sturgiss,[2] Nicole Williams,[7] Louise Tofts,[1] Vance Locke,[8] Terry Haines,[2] Sue Brennan,[9] Stephen Maloney,[2] Mitchell Sarkies,[10] Ornella Clavisi,[11] Dan Miles,[12] Lisa Nissen;[2] Cylie M. Williams[2]

1. Department of Health Sciences, Faculty of Medicine, Health and Human Sciences, Macquarie University, Sydney, NSW, Australia
2. School of Primary and Allied Health Care, Monash University, Melbourne, VIC Australia
3. Rheumatology Unit, Royal Children's Hospital, Arthritis and Rheumatology Murdoch Children's Research Institute, Melbourne, VIC, Australia.
4. Faculty of Medicine, The University of Queensland, Brisbane, QLD, Australia.
5. Child Health Research Centre, The University of Queensland, Brisbane, QLD, Australia.
6. Department of Endocrinology and Diabetes, Queensland Children's Hospital, Brisbane, QLD, Australia
7. Adelaide Medical School, Faculty of Health and Medical Sciences, The University of Adelaide, Adelaide, SA, Australia.
8. Western Kids Health, WA, Australia.
9. School of Public Health & Preventive Medicine, Monash University, Melbourne Australia.
10. Sydney School of Health Sciences, Faculty of Medicine and Health, The University of Sydney, Sydney, NSW, Australia.
11. Musculoskeletal Australia, Melbourne, VIC, Australia.
12. Australian Podiatry Association, Melbourne, VIC, Australia.

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Corresponding author: Cylie Williams, e-mail: cylie.williams@monash.edu; address: Monash University, School of Primary and Allied Health Care, 47-49 Moorooduc Hwy, Frankston, VIC, 3199, Australia. Ph: +61(3)99044344

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ABSTRACT

Objective

To identify the types of conditions reported in peer-reviewed literature that result in chronic musculoskeletal lower limb pain in children and adolescents and explore alignment of these conditions with the chronic pain reporting codes indexed in the International Classification of Diseases 11th Revision (ICD-11).

Design

This scoping review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.

Data sources

Five electronic databases were searched (Medline, EMBASE, PsycINFO, CINAHL, and the Cochrane library).

Eligibility criteria

Articles involving children and adolescents under 18 years and reporting on chronic musculoskeletal pain of the lower limb were included.

Data extraction and synthesis

We assigned an ICD-11 code to each condition based on details reported in the study. We recorded whether any of the presenting conditions were linked to an ICD-11 chronic pain manifestation code.

Results

From 12,343 records, 418 papers were included. There were 124 unique conditions associated with chronic lower limb pain, the most commonly reported being chronic widespread musculoskeletal pain (24 studies) and juvenile idiopathic arthritis (26 studies). Only 10.2% of presenting conditions were linked to an ICD-11 chronic pain manifestation code.

Conclusion

Most presenting conditions associated with chronic pain in the lower limb do not have a chronic pain manifestation code in the new global standard for recording health information.

This means, chronic pain associated with common lower limb conditions may remain invisible in global statistics.

Trial registration: The protocol for this scoping review was registered with the Open Science Framework

Strengths and limitations

- We used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews and a registered protocol to guide this review
- We used the ICD-11 for recording diagnostic health information to classify conditions and chronic pain
- Only studies published in English were included
- One reviewer extracted data due to the breadth of data collected
- No studies had a risk of bias or quality assessment

INTRODUCTION

Chronic pain, defined as pain lasting for more than 3 months, can occur in 20.8% (95% CI 19.2-22.4%) of children and adolescents.[1, 2] Children and adolescents face difficulties as a result of chronic pain including reduced participation in daily activities, such as attending school, playing with their peers, and engaging in physical activity.[3] Chronic pain negatively impacts quality of life and increases the risk of psychological disturbances such as anxiety and depression in adulthood.[2, 4-6] The lower limb (foot, ankle, leg, knee, thigh, and hip) is one of the most common sites of chronic musculoskeletal pain in children and adolescents, accounting for almost 40% of all childhood chronic disease pain patterns.[3, 7] The onset of chronic lower limb pain in childhood tends to occur before children enter formal schooling,[8] but diagnoses vary considerably. It is likely to persist for up to four years following their first episode.[9]

Children commonly experience chronic pain for 12 months prior to seeing a professional with additional experience in managing chronic pain such as a pain medicine specialist or allied health professional such as a physiotherapist, psychologist, or occupational therapist.[9] Adequate education, identification, and assessment at early stages in the pain journey is pivotal in minimising any pain chronification risk. This is because children and their families initially present to primary care or community-based health professionals such as allied health, well before specialist consultation.[10, 11] To enable adequate care from the outset, primary care clinicians and community-based healthcare professionals may benefit from specific evidence-based guidelines to provide optimal and early diagnosis and treatment of chronic pain in children and adolescents prior to engaging with specialist services.[12]

Population-level research conducted in Australia shows that children and adolescents' musculoskeletal lower limb presentations to general practice are twice as common as spinal and trunk problems.[12] The authors of the study,[12] however, noted that they could not distinguish presentations that were acute or chronic in nature, highlighting the need for a

standardised system to collect such data. Recently, the *International Classification of Diseases* (ICD) framework (https://icd.who.int/en) was revised to include chronic pain as a separate disease category.[13, 14] Incorporating chronic pain classifications into the ICD-11 allows capture of health statistics, hence making chronic pain more visible as a public health issue.[15] This is an important goal to address the under-recognition of chronic pain in children and adolescents and improve health outcomes.[16] While the ICD-11 may better highlight the burden of chronic pain in children and adolescents, its usefulness is yet to be explored in the context of chronic musculoskeletal pain in the lower limb of children and adolescents.[17]

The primary aim of this scoping review was to identify the breadth, and types of conditions reported in peer-reviewed literature that may result in chronic lower limb pain in children and adolescents. The secondary aim was to explore the alignment of these conditions with the new chronic pain reporting codes indexed in the *International Classification of Diseases 11th Revision* (ICD-11). This secondary aim served as an exercise to field test the usefulness of the ICD-11 in capturing cases in which certain health conditions are associated with chronic musculoskeletal pain of the lower limb. Scoping review methodology was chosen to ensure a broad approach guided data capture.

METHODS

This scoping review was conducted in accordance with the Joanna Briggs Institute methodology for scoping reviews.[18] We reported the review in line with Preferred Reporting Items for Systematic Reviews and Meta-Analyses reporting guidelines for scoping reviews (PRISMA – ScR). A protocol for this scoping review was registered on Open Science Framework on 3rd of March 2023 (https://doi.org/10.17605/OSF.IO/2RYV6).

This scoping review was overseen by a steering group of 15 paediatric and methodological experts assembled by the research team. The group comprised 10 paediatric healthcare professionals who routinely support children who experience chronic musculoskeletal lower

limb pain. These included a rheumatologist, endocrinologist, general practitioner, orthopaedic surgeon, paediatrician, psychologist, pharmacist, two physiotherapists/clinical researchers, and a podiatrist/clinical researcher. We also were supported by three methodology experts, and two consumer representatives with an interest in chronic lower limb pain in children and adolescents. The role of the steering group was to provide input into the search strategy and resolve disagreements in the categorisation of conditions according to the ICD-11. This steering group also established which conditions included in this review were musculoskeletal in nature which aligned with the funding directions and aims.

Eligibility criteria

Studies were eligible for inclusion if they were available in English, sampled a paediatric population (<18 years of age or mean or median population <18 years of age)[19] and reported on the presence of chronic or persistent musculoskeletal pain in the lower limb. Chronic or persistent musculoskeletal pain was defined as studies describing pain lasting for longer than 3 months that originates in the joints, bones, muscles, tendons, and related soft tissues.[20] For the purposes of this review, the lower limb included the hip, thigh, knee, leg, ankle, and foot, but excluded the pelvis, pubic symphysis, and sacroiliac joints. This review included randomised controlled trials, observational studies, and case reports and series to ensure study conclusions were based on the primary analysis of human data. This eligibility criteria were chosen to ensure only conditions relevant to chronic musculoskeletal pain were included and aligning to the overall research aim of the funder. Therefore, pain that was dermatological or neuropathic/potentially neuropathic in nature were excluded (e.g. chronic regional pain syndrome), work-related pain or articles describing a region of pain without a diagnostic name (e.g., juvenile idiopathic arthritis) or condition (e.g., primary chronic musculoskeletal pain) were excluded. Papers that were trial protocols, editorials, opinion pieces, or where no data were presented were excluded. In studies with mixed populations (e.g., in terms of age, location of pain, mechanisms of pain such as neuropathic pain), only

data from participants that met this review's eligibility criteria were included: individuals less than 18 years of age with chronic musculoskeletal pain of the lower limb.

Information sources and search strategy

An initial, limited search of PubMed and Google Scholar were conducted to identify any papers on the topic of "chronic lower limb pain", "musculoskeletal pain", and "paediatric pain". To ensure a comprehensive search of the literature, a clinical research librarian assisted in the development of a systematic search strategy for each of the databases. Five electronic databases were then searched, including Medline, EMBASE, PsycINFO, CINAHL, and the Cochrane library using keywords such as "chronic pain", "lower extremity", and "paediatric". The full electronic search strategy for Medline is presented in Table 1 (for all strategies see Supplementary Table 1), which was adapted for the each of the included databases. No limitations were placed on publication date or status. The search was conducted from database inception until the 25th of July 2024. Studies meeting the eligibility criteria were uploaded onto EndNote Version X9 (Clarivate Analytics, PA, USA) then exported to Covidence Systematic Review Software (Veritas Health Innovation, Melbourne, Australia) for de-duplication and screening.

Selection of sources of evidence

Two reviewers (CW and VP) independently screened titles and abstracts of papers based on the eligibility criteria. In the event of disagreements, a third reviewer (EI) was consulted to reach consensus. Full texts were screened independently by two of five reviewers (CW, VP, EI, LD, MS). Any concerns regarding the eligibility of a study were resolved by consensus among the authors first, and then by the steering group in cases where the musculoskeletal nature of the conditions reported was unclear. Extensive efforts were made to retrieve full-text records through multiple physical and digital sources including two university libraries and a hospital library. Due to the data capture strategies, and volume of data, we did not use any citation chaining methods.

Data charting process and data items

Data from eligible studies were extracted into a purpose-built spreadsheet in Microsoft Excel. Data items included first author, year of publication, type of study design, the country/countries in which the study was conducted, the age groups researched, duration of pain described in the study, lower limb location of pain, and the specific condition(s) that were reported to be associated with chronic musculoskeletal pain of the lower limb.

Data were extracted by one reviewer. Following extraction, one reviewer (EI, LD, VP, CW, or MS) independently used the *International Classification of Diseases 11th Revision* (ICD-11) (https://icd.who.int/en) to assign a code to each of the conditions presented in the studies. The ICD-11 browser version 2022.02 release (https://icd.who.int/en) was used for coding. All codes were then discussed during a regular meetings between reviewers (EI, LD, VP, CW, MS) to ensure coding consistency and agreement, where several cases or diagnoses were independently coded differently by reviewers and all similar condition codes were checked to ensure correct alignment and decisions. We did not record the number of disagreements in coding. Coding was done to the level at which the paper provided sufficient detail about the condition. Given the scope of this review, we did not contact authors of papers with the necessary missing information. Disagreements were resolved through discussion, and adjudication by a third reviewer or steering group experts if a resolution could not be found. Using the ICD-11, each study was assigned a 'parent' code (a two-digit code) to facilitate hierarchical organisation of the data. In studies which reported more than one condition, multiple codes were assigned to reflect the number of conditions reported. We also recorded cases which had multiple parent codes. Where a presenting condition was aligned with a secondary chronic pain manifestation code, this was also recorded within the spreadsheet. An ICD manifestation code describes the manifestation, symptoms, or signs of the underlying disease (e.g., pain) rather than the disease itself. Only codes that reflected the primary condition/s and, if different, the pain conditions, were recorded. For example,

FB82.00: Chondromalacia patellae is linked to the manifestation code *MG30.31: Chronic secondary musculoskeletal pain associated with structural changes*. Manifestation codes in the ICD-11 refer to the manifestation of the disease (e.g., chronic pain), not the disease itself. Therefore, all chronic pain manifestation codes refer to chronic secondary pain conditions, not chronic primary pain conditions.

Data synthesis

Data were summarised descriptively using frequencies and percentages to characterise the published literature (e.g., country, study design, sample size, age, and sex of participants). To address the review aims, data were also summarised descriptively to determine types and percentage of conditions associated with chronic lower limb pain in children and adolescents. This was achieved by analysing the ICD-11 parent codes of the relevant conditions, which were then categorised into primary and secondary chronic pain groups, according to the definitions provided by Treede et al.[7] In addition, conditions relating to the same anatomical structure or physiological process were grouped under a single broad heading. For example, conditions associated with joint instability of the hip, patella, ankle were merged and grouped under “joint instability of the lower limb”. Finally, the alignment of these conditions with the new chronic pain classification system was explored by determining whether any presenting conditions (where pain was not a result of chronic primary pain) were indexed with a chronic pain manifestation code in the ICD-11.

Patient and public involvement

There were two consumer representatives. One who had lived experience of a child with chronic lower limb pain and supporting families with chronic lower limb pain. The other provided support and education to health professionals who provide services to children who have chronic lower limb pain.

RESULTS

Characteristics of included studies

A total of 12,343 records were identified through the database searches. After duplicates were removed, records combined where they reported on same data, and titles and abstracts screened, 1,409 papers were downloaded for full text screening, with a final 418 studies (from 422 reports where four described data from the same population) included in the review (Figure 1). A common reason for exclusion was that studies did not report on participants with chronic and/or persistent pain.

Of the 418 studies included in this review (Supplementary Table 2), most studies were case reports (n = 220 studies) or retrospective medical record reviews (n = 54) which were published in the 2010's (n = 220/418), conducted in the United States of America (n = 143/418 studies), and sampled adolescents between 11 and 17 years of age (n = 179/418 studies). Of those studies that reported sex (336 studies), studies sampled more females (n = 4,782) than males (n = 2,556) in total. No paper included in this review sampled infants less than a year old (Table 2).

Conditions related to chronic musculoskeletal pain of the lower limb

Discounting duplicate conditions, this review found 124 unique conditions that were associated with chronic musculoskeletal lower limb pain in children and adolescents (Supplementary Table 3). The most commonly reported health conditions identified resulting in chronic lower limb pain in children and adolescents were juvenile idiopathic arthritis (n = 26/418 studies), chronic widespread musculoskeletal pain (n = 24/418 studies), spasticity-related musculoskeletal pain in cerebral palsy (n = 20/418 studies), post-surgical pain (n = 13/418 studies), osteoid osteoma (n = 14/418 studies), and post-fracture (n = 14/418 studies) (Table 3).

The most common description of pain was having pain for at least 3 months (n = 143/418 studies) or for longer than a year (n = 113/418 studies). Most commonly, studies reported on

pain related to the knee only (n = 111/418 studies), mixed cases of various locations of the lower limb (n = 96 studies), or the hip only (n = 76/418 studies) (Table 3).

Conditions related to chronic musculoskeletal pain of the lower limb based on the ICD-11

All records could be assigned an ICD-11 code. Out of the 27 parent codes available on the ICD-11 classification system (ICD-11 codes: 01-26, V and X), 18 codes were associated with chronic lower limb pain (ICD-11 codes: 1-8, 11-15, 20-23, X) (Table 3). In total, 456 parent codes were assigned to the conditions of participants in the studies (Figure 2). The top three parent codes used most frequently were *15: Diseases of the musculoskeletal system or connective tissue* (n = 171 conditions), *20: Developmental anomalies* (n = 59 conditions), *21: Symptoms, signs, or clinical findings, not elsewhere classified* (n = 46 conditions).Several other parent codes (ICD-11 codes: 6, 7, 11-14, 23) were used for less than 5 conditions.

Alignment of the chronic pain classification with the ICD-11 or condition linked with chronic pain manifestation code

Chronic pain was reported as the presenting condition in 41 conditions in this review and assigned the parent code *21: Symptoms, signs, or clinical findings, not elsewhere classified,* and then the code *MG30: Chronic Pain.* These included the codes *MG30.2: Chronic post-surgical or post-traumatic pain* (n = 13 conditions), *MG30.0: Chronic primary pain* (n = 9 conditions), and *MG30.Y: Other specified chronic pain* (n = 9 conditions).

For cases in which chronic pain was not the presenting condition (n = 420 conditions, i.e., chronic secondary pain), only 43 conditions (10.2% of 420 conditions, or 13.7% of the 124 unique conditions once duplicates were removed) were linked to a chronic pain manifestation code (MG30) (Additional file 2). These 43 conditions included chronic secondary musculoskeletal pain associated with structural changes (n = 19), chronic secondary musculoskeletal pain (n = 9), chronic cancer pain (n = 7), chronic secondary

musculoskeletal pain from persistent inflammation (n = 6), and chronic musculoskeletal pain due to disease of the nervous system (n = 2) (see Figure 2).

DISCUSSION

This scoping review identified 124 unique conditions reported in the literature that may be associated with chronic musculoskeletal pain of the lower limb in children and adolescents. Most studies reported chronic pain as a symptom (e.g., chronic secondary musculoskeletal pain from juvenile idiopathic arthritis) rather than a disease in its own right (e.g., chronic primary pain such as chronic widespread musculoskeletal pain). The findings of this review suggest that there is considerable variability in the cause of secondary chronic lower limb pain investigated in the peer reviewed literature.[21] The ICD-11 coding system aligned with the plethora of chronic pain conditions presented. However, only 11.1% of all presenting conditions in the review had a manifestation code linked to chronic pain. This highlights the possibility the global burden of chronic musculoskeletal pain of the lower limb in children and adolescents may not be adequately captured by the ICD-11 due to the under-utilisation of manifestation codes.

The number of conditions that result in lower limb musculoskeletal chronic pain was extensive. As a result, this breadth will result in diversity in health professionals who may be involved in care. Given the breadth of conditions the review found that may result in chronic musculoskeletal lower limb pain, there is a need for health professionals to be aware of multiple paediatric musculoskeletal health conditions that may result in chronic pain.[22] This is currently an international focus.[22] This finding also lends itself to consistency in guidelines that are multi-disciplinary and not just focused on a single health profession. These opportunities are in place for conditions such as juvenile idiopathic arthritis, the most commonly reported condition in the literature. This condition has a number of guidelines on medication management with limited consideration to chronic musculoskeletal lower limb pain.[23]

This review highlights that, due to the lack of manifestation codes, there is potential of the ICD-11 in under-reporting diseases that may result in chronic musculoskeletal pain of the lower limb in children and adolescence. The under-recognition of chronic musculoskeletal pain in children and adolescents[16] may have far-reaching detrimental impacts on children and adolescents,[24] families,[25] and society[16] including the under -assessment and -management of chronic pain. Making chronic musculoskeletal pain of the lower limb in children and adolescents visible first requires capturing the burden in order to facilitate the adequate allocation of funding and resources. While the ICD-11 offers a potential solution for health systems to enable the evaluation of the burden, the problem of chronic pain needs to be made more visible by incorporating manifestation codes in all potential conditions that could lead to chronic pain. Because manifestations codes are linked to primary health conditions, ensuring that chronic pain manifestation codes exist for those health conditions that are associated with pain may ensure that health professionals, researchers, and policy makers are able to select these manifestation codes when inputting data. This presents opportunities for future data capture and practice reform.

Limitations of this review arise from the result of the large number of studies included in this review, data from studies were extracted by one reviewer only. We also acknowledge that only English-language papers were included in this review. This may mean that a large number of region-specific conditions resulting in chronic musculoskeletal lower limb pain in children and adolescents were not captured. Lastly, the assignment of ICD-11 codes was based on what was reported in papers included in this review and while we extensively consulted with our steering committee, the reported information may have not covered all the required criteria of the that diagnosis.

Conclusion

Many conditions may be associated with chronic musculoskeletal lower limb pain in children and adolescents as investigated in the peer reviewed literature. While the ICD-11 captures chronic pain classifications related to primary and secondary pain conditions, chronic secondary pain must be made more visible by having the ability to link conditions to chronic pain manifestation codes. This may allow clinicians, researchers, and policy makers to better estimate the burden of chronic musculoskeletal pain of the lower limb in children and adolescents. Increasing the visibility of chronic musculoskeletal pain in children and adolescents will allow a more equitable distribution of funding and resources for the development of strategies for the appropriate identification of children and adolescents with chronic musculoskeletal lower limb pain.

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Data availability statement

The dataset generated analysed during the current study are available from the corresponding author on reasonable request. An abbreviated version of the data used for analysis in this review is available in the Additional files 1 and 2.

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Contributor statement

EI, LD, VP and CMW conceptualised the study. EI, LD, VP JM, CM, ES, NW, LT, VL, TH, SB, SM, MS, OC, DM, LN and CMW designed the study and its methodology. All authors substantially contributed to data collection, analysis and coding frameworks. EI, LD, VP and CMW drafted the initial manuscript and all authors critically reviewed the draft manuscript and revised the manuscript for important intellectual content. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work. The guarantor of the study is CMW and accepts full responsibility for the finished work, had access to the data, and controlled the decision to publish.

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Figure legends

Figure 1: PRISMA flowchart of records screened and included in the scoping review.

Figure 2: The coding of primary and secondary chronic pain conditions of the lower limb in children and adolescents using the ICD-11 in the peer reviewed literature. N is the number of codes assigned within each category. Parent codes 6 (Mental, behavioural, or neurodevelopmental disorders, n = 1), 14 (Diseases of the skin, n = 1 relating to malformations involving cutaneous blood vessels, Code EF2Z), and 23 (External causes of morbidity and mortality, n = 2) were omitted from this figure for brevity.

Table 1: Full search strategy for Medline

Search	Query
1	Lower Extremity/ or Leg/ or Hip/ or Knee/ or Ankle/ or Foot/
2	(leg* or hip* or knee* or ankle* or foot or feet or lower limb* or lower extremit*).mp.
3	1 or 2
4	Chronic Pain/ or arthralgia/ or musculoskeletal pain/ or nociceptive pain/ or pain, postoperative/ or neuralgia/
5	((persistent or chronic or ongoing or long-term or nociceptive or musculoskeletal or post-operative or joint or neuropathic or nerve) adj3 pain).mp.
6	arthralgia.mp.
7	4 or 5 or 6
8	3 and 7
9	Infant/ or Child/ or Child, Preschool/ or Adolescent/
10	(baby or babies or neonate* or newborn or child* or infant* or toddler* or paediatric* or pediatric* or teen* or adolesc* or pre-pubesc* or prepubesc* or youth* or juvenile).mp.
11	9 or 10
12	8 and 11
13	exp animals/ not humans.sh.

Table 2: Characteristics of included studies

Type of study design	N = 418	%
Case report	220	52.6
Case series	30	7.2
Cohort	40	9.6
Cross-sectional	53	12.7
Longitudinal	9	2.2
Randomised controlled trial	10	2.4
Retrospective medical record review	54	12.9
Review	2	0.5
Country of data collection		
Australia	15	3.6
Canada	8	1.9
China	12	2.9
Denmark	11	2.6
France	10	2.4
Germany	12	2.9
India	19	4.5
Italy	16	3.8
Japan	18	4.3
Spain	8	1.9
Turkey	22	5.3
United Kingdom	20	4.8
United States of America	143	34.2
*Other**	104	24.9
Decade of publication		
1980's	2	0.5
1990's	27	6.5
2000's	76	18.2
2010's	220	52.6
2020-2024	93	22.2
Age groups[1]		
Infancy (0-1 years)	0	0.0
Childhood (2-10 years of age)	79	18.9
Adolescence (11-17 years)	179	42.8
Mixed age groups (0-17 years)	160	38.3
Sex		
Males (total N)	2,556	34.8
Females (total N)	4,782	65.2
Studies in which sex was not reported	79	-

* Algeria (1), Austria (1), Bangladesh (1), Belgium (1), Bolivia (1), Bosnia (1), Brazil (1), Bulgaria (2), Croatia (2), Czech Republic (1), Egypt (1), Finland (4), Greece (5), Hong Kong (1), Hungary (2), Indonesia (1), Iran (2), Ireland (3), Israel (2), Kenya (1), Korea (6), Lebanon (1), Libya (1), Macedonia (1), Malaysia (4), Mexico (2), Nepal (1), Netherlands (6), New Zealand (1), Nigeria (2), Norway (4), Oman (1), Pakistan (3), Poland (4), Portugal (4), Qatar (2), Saudi Arabia (2), South Africa (2), Sri Lanka (1), Sweden (5), Switzerland (3), Taiwan (3), Thailand (5), Ukraine (2), multiple countries in Africa (1)

[1] Based on the *American Academy of Pediatrics*; Adolescence is divided into 3 groups according to this classification but was collapsed into one category for the purposes of this review (>10 years of age). Late adolescence, being 18-21 years of age, was excluded from this study.

Table 3: Chronic musculoskeletal pain of the lower limb

	N = 418 studies	%
Most common conditions reported		
Juvenile idiopathic arthritis	26	6.2
Chronic widespread musculoskeletal pain	24	5.7
Spasticity-related musculoskeletal pain from cerebral palsy	20	4.8
Osteoid osteoma	14	3.3
Fracture	14	3.3
Post-surgical pain	16	3.8
ICD-11 Parent codes	N = 456 cases	
1: Certain infectious or parasitic diseases	10	2.2
2: Neoplasms	19	4.2
3: Diseases of the blood or blood-forming organs	10	2.2
4: Diseases of the immune system	20	4.4
5: Endocrine, nutritional, or metabolic diseases	14	3.0
6: Mental, behavioural, or neurodevelopmental disorders	1	0.2
7: Sleep-wake disorders	1	0.2
8: Diseases of the nervous system	35	7.7
11: Diseases of the circulatory system	1	0.2
12: Diseases of the respiratory system	2	0.4
13: Diseases of the digestive system	2	0.4
14: Diseases of the skin[a]	1	0.2
15: Diseases of the musculoskeletal system or connective tissue	171	37.5
20: Developmental anomalies	59	12.9
21: Symptoms, signs, or clinical findings, not elsewhere classified	46	10.1
22: Injury, poisoning, or certain other consequences of external causes	25	5.4
23: External causes of morbidity and mortality	2	0.4
X: Extension codes	37	8.1
Presence of a chronic pain manifestation code in cases where chronic was not the primary condition	47/418 cases	11.1
Duration of pain	N = 418 studies	%
Pain at least ≥3 months	143	34.2
Pain at least ≥6 months	65	15.6
Pain at least ≥12 months	113	27.0
Chronic, but not specified	97	23.2
Location of pain	N = 418	
Hip	73	17.5
Thigh/groin	7	1.7
Knee	111	26.6
Leg	9	2.6
Ankle	42	10.0
Foot (including toes)	32	7.7
Widespread lower limb	44	10.5
Mixed cases	96	23.0

[a]This referred to one case related to "malformations involving cutaneous blood vessels" (Code EF2Z).

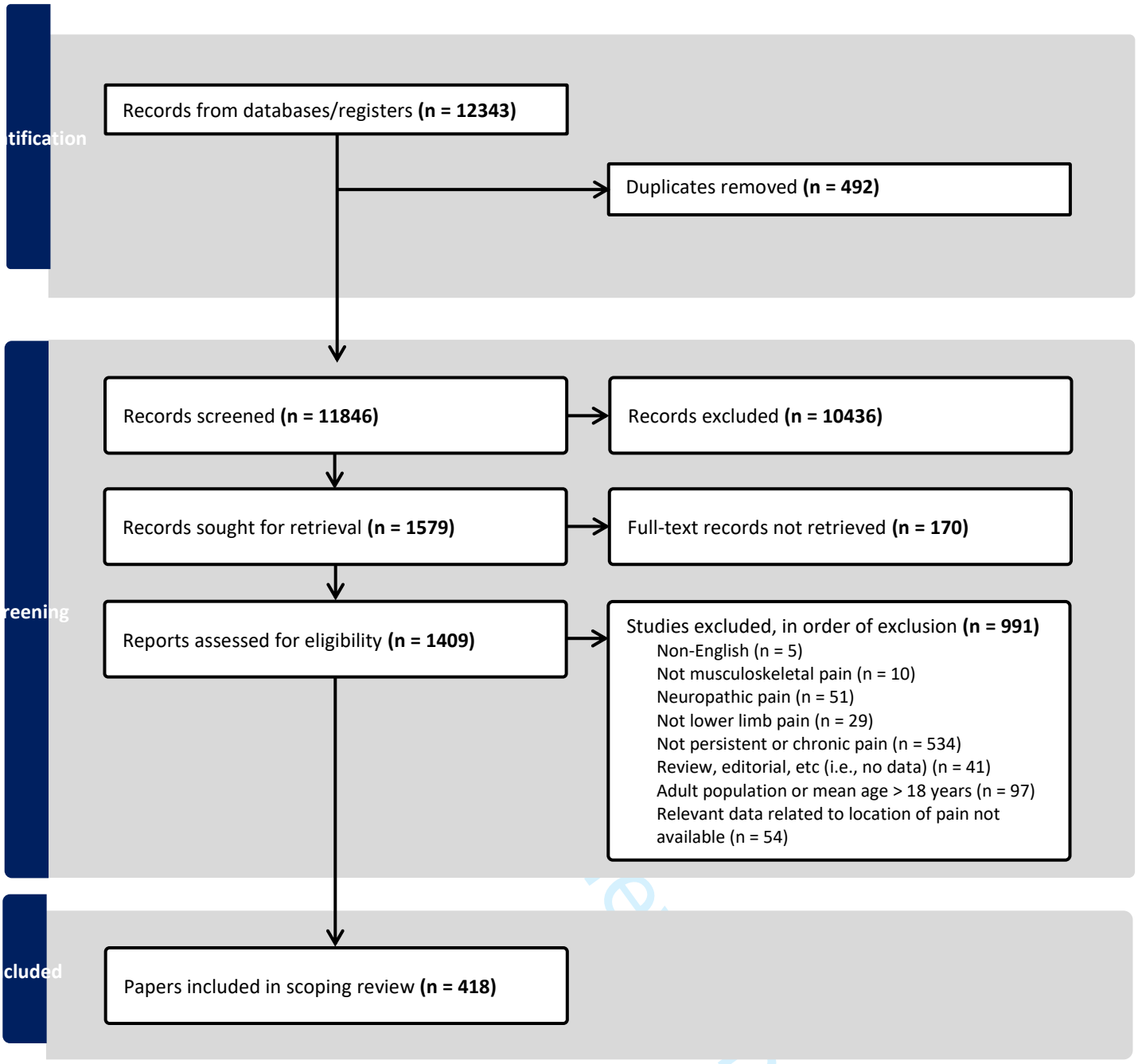
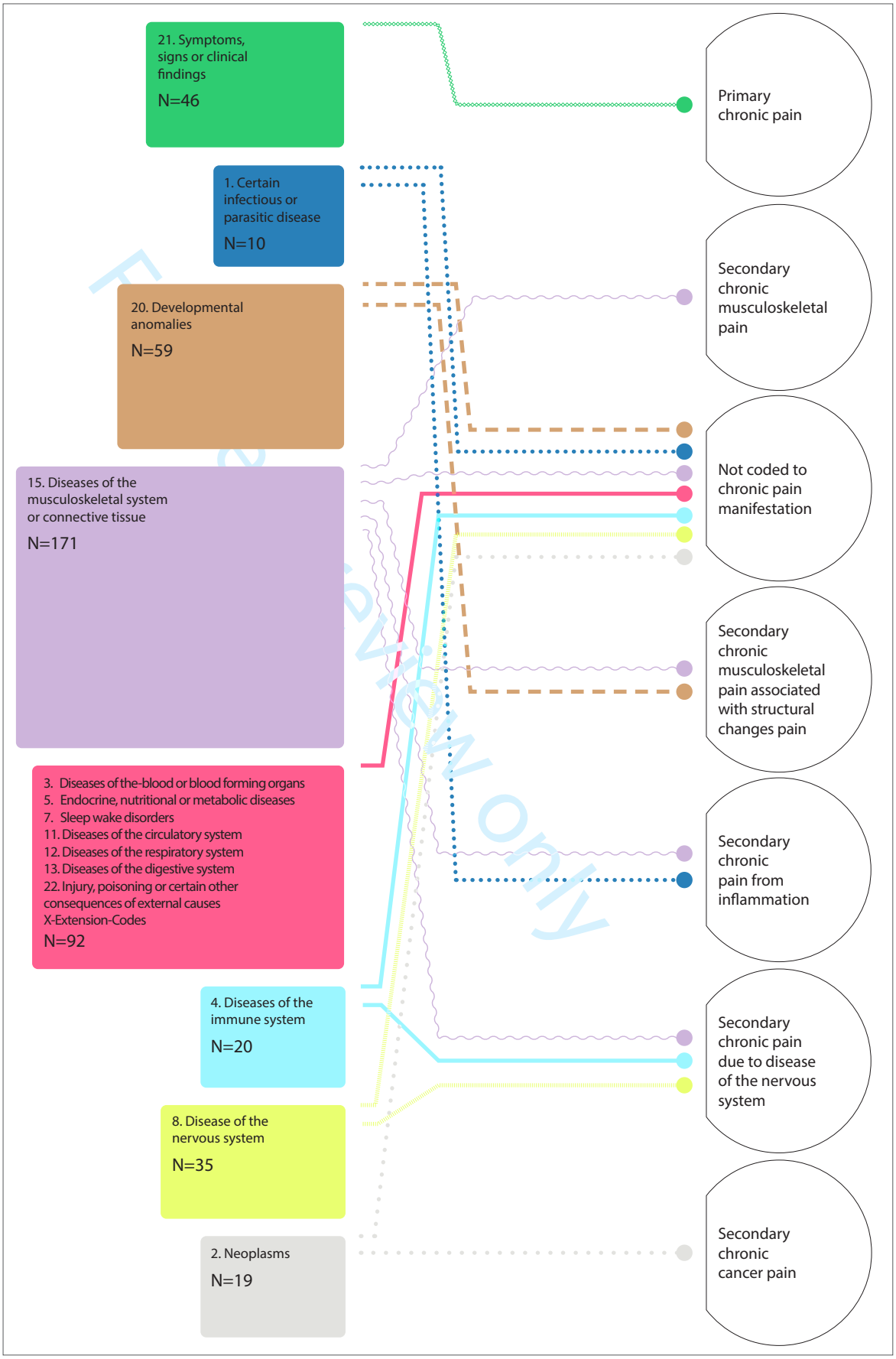


Figure 1: PRISMA flowchart of records screened and included in the scoping review.



Supplementary Table 1: Full search strategies

A. Full search strategy for Embase

Search	Query
1	Lower Limb/ or Leg/ or Hip/ or Knee/ or Ankle/ or Foot/
2	(leg* or hip* or knee* or ankle* or foot or feet or lower limb* or lower extremit*).mp.
3	1 or 2
4	Chronic Pain/ or arthralgia/ or musculoskeletal pain/ or nociceptive pain/ or postoperative pain/ or neuropathic pain/
5	((persistent or chronic or ongoing or long-term or nociceptive or musculoskeletal or post-operative or joint or neuropathic or nerve) adj3 pain).mp.
6	arthralgia.mp.
7	4 or 5 or 6
8	3 and 7
9	infant/ or child/ or adolescent/
10	(baby or babies or neonate* or newborn or child* or infant* or toddler* or paediatric* or pediatric* or teen* or adolesc* or pre-pubesc* or prepubesc* or youth* or juvenile).mp.
11	9 or 10
12	8 and 11
13	exp animals/ not humans.sh.
14	12 not 13

B. Full search strategy for PsycINFO

Search	Query
1	Lower Limb/ or Leg/ or Hip/ or Knee/ or Ankle/ or Foot/
2	(leg* or hip* or knee* or ankle* or foot or feet or lower limb* or lower extremit*).mp.
3	1 or 2
4	Chronic Pain/
5	((persistent or chronic or ongoing or long-term or nociceptive or musculoskeletal or post-operative or joint or neuropathic or nerve) adj3 pain).mp.
6	4 or 5
7	(baby or babies or neonate* or newborn or child* or infant* or toddler* or paediatric* or pediatric* or teen* or adolesc* or pre-pubesc* or prepubesc* or youth* or juvenile).mp.
8	3 and 6 and 7
9	exp animals/ not humans.sh.
10	8 not 9

C. Full search strategy for CINAHL

Search	Query
S1	(MH "Chronic Pain")
S2	"(persistent OR chronic OR ongoing OR long-term OR nociceptive OR musculoskeletal OR post-operative OR joint OR neuropathic OR nerve) AND pain"
S3	(MH "Lower Extremity+")
S4	(MH "Leg"+)
S5	(MH "Hip"+)
S6	(MH "Knee"+)
S7	(MH "Ankle"+)
S8	(MH "Foot+")
S9	"leg* OR hip* OR knee* OR ankle* OR foot OR feet OR lower limb* OR lower extremit*"
S10	S1 OR S2
S11	S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9
S12	(MH "Infant+")
S13	(MH "Child+")
S14	(MH "Adolescence+")
S15	""(baby or babies or neonate* or newborn or child* or infant* or toddler* or paediatric* or pediatric* or teen* or adolesc* or pre-pubesc* or prepubesc* or youth* or juvenile)""
S16	S12 OR S13 OR S14 OR S15
S17	S10 AND S11 AND S16

D. Full search strategy for Cochrane Library

Search	Query
#1	MeSH descriptor: [Lower Extremity] explode all trees
#2	(leg* or hip* or knee* or ankle* or foot or feet or lower limb* or lower extremit*
#3	#1 OR #2
#4	MeSH descriptor: [Chronic Pain] explode all trees
#5	(persistent or chronic or ongoing or long-term or nociceptive or musculoskeletal or post-operative or joint or neuropathic or nerve) AND pain
#6	#4 OR #5
#7	MeSH descriptor: [Infant] explode all trees
#8	MeSH descriptor: [Child] explode all trees
#9	MeSH descriptor: [Adolescent] explode all trees
#10	baby OR babies OR neonate* OR newborn or child* OR infant* OR toddler* OR paediatric* OR pediatric* OR teen* OR adolesc* OR pre-pubesc* OR prepubesc* OR youth* OR juvenile
#11	#7 OR #8 OR #9 OR #10
#12	#3 AND #6 AND #11 in Trials

Supplementary Table 2: Expanded characteristics of studies included in the review

First author	Country	Study type	Definition and average length of chronic pain	Included sample size*	Age (measure of central tendency, range, and measure of variance (SD)	Sex	Primary condition described as resulting in chronic lower limb pain	Location(s) of pain in the lower limb
Abdullah	Malaysia	Case report	Pain (>2 years)	1	17 years	Male	Pachydermoperiostosis	Knee, Ankle
Abe	Japan	Case report	Chronic (3months or longer)	1	14 years	Female	Bilateral navicular stress fracture	Foot
Abiodun	Ukraine	Cross-sectional	Chronic (3 years)	84	2-18 years	51 Female 33 Male	Juvenile idiopathic arthritis	Hip, Knee, Ankle
Abousamra	USA	Cross-sectional	Chronic (at least 1-year post op)	13	3-15 years	6 Female 4 Male	Hip instability	Hip
Abramowicz	USA	Cross-sectional retrospective	Average 4.6 years	65	Mean 11.7 (SD 3.8)	48 Female 17 Male	Systemic Arthritis (, psoriatic arthritis, enthesitis)	Knee, Ankle
Abushhaiwia	Libya	Case report	Chronic pain >3 years	1	14 years	Male	Chronic recurrent multifocal osteomyelitis	Leg
Accadbled	France	Case report	Pain >2 years	1	13 years	Male	Post - surgical Subtotal lateral meniscectomy	Knee
Adba	Qatar	Case report	Chronic Pain (>1 year)	2	3 and 6	Male	Juvenile idiopathic arthritis	Knee
Adiguzel	Turkey	Case report	8 months	1	14 years	Female	Traumatic brain injury (heterotrophic ossification associated)	Knee
Agarwal (2015)	India	Case report	Pain 4 months	1	15 years	Male	Juvenile-onset ankylosing spondylitis	Hip
Agrawal (2018)	India	Case report	Pain (>6 months)	1	13 years	Male	Pachydermoperiostosis	Hip/knee/Large joints
Aiyer	India	Case report	Pain for 3 months	1	14 years	Female	Dysplasia / Tuberculous infection	Hip
Alkadumi	USA	Case report	Pain >12months	1	16 years	Male	Chondroblastoma	Knee
Allessandrella	Spain	Case report	Chronic (5 years)	1	17 years	Male	Pachydermoperiostosis (genetic)	Knee, Ankle
Alpigiana	Italy	Case report	Chronic (>1 year)	1	15 years	Male	Juvenile idiopathic arthritis	Hip
Alqanatish	Saudi Arabia	Case report	Chronic pain (>3 months)	1	12 years	Male	Scurvy	Lower limb
Anderson	Switzerland	Case series	Chronic (Undefined)	4*	Mean 16.3 years	4 Female	Pseudotumor	Ankle
Andias	Portugal	Cross-sectional	Chronic (3months or longer)	1249*	Mean 16.4 years	819 Female	Musculoskeletal pain	Lower Limb/multiregional
Andreucci	Denmark	Cross-sectional secondary analysis	Chronic Pain (undefined)	323	Mean 14.4	237 Female 86 Male	Patellofemoral pain and Osgood-Schlatter disease	Knee
Anghelescu	USA	Retrospective review	Pain (>6 months)	129*	Mean 14 years (range 6-21)	63 Female	Post surgical pain	Thigh, shin
Arici	Turkey	Case report	Chronic (3 months or longer)	1	11 years	Female	Chronic recurrent multifocal osteomyelitis	Legs
Assafiri	USA	Case report	Pain (>3 months)	1	13 years	Male	Osteoid osteoma	Ankle
Auvinen	Finland	Cohort (two year follow up)	Pain in last 6 months	86*	15-18 years	43 Female 43 Male	Musculoskeletal pain	Knee, Ankle
Awan	USA	Case report	Chronic (6 months)	1	17 years	Male	Cuboid-navicular coalition	Foot
Azabagic	Bosnia	Longitudinal study	Chronic pain (>1 year)	310	Mean 11.3 years (range 7-14)	NR	Musculoskeletal pain	Knee, Ankle
Baghdadi	Iran	Retrospective medical record review	Chronic pain (>1 year)	13	1-18 years of age	7 Female 6 Male	Septic Arthritis	Hip
Baima	USA	Case report	Chronic pain (>3 months)	1	6 years	Male	Prosthesis-related pain (post chopart amp)	Knee, Ankle

Bakkaloglu	Turkey	Case report	Persistent pain 8 months	1	8 years	Female	ilial Mediterranean fever arthritis	Knee
Banskota	Nepal	Retrospective case series	Pain (>12 months)	30	Mean 8.5 years (range 2-16)	9 Female 21 Male	raumatic hip dislocation	Hip
Barfield	USA	Case report	Chronic pain (no time frame mentioned)	1	17 years	Female	Celiac disease	Achillies tendon/bilateral thigh and calf
Bari	Pakistan	Case report	Pain (condition gradually worsened over a few months)	1	4 years	Female	Scurvy	Lower limbs
Barut	Turkey	Cross-sectional observational	Chronic	168	16 years (IQR 9)	87 Female 81 Male	venile idiopathic arthritis	Hip, Knee, Ankle, Foot
Bauer	France	Case series	Chronic pain (15 months)	1*	16 years	Male	ngement from bimalleolar fracture	Ankle
Baydogan (2012, 2015)	Turkey	RCT	Chronic pain (no definition provided)	30	9.3 (1.4) years 6-18 years	21 Female 9 Male	venile idiopathic arthritis	Knee
Bazette-Jones	USA	Cross sectional survey	Pain frequency (ranges from daily to rarely)	437*	10-18 years	NR	Musculoskeletal pain	Hip, Knee, Ankle
Behzadi	Norway	Case report	> 2 years	1	14	Female	hiofemoral impingement	Hip
Belke	Germany	Case report	Chronic (at least 3 months)	1	12 years	Male	habdomyolysis (diabetic ketoacidosis)	Lower leg, Foot
Benaroch	USA	Case series	> 6 years	7*	15.5 years	Male	Post operative pain	Knee
BenEliyahu	USA	Case report	Chronic (Undefined)	1	17 years	Female	Exer onal compartment syndrome	Calf
Berend	USA	Case series	Chronic pain (>3 months)	8	14.9 years	NR	gg-calve-perthes-disease	Hip
Bettin	Germany	Case report	Persistent pain	1	12 years	Male	moral neck stress fracture	Hip
Bica	Brazil	Case report	Chronic pain (>1 year)	1	10 years	Male	emoral osteochondrosis	Knee
Biddeci	Italy	Cross-sectional observational	Persistent pain (Undefined)	19*	10+ years (all paediatric)	10 Female 9 Male	A ular osteonecrosis secondary to treatment for acute mphoblastic leukaemia	Hip, Knee, Ankle
Black	USA	Secondary analysis	Chronic pain (Undefined)	36	Range 12-18 years	Female	enile Fibromyalgia and Joint hypermobility	Hip, Knee, Ankle
Blackman	USA	Retrospective case series	Persistent pain (Undefined)	71	Mean 15.5 years (range 11.7-19.8)	66 Female 5 Male	l patellofemoral ligament	Knee
Blatnik	USA	Case report	Persistent pain (Undefined)	1	12 years	Female	B eral distal femur salter-harris type fracture / persistent osgood-schlatter disease	Knee
Bloch	USA	Case report	Chronic (Undefined)	1	2 years	Male	Recurrent cervical lymphadenopathy	Bilateral leg
Bloomfield	USA	Case report	Chronic (>6 years)	1	13 years	Female	Periosteal tumour	Lower Limb
Bonfiglio	USA	Case report	Chronic pain	1	13 years	Female	ogenic bone abscess / osteomyelitis (brodies abscess)	Ankle
Boulter	Australia	Retrospective medical review	Chronic pain (>3 months)	26	3-17 years	14 Female 12 Male	ystic fibrosis, reactive arthropathy, widespread musculoskeletal pain, chondromalacia patellae osteochondrosis, osteonecrosis, steochondritis dissecans	Lower limb

Bout-tabaku	Qatar	Prospective cohort	Chronic pain	219	Mean 17 years (SD 1.6 years)	167 Female 52 Male	Musculoskeletal pain	Hip, Knee, Ankle, Feet
Boyer	USA	Retrospective cohort	Chronic (at least 9 months)	86	10 years (range 4-17 years)	41 Female 45 Male	Cerebral palsy (post operative)	Hip, Knee, Ankle, Feet
Brandao	Portugal	Retrospective cohort	Chronic pain (.3 months)	143*	13 years	67 Female 76 Male	Musculoskeletal pain	Lower limb
Brix	Denmark	Retrospective cohort	Chronic pain (Undefined)	53*	3-10 years of age	30 Female 23 Male	e lymphoblastic leukaemia	Hip, Knee, Ankle
Brizini	China	Case report	Persistent pain (>3 months)	1	13 years	Male	Slipped capital femoral epiphysis / FGFR TKI inhibitor	Knee
Broström	Sweden	Cross-sectional observational study	Chronic pain (>1 year)	18	Mean 10 years (SD 3.1)	15 Female 3 Male	venile idiopathic arthritis	Hip, Knee, Ankle
Bueso	USA	Case report	Chronic pain (>6 months)	1	7 years	Male	Juvenile idiopathic arthritis	Knee
Buoncristiani	USA	Case series	Chronic pain	8	3-10 years	3 Female 2 Male	ry to tarsometatarsal joint	Foot
Burgos-Vargas	Mexico	Secondary analysis of RCT	Chronic pain (mean 4.2 years)	33	11 years	6 Female 27 Male	Enthesopathy due to spondyloarthropathy	Hip, Knee, Ankle
Busconia	USA	Case report	Chronic pain (Undefined)	10*	13 years (range 10-17)	6 Female 4 Male	hronic ankle instability	Ankle
Caldonazzi	Italy	Cross-sectional observational study	Persistent pan (Undefined)	7	Mean 11 years	6 Female 1 Male	Vitamin D deficiency	Foot
Cappuccio	Italy	Case report	Chronic pain	1	10 years	Female	PPP2A-related disorder (genetic)	Lower limb
Carozza	Australia	Cross-sectional	Chronic pain (>3months)	27	Mean 13.7	16 Female 8 Male	Cerebral palsy	Hips, knee, ankle, foot
Castle	Australia	Phenomenological study	Chronic pain (>3months)	4*	Mean 17.6 years	4 Male	Cerebral palsy	Hip
Catli (2011)	Turkey	Case report	Pain for 6 months	1	8 years	Female	Osteopetrosis tarda	Ankle
Catli (2022)	Turkey	Case report	Chronic pain (Undefined)	1	26 months	Female	Hypophosphatasia	Legs
Ceglie	Italy	Case report	Chronic pain (>7 months)	1*	4.5 years	Male	Scurvy	Leg
Ceroni	Switzerland	Case report	Chronic pain (Undefined)	1	13 years	Female	ccessory ossicle of foot	Ankle
Champion (2020)	Australia	Cross-sectional questionnaire	Chronic (3 months or longer)	104*	3-18 years	NR	Restless leg syndrome	Leg
Champion (2022)	Australia	Cross- sectional	Persistent pain (undefined)	857*	Mean 10.5 years	NR	Growing pains	Lower Limb
Chang	Taiwan	Case report	Persistent pain (>2 months)	1	14 years	Male	Juvenile idiopathic arthritis	Hip
Chaturvedi	India	Retrospective medical record review	Chronic pain (Undefined)	17*	4-14 years	14 Female 5 Male (whole sample)	hritis due to bancroftian ariasis (Filarial arthritis)	Knee, Ankle
Chollet	USA	Prospective cohort	Chronic pain (Undefined)	10*	2-14 years	NR	Osteonecrosis due to chemotherapy for ALL or non-hodgkins lymphoma	Ankle
Chua	Malaysia	Case report	Chronic pain (>3 months)	1	7 years	Female	Melorheostosis (Mesenchymal dysplasia)	Hip, Knee
Cibulka	USA	Case report	Chronic pain (>8 months)	1	15 years	Female	Patellofemoral pain syndrome	Knee
Cilliers	South Africa	Case series	Chronic pain (since infancy)	NR	NR	NR	Beukes familial hip dysplasia (autosomal dominant condition)	Hip

Cirakli	Turkey	Cross-sectional observational	Chronic (> 12 months)	16*	Mean 11 years (2-17 years)	NR	Brucellosis	Leg
Clohisy	USA	Prospective cohort	Persistent pain (Undefined)	NR	17.6 years (range 13-31.8)	NR	Acetabular dysplasia	Hip
Colgan	Ireland	Case report	Persistent pain (>3 months)	1	14 years	Male	Slipped upper femoral epiphysis	Knee
Constantinou	Australia	Case report	Chronic pain (>3 months)	1	16 years	Male	Non-union distal fibula avulsion fracture	Ankle
Corominas	Spain	Case report	Pain (18 months)	1	14 years	Male	Osteochondritis dissecans	Foot
Craig	USA	Case report	Chronic pain (Undefined)	1	9 years	Male	Activated phosphoinositide 3-kinase (PI3K) delta syndrome	Hip
Crosby	USA	Retrospective review	Pain (>12 months)	4*	Mean 12.9 years (range 8-17)	NR	Femoral shaft fracture	Hip
Curtin 2005	Ireland	Case report	Pain (18 months)	1	12 years	Male	Osteochondritis of medial lallucial sesamoid	Foot
Curtin 2010	USA	Case report	Pain (3 months)	1	16 years	Male	Bucket handle medial plica	Knee
Dagher	Lebanon	Case report	Chronic (>1 year)	1	5 years	Female	Juvenile idiopathic arthritis	Knee, Ankle
Dartnell	UK	Retrospective review	Persistent pain (Undefined)	4*	Mean 14.7 years	NR	Hip dislocation or subluxation in cerebral palsy	Hip
Das	India	Cross-sectional observational	Chronic pain (Follow up 1.6-3 years)	14	11-16 years	3 Female 11 Male	Post operative cerebral palsy	Knee
de Rooy	Netherlands	Case report	Chronic pain (6 months)	14	14 years	Female	Growth arrest at secondary growth plate	Knee
Deere	UK	Longitudinal study	Pain (>3 months)	845	Mean 17.8 years	550 Female 295 Male	Musculoskeletal pain	Hip, Thigh, Knee, Ankle, Foot
Demir (2019)	Turkey	Case series	Pain 2 years	3	<18 years	NR	Takayasu arteritis	Knee
Demir (2014	Turkey	Case report	Chronic (undefined)	1	11 years	Female	Juvenile idiopathic arthritis	Ankle
Den Hoed	Netherlands	Prospective evaluation	Persistent pain (Undefined)	30*	> 4 years osteonecrosis subgroup (range 4-18 years)	16 Female 14 Male	Osteonecrosis	Hip, Knee, Ankle
Deniz	Turkey	Case report	Pain 6 months	1	10 years	Female	Iselins disease	5th metatarsal
DePhillipo	USA	Case report	Persistent pain (Undefined)	1	11 years	Male	Osteochondral defect	Knee
Derfalvi 2022/2014	Hungary	Cross-sectional observational	Persistent pain (Undefined)	82	Mean 13.7 years (SD 3.2)	37 Female 45 Male	Crohn's disease	Hip, Knee, Ankle
Dicaprio	USA	Case report	Persistent pain (>4 months)	1	14 years	Female	Osteosarcoma	Knee
Dimitrovska	Macedonia	Case series	Chronic	49	3-14 years	23 Female 26 Male	Brucellosis	Big joints of lower limb
Doyle	USA	Case series	Pain (>4 months)	3	2.5 years, 14 years, 8 years	3 Female	Talonavicular coalition	Foot
Duan	China	Case report	>2 year history of pain	1	11 years	Female	Talonavicular coalition	Foot
Duckers	Germany	Case report	Chronic pain (8 years)	1	11 years	Female	Purpura schoenlein hennoch	Ankle

Ece	Turkey	Follow up	Chronic pain (Undefined)	111*	Mean 10 years (Range 1.5-18 years)	NR	Juvenile idiopathic arthritis	Hip, Knee, Ankle, Foot
Eichenbaum	USA	Case report	Pain (>12 months)	2	14 years 16 years	2 Male	Talus partitus	Ankle
Eisenstein	USA	Case report	Chronic pain (6 months)	1*	12 years	Female	Chronic recurrent multifocal osteomyelitis	Hip, Ankle, Foot
Ekinci	Turkey	Case report	Chronic pain (3months or longer)	1	13 years	Female	Multifocal AVN (neuropsychiatric SLE)	Knee
Eliasberg	USA	Case report	Persistent pain (Undefined)	1	17 years	Male	Meniscal ossicle	Knee
Emad	Saudi Arabia	Case study	Chronic pain (3 years)	1	12 years	Male	Lipomovitis prepatellaris (Hoffa's syndrome)	Knee
Encinas	Bolivia	Case report	Pain (15 months)	1	12 years	Female	Bechet's disease	Knee
Endo	Japan	Case report	Chronic pain (12 months)	1	16 years	Female	Chondroblastoma	Knee
Eng	USA	RCT	Pain (> 6months)	20	13-17 years	20 Female	Patellofemoral pain syndrome	Knee
Engel	USA	Cross-section observational	Chronic (>3 months)	23*	8-20 years	NR	Neuromuscular disease (e.g., DMD)	Leg, Feet
Ergen	Turkey	Case report	Pain (5 months)	1	13 years	Male	Overuse injury – triradiate cartilage	Hip
Farsetti	Italy	Case report	Chronic pain (>3 months)	1	11 years	Female	Osteochondrosis	Ankle
Fellas	Australia	RCT	Chronic pain (>3 months)	66	Mean 12 years	45 Female 21 Male	Juvenile idiopathic arthritis	Foot
Ferguson	Canada	Case report	Chronic pain (>3 months)	1	13 years	Female	Chronic recurrent multifocal osteomyelitis	Ankle
Ferrada	USA	Cross-sectional Survey	Persistent pain (Undefined)	NR	Mean 14.6 years	NR	Relapsing polychondritis	Knee, Ankle
Fisher	UK	Longitudinal	Chronic pain (>3 months)	118	Range 8-16 years	57 Female 61 Male	Lower limb injury	Hip, Knee, Lower leg, Ankle, Foot, Toe
Ford (2009)	USA	Case report	Chronic pain (2 years)	1	9 years	Female	Autoimmune polyendocrinopathy candidiasis ectodermal dystrophy	Knee, Ankle
Ford (2021)	USA	Case report	Chronic pain (Undefined)	1	16 years	Female	Patellar sleeve fracture	Knee
Foxen-craft	USA	Cross-sectional survey	Chronic pain (>6 months)	21	Mean 14.3 years	NR	Musculoskeletal pain	Hip, Knee, Ankle
Fuglkjaer	Denmark	Prospective longitudinal study	Chronic pain (>12 weeks)	NR	8-17 years	NR	Musculoskeletal pain (traumatic/non traumatic)	Thigh, Knee, Lower leg, Ankle, Foot
Funk	USA	Case report	Chronic pain (Undefined)	1	12 years	Male	Type 3 von willebrand disease	Ankle
Gallagher	USA	Case report	Chronic pain (>4 months)	1	3 years	Female	Avoidant restrictive intake disorder	Hip, Knee
Gamble	USA	Cross-sectional	Chronic pain (Undefined)	77	0-19 years	48 Female 28 Male	Pseudoachondroplasia	Hip, Knee
Garg	UK	Case report	Pain (>7 months)	1	15 years	Female	Primary diaphyseal tuberculosis	Leg
Geiduschek	USA	Cross-sectional observational study	Persistent pain (Undefined)	55	3-22 years (Median 5 years)	20 Female 25 Male	Spasticity related to cerebral palsy	Lower extremity
Gemulla	Germany	Case series	Pain (5 months)	1*	15 months	Female	Adeno or influenza virus	Ankle
George 2019	India	Case report	Pain (> 12 months)	1	15 years	Male	Slipped capital femoral epiphysis in hyperparathyroidism	Hip
George 2008	UK	Case report	Persistent pain (undefined)	2	14-16 years (Mean age 15 years)	1 Female 1 Male	Benign lesion of proximal femur	Femur
Georgoulis	Greece	Case series	Persistent pain (Undefined)	NR	13-24 years of age (mean 18 years)	NR	Osteoid osteoma	Knee

Gerberg	USA	Case report	Chronic pain	1	8 years	Male	Legg-calve-perthes disease	Hip
Gerbino	USA	Cross-sectional observational	Chronic pain (3 months)	NR	Mean age 16.9 years	NR	Patellofemoral pain syndrome	Knee
Gibbons	Canada	Case series	Chronic pain (unspecified)	1*	NR	NR	Chronic ankle pain following lateral ankle sprain	Ankle
Glard	France	Retrospective review	Pain (>10 months)	4	11-17 years	4 Female 1 Male	Os trigonum	Ankle
Gokhale	UK	Case report	Pain (>7 months duration)	1	9 years	Female	Ganglion	Hip/groin
Goraya	India	Case report	Chronic pain (3 months or >)	1	9 years	Female	Arteriovenous malformation of the knee	Knee
Gottesman	USA	Case report	Chronic pain (Undefined)	1	16 years	Female	Spondyloepimetaphyseal dysplasia	Knee
Greenberg	USA	Case report	Chronic Pain (>3 months)	1	15 years	Male	Fibular stress fracture	Lower leg
Guizar-Sanchez	Mexico	Retrospective case-matched control study	Chronic pain (Undefined)	21*	Mean 7 years	8 Female 12 Male	Cerberal Palsy	Hip
Gupta	India	Cohort study	Pain (>12 months)	1*	Mean 12.6 years	NR	Contusio acetabulae / septic arthritis	Hip
Gutierrez	Spain	Retrospective medical record review	Chronic pain (>2 years)	22*	Mean 9.4 years (SD 0.3)	NR	Flat foot	Foot
Hadef	Algeria	Case report	Chronic pain (Undefined)	1	9 yearrs	Male	Bechets disease	Hip, Knee
Hanna	UK	Case series	Pain (12 months)	2	13 years 17 years	Male	Condylar osteochondritis dissecans	Knee
Harlewijn	Belgium	Case report	Pain (> 6 months)	1	14 years	Male	Haemophilic A	Foot
Hashkes	USA	Cross-sectional observational	Chronic pain (mean 1.4 years)	11	4-15 years	3 Female 8 Male	Growing pains	Lower leg (shin, calf)
Hayat	UK	Case report	Pain (>12 months)	1	16 years	Male	Subchiofemoral impingement	Groin
Hayyun	Malaysia	Case report	Persistent pain (>5 months)	1	10 years	Male	Femoral neck stress fracture	Hip
Heinemann	Germany	Longitudinal	Chronic pain (>3 months)	10	<15 at age of diagnosis	NR	Ewing sarcoma	Lower limb
Heinen	Germany	Prospective cohort	Chronic pain (Undefined)	278*	2-17 years		Cerebral palsy (spasticity related pain)	Hip, Knee, Ankle, Foot
Helenius	Finland	Case series	Chronic pain (undefined)	28*	15.7 years (Range 3.7 - 32.8 years)	NR	Avascular bone necrosis, slipped capital femoral epiphysis, Osteochondritis dissecans of the medial femoral condyle, Osteoarthritis, meniscal tear,	Hip
Hensley	USA	Case report	Chronic pain (>6 months)	1	15 years	Male	Navicular fracture (non-displaced)	Foot
Hetsroni	USA	Retrospective office chat review	Chronic pain (>3 months, >1 year)	6	Range 14-18 years	5 Female 1 Male	Medial meniscocapsular separation	Knee
Hevesi	USA	Retrospective geographic database review	Persistent pain (Undefined)	4*	Mean 12.5 years	NR	Osteochondritis dissecans	Knee
Higuchi 2016	Japan	Case report	Persistent pian (>5 months)	1	14 years	Female	Familial neurofibromatosis type 1	Hip, Leg
Higuchi 2019	Japan	Case report	Persistent pain (3 months)	1	14 years	Male	Osteoid osteoma	Knee
Ho	USA	Case report	Pain (>8 years)	1	15 years	Male	Skeletal dysplasia and open physes	Knee

Holden	Denmark	Prospective longitudinal	Persistent pain (Mean 24 months)	220*	Median 17 years	NR	Musculoskeletal pain	Knee
Holm	Norway	Cohort	Pain (2.5 years)	21*	Mean 11.7 (range 5.5-22.4)	NR	Hip Dysplasia	Hip
Holzheimer	Germany	Case report	Chronic pain (Undefined)	1	10 years	Female	Inguinal hernia	Groin
Hong	China	Case report	Chronic pain (Undefined)	1	7 years	Male	Perthes Disease	Hip
Hori	Japan	Case series	Chronic pain (>4 years)	1*	10 years	Female	[illegible]-adipose vascular anomaly	Thigh
Hornsby	Australia	Single case experimental design	Chronic pain (>3 months)	3	Mean 10.6 years	1 Female 2 Male	Generalised joint hypermobility / chronic musculoskeletal pain	Hip, Knee, feet
Hosny	Egypt	Cohort	Consistent pain (Undefined)	3*	8-14 years	NR	Legg-calve-perthes disease	Hip
Houx	France	Cross-sectional observational	Chronic pain	33*	NR	NR	Pyrin-associated periodic syndrome	Lower limb
Howe	USA	Case report	Chronic pain (>3 months)	1	9 years	Female	Discoid lateral meniscus	Knee
Huppertz	Germany	Cross-sectional	Chronic (3 months or >)	2	Median 11 years (Range 3-16 years)	NR	Lyme arthritis	Hip, Knee, Ankle
Huang	China	Cross-sectional	Chronic (3 months or >)	18*	Mean 10 years	Male	[illegible]thene muscular dystrophy	Hip, Leg, Feet
Huynh	USA	Case series	Pain (4 month and 2-year history)	2	3 years 4 years	2 Male	[illegible]onitis, Juvenile idiopathic arthritis	Lower limb, Knees, Ankle
Ifedic	USA	Case report	Chronic pain (at least 3 months)	1	11 years	Male	Chronic recurrent multifocal osteomyelitis	Knee
Iliev	Bulgaria	Case report	Pain (several months)	1	18 years	Male	Os subtibiale	Ankle
Ismail	USA	Case report	Chronic pain (>2 years)	1	14 years	Female	Osteochondroma	Ankle
Issever	Germany	Case report	Chronic pain (>1 year)	1	10 years	Female	Accessory navicular bone	Ankle, Foot
Iwaasa	Japan	Case report	Persistent pain (>6 months)	1	16 years	Female	Plica syndrome	Knee
Jain	India	Case report	Pain (6 months)	1	13 years	Female	Primary sjogrens syndrome with distal renal tubular acidosis and metabolic disease	Hip, Knee
James 2017	USA	Case report	Pain (7 years)	1	11 years	Female	Recurrent ankle sprain	Ankle
James 2015	Australia	Cross-sectional	Paim (mean10 months)	124	Mean 10.8 years	52 Female 72 Male	Calcaneal apophysitis	Heel
Jasiexicz	Poland	Retrospective medical record review	Persistent pain (5.6 years)	1*	Mean 14 years (range 9-22 years)	NR	Accessory navicular bone	Foot
Jiang	China	Care report	Persistent pain (Undefined)	1	16 years	Female	Hoffa's fracture	Knee
Jimenez	USA	Prospective cohort	Chronic pain (>2 years)	39*	Mean 16 years	35 Female 4 Male	Femoroacetabular impingement	Hip
Johnson	USA	Retrospective medical record review	Chronic pain (>7 months)	7*	Mean 12 years (Range 2-23)	2 Female 5 Male	Klippel-trenaunay syndrome (vascular malformation)	Knee
Kalra	UK	Case report	Chronic pain (5 years)	1	9 years	Female	Recurrent rhabdomyolysis	Calves

Kamal	Indonesia	Case report	Persistent pain (>2 years)	1	10 years	Female	Osteofibrous dysplasia	Tibia
Kaplan	USA	Case report	Chronic pain (Undefined)	1	16 years	Female	Chondrolysis	Hip
Karadag	Tirkey	Case report	Pain (>3 months)	1*	3 years	Female	Hyperimmunoglobulin D syndrome	Leg
Kaser	USA	Case report	Chronic pain (>3 months)	1	11 years	Female	Chondroblastoma	Knee
Kashikar-Zuck	USA	Clinical trial	Chronic pain (undefined)	135	Mean 15.6 years	120 Female 11 Male 4 Trangender /Non binary	Primary chronic musculoskeletal pain	Lower limb
Kaspiris	Greece	Retrospective	Chronic pain (Undefined)	130*	Mean 8.6 years (SD 2.5)	69 Female 63 Male	Growing pain	Leg
Kawaji	Japan	Case report	Chronic pain (>3 months)	1*	16 years	Female	Autosomal dominant precocious osteoarthropathy	Hip
Kawakami	Japan	Case report	Chronic pain (>2 years)	1	9 years	Male	Extraskeletal para-articularosteochondroma	Ankle
Kaymaz	Turkey	Case report	Pain (3 months)	1	16 years	Male	Patella chondroma	knee
Keeratisiroj	Thailand	Cross-sectional observational	Pain (7days, 12 months)	270*	Range 10-19 years	NR	Musculoskeletal pain	Hip, Knee, Ankle
Kehoe	USA	Case series	Chronic pain (>11 months)	1*	11 years	Male	Os sustentaculum tali fracture adjacent to talocalcaneal tarsal coalition Kempert	Foot
Kempert	USA	Cross-sectional observational	Chronic pain (at least 3 months)	109	8-19 years	73 Female 15 Male	Musculoskeletal pain	Lower limb
Kernbach	USA	Case series	Chronic pain (>16 months)	6	12-17 years	NR	Middle facet talocalcaneal coalition	Ankle
Khan 2014	UK	Case report	Chronic pain (10 months)	1	14 years	Male	Iliopsoas iliaccus haematoma after apophyseal injury	Hip
Khan 2018	USA	Case report	Chronic pain (several months)	1	11 years	Female	Septic arthritis	Hip
Kizilkaya	Turkey	Case report	Pain (3 years)	1	7 Years	Male	Skeletal dysplasia	Knee, Ankle
Knaus	Norway	Retrospective medical record review	Chronic pain (>3 months)	4*	Mean 15 years (Range 3-27)	Male	Post operative proximal femoral resection arthroplasty	Hip
Kramer	USA	Case series	Chronic pain (>3 months)	14	9-18 years	NR	Osteochondritis dissecans	Knee
Kreetapirom	Thailand	Case report	Pain (>3 months)	1	15 years	Male	Hyperthyroidism	Hip
Krishnamoorthy	USA	Case report	Severe pain (2 years)	1	17 years	Female	Primary hyperthyroidism	Knee
Krutzke	Germany	Case report	Chronic pain (>3 months)	1	15 years	Female	COPA syndrome	Knee, Ankle, Foot
Kumar (2001)	India	Retrospective study	Pain (9 months)	7	Mean 15 years	NR	Undifferentiated spondyloarthropathy	Hip, Knee, Ankle
Kumar (2017)	India	Cross-sectional observational	Chronic pain (>3 months)	94*	5-16 years	NR	Primary chronic musculoskeletal pain	Lower limb
Labotka	USA	Observational	Pain (undefined)	49	Mean 18 years	NR	Sickle cell disease	Leg
Lager	Sweden	Cross-sectional	Chronic (3 months or >)	38*	15 years	NR	Spinal muscular atrophy, duchenne and becker muscular dystrophy	Leg
Lambrechts	USA	Case report	Chronic pain (>12 months)	1	15 years	Male	Heterotopic ossification of rectus femoris post AIIS avulsion fracture	Hip

LaMont	USA	Retrospective chart review	Persistent pain (>12 months)	19	Mean 15 years (range 9.5-17)	5 Female 14 Male	Injured discoid meniscus segment	Knee
Larson	USA	Cross-sectional	Chronic (>1 year)	28*	Mean 13 years (range 6-17)	NR	Slipped capital femoral epiphysis	Hip, Knee
Lavoie	USA	Case report	Chronic (4 years)	1	11 years	Male	Philadelphia chromosome-positive CML	Leg
Lee 2015	Korea	Cross-sectional observational	Chronic (6 months)	20	Mean 11 years (SD 2)	8 Female 12 Male	Symptomatic flexible flat foot	Foot
Lee 2015	Korea	Cross-sectional observational	Chronic (6 months)	20	Mean 9.1 years (SD 2.32)	13 Female 7 Male	Growing pain	Lower limb
Lefkir	Algeria	Case series	Pain (>3 months)	1*	14 years	Female	Juvenile angio-bechet's disease	Knee
Lepore	Canada	Case report	Persistent pain (5 months & >3 years)	2*	9 years 14 years	Female	Polyarticular juvenile arthritis	Groin, Knee
Lequang	USA	Case report	Pain (>3 years)	1	15 years	Female	Von Willebrand factor I type A variant	Knee
Lescot	France	Prospective cohort	Persistent pain (undefined)	4*	Median 13 years (range 10-15)	NR	Post-surgical pain	Foot
Li	China	Case report	Pain (6 months)	1	13 years	Female	Wilson disease	Knee
Liu	Taiwan	Case report	Chronic pain (>4 months)	2	2 months & 2 years	Male	Spinal meningioma	Knee
Logan (2021)	USA	Retrospective review	Pain (11 months)	51*	Mean 11 years	NR	Symptomatic discoid meniscus	Knee
Logan (2010)	USA	Case report	Pain (>3 years)	1	8 years	Female	Limb length secondary to ABI	Hip
Lolekha	Thailand	Prospective cohort	Chronic pain (>3 months)	4*	Range 4-11 years	NR	Human immunodeficiency virus	Lower limb
Lu	China	Case report	Pain (3 years)	1	9 years of age	Male	Pyogenic arthritis	Knee, Ankle
Luhmann	USA	Retrospective review	Chronic pain (>12 months)	9	Mean 14.6 years (range 10.3-19.9)	1 Female 8 Male	Painful idiopathic rigid flatfoot	Foot
Luthi	Switzerland	Case report	Chronic pain (>3 months)	1	16 years	Male	Complication of oral retinoids	Knee
Lyback	Finland	Cross-sectional observational	Chronic pain (>3 months)	15*	Range 1.5-16 years	NR	Juvenile rheumatoid arthritis	Knee
Macdonald	USA	Case report	Chronic pain (Undefined)	1	7 years	Female	Post fibular fracture	Ankle
Maj	Malaysia	Case report	Chronic pian (>6 months)	1	11 years	Female	Anterior horn deficient discoid meniscus	Knee
Majumder	India	Case report	Chronic pain (>3 months)	1	5 years	Male	Pigmented villonodular synovitis	Knee
Malec	USA	Case report	Persistent pain (several months)	1	14 years	Female	FVII deficiency	Knee
Mardanpour	Iran	Case report	Pain (4 month history)	1	11 years	Female	Calcaneus osteosarcoma	Ankle
Mariani	Italy	Retrospective review	Chronic pain (>1 year)	1*	Mean 15 years	Male	Chronic patella instability	Knee
Maru	Japan	Case report	Chronic pain (>3 months)	1	12 years	Female	Chondroblastoma	Hip
Masiero	Italy	Cohort	Persistent pain (>3 months)	2584	Mean 15 years (SD 1.21)	NR	Musculoskeletal pain	Hip, Knee, Ankle
Maslon	Poland	Observational	Permanent pain (Undefined)	11*	Mean 9.6 years	NR	Cerebral palsy	Hip
Masud	Bangladesh	Case report	Chronic pain (>2 years)	1	15 years	Female	Giant cell tumour	Tibia

Matava	USA	Retrospective review	Pain (4 months, 12months)	3*	Mean 12.7 years	NR	Slipped capital femoral epiphysis	Hip, Leg, Knee
Mattila	Finland	Retrospective review	Chronic pain (>2 years)	14	Mean 6 years	6 Female 8 Male	Intra-articular venous malformation of the knee	Knee
Mauro (2018)	Italy	Case report	Chronic pain (6 months)	1	16 years	Female	Pigmented villonodular synovitis	Knee
Mauro (2018a)	Italy	Case series	Chronic pain (several months)	1	7 years	Female	Beta thalassemia minor	Hip, Knee, Ankle
Maximen	France	Case report	Chronic pain (6 months)	1	17 years	Male	Hemangioendothelioma	Knee
May	USA	Retrospective review	Chronic pain (>6 months)	52	Mean 12.5 years (range 3-19)	NR	Osteoid osteoma	Hip, Thigh, Knee
Mazzella	Australia	Cross-sectional cohort	Pain (>2 years)	28*	Mean 14.31years	12 Female 16 Male	Patellofemoral pain	Knee
McKinnon	Australia	Cross-sectional observational	Chronic pain (>3 months)	75	Range 5-18 years	NR	Cerebral palsy	Lower limb
Mehdinasab	Pakistan	Case report	Chronic pain (1.5 years)	1	15 years	Female	Osteoid osteoma patella	Knee
Menge	USA	Case report	Chronic pain (>3 months)	1	14 years	Male	Distal malleolar stress fracture	Ankle
Mensink	Netherlands	Cross-sectional case control	Chronic pain (Undefined)	16	Mean 14.8 years	12 Female 4 Male	Juvenile idiopathic arthritis	Knee
Messia	Italy	Case report	Chronic (>1 year)	1	4 years	Female	Aging associated vasculopathy (SAVI)	Knee, Ankle
Messner	Sweden	Case series	Chronic pain (>12 months)	1	18 years	1 Female 1 Male	Chondral damage due to trauma	Knee
Miettunen	Canada	Prospective	Chronic pain (>3 months)	40	Range 0-18 years	NR	Osteonecrosis related to chemotherapy (ALL)	Hip, Knee
Miltner	Germany	Prospective cohort	Chronic pain (>6 months)	27	Range 13-18 years	24 Female 3 Male	Patellar hypertension syndrome	Knee
Mir	India	Case report	Chronic pain (2 years)	1	17 years	Male	Osteoblastoma of talus body	Ankle
Miro	Spain	Cross-sectional	Chronic pain (Undefined)	115	Mean 14 years (SD 3)	44 Female 56 Male	Chronic pain in context of physical disability (Cerebral palsy, Neuromuscular disease, Spina bifida),	Hips, Leg, Feet
Miyazaki	Japan	Case report	Chronic (9 months)	1	16 years	Female	Chondroblastoma	Knee
Moore	Canada	Case report	Chronic (3 years)	1	8 years	Male	Lyme arthritis	Knee
Morris	USA	Case report	Chronic pain (>6 months)	1	11 years	Male	Osteoid osteoma	Ankle, Foot
Mortensen	USA	Case report	Chronic pain (6 months)	1	15 years	Male	Ischial osteoid osteoma	Hip
Motsis	Greece	Case report	Chronic pain (2 years)	1	16 years	Female	Intra-articular synovial lipoma	Knee
Moukoko	France	Cohort	Chronic pain (>12 months)	36	Mean 8 years	26 Female 10 Male	Subfibular ossicle	Ankle
Muramastsu	Japan	Case series	Chronic pain (>3 months)	8*	Range 0-17 years	3 Female 5 Male	Synovial hemangioma	Knee
Muschol	USA	Case report	Pain (5 months)	1	5.5 years	Male	Hypertrophic medial plica / medial femoral condyle damage	Knee
Naranje	India	Case report	Chronic pain (>6 months)	1	10 years	Male	Cirsoid aneurysm	Knee

Nayak	USA	Case report	Chronic pain (Undefined)	1	12 years	Female	Chronic dislocated hip	Hip
Nemcovaf	Denmark	Retrospective medical record review	Chronic pain 2-84 months)	21	Mean 10.5 years	12 Female 9 Male	Chronic recurrent multifocal osteomyelitis	Lower extremities
Nevins	USA	Case report	Pain (>6 months)	1	10 years	Male	Lipoma arborescence	Knee
Ningegowda	India	Case report	Chronic pain (>1 year)	1	13 years	Male	Chondroblastoma	Ankle
Novaczyk	USA	Retrospective cohort	Chronic (months or >)	265	Range 9-11 years	NR	Cerebral palsy	Hip, Knee, Ankle, Foot
Novais	USA	Prospective cohort	Chronic (Undefined)	13*	Range 9-18 years	2 Female 11 Male	Osteonecrosis of femoral head	Hip
Nwachukwu	USA	Retrospective medical record review	Chronic pain (post-op, >6 months f/u)	11*	Mean 16.2 years (range 13-18)	NR	Arthrofibrosis following ACL reconstruction	Knee
Nwankwo	Nigeria	Case report	Chronic pain (>3 months)	1	11 years	Female	Dermatomyositis	Lower limbs
Oh	Korea	Retrospective with single follow up	Chronic (6 months)	10	Mean 15.6 years (range 10-22)	5 Female 5 Male	Idiopathic flat foot	Ankle, Foot
Oshlyanska	Ukraine	Case report	Chronic pain (>3 months)	1	14 years	Male	Paraneoplastic arthritis	Knee
Pacey 2014	Australia	Intervention	Chronic pain (Undefined)	9*	Mean 11.6 years	NR	Joint hypermobility syndrome	Knee
Pacey 2013	Australia	RCT	Chronic pain (Undefined)	265	Mean 12.04 years (SD 2.93)	18 Female 8 Male	Generalised joint hypermobility	Knee
Padeh	Israel	Cross-sectional observational	Chronic pain (Undefined)	61	Mean 9.4 years	47 Female 24 Male	Juvenile rheumatoid arthritis	Hip, Knee, Ankle
Padhye	Australia	Retrospective medical record review	Persistent pain (undefined)	20	Mean 13 years	NR	Osteonecrosis	Hip, Knee, Ankle
Paluska	USA	Case report	Persistent pain (3 months)	1	11 years	Male	Osteomyelitis	Thigh
Papakonstantinou	Greece	Retrospective review	Persistent pain (Undefined)	5	Median 12 years	3 Female 2 Male	Osteonecrosis	Hip, Knee
Park	Korea	Case report	Chronic pain (>1 year)	1	16 years	Male	Recurrent macrophage activation syndrome	Ankle
Paruk	South Africa	Case series	Chronic pain (>3 months)	2	13 years 17 years	Male	Primary hyperthyroidism	Knee, Ankle
Patel	India	Case report	Chronic pain (>3 years)	1	12 years	Male	Wilsons disease	Knee
Perez	Spain	Case report	Pain (>3 years)	1	7 years	Male	Haploinsufficiency of A20 with novel mutation p.W365R	Lower limbs
Pietrzak	Australia	Case report	Chronic pain (>6 months)	1	16 years	Female	Patellofemoral pain syndrome and iliotibial band syndrome	Knee
Pilbury	UK	Case report	Pain (>4 years)	1	12 years	Male	Cystic fibrosis	Knee
Pill	USA	Retrospective case series	Chronic pain (Undefined)	23	Mean 10.4 years (range 8-13)	15 Female 8 Male	Symptomatic os subfubare	Foot
Pinto (data combined with Paredes)	Portugal	Cross-sectional	Chronic pain (3 months or >)	18*	Range 10-17 years	NR	Haemophilia	Knee, Ankle
Poirot	France	Cohort study	Pain (Long duration)	65*	Mean 6.79 (SD±1.93)	NR	Cerebral palsy	Hip, Knee, Feet
Porter-Bishop	New Zealand	Case report	Chronic pain (Undefined)	1	12 years	Male	Von Willebrand disorder	Ankle
Portin	USA	Case report	Chronic (3 months or >)	1	7 years	Male	Juvenile idiopathic arthritis	Ankle

Pouliquen	France	Retrospective medical record review	Chronic pain (>2 years)	25	Range 6-16 years	20 Female 5 Male	Anatomical variant “Too long” posteromedial calcaneal process	Foot
Pountney	UK	Randomised trail	Chronic pain (>6 months)	6	Mean 12.1 years	2 Female 4 Male	Cerebral palsy	Hip
Pourbordbari	Denmark	Cross-sectional population	Chronic pain (median pain 5 months)	56*	Median 13 years (IQR 12-16.5)	NR	Musculoskeletal pain	Knee, Ankle, Foot, Heel
Poutoglidou	Greece	Case report	Chronic Pain (4 months)	1	10 years	Male	Pigmented villonodular synovitis	Knee
Powell	USA	RCT	Persistent pain (>1 month, less than 24 months)	25*	Mean 12.4 years	NR	Juvenile idiopathic arthritis	Foot, Ankle
Prakash	India	Case report	Chronic pain (>6 months)	1	8 years	Male	Metatarsal tubercular osteomyelitis	Foot
Prigent	France	Case report	Chronic pain (>18 months)	1	13 years	Male	Traumatic lower limb amputation	Foot
Provenzano	Sweden	Cross-sectional	Chronic pain (Undefined)	27	Median 11 years	NR	Osteogenesis imperfecta	Hip, Knee, Foot
Pybus	UK	Case report	Chronic pain (>3 months)	1	4 years	Female	Takayasu arteritis	Lower limbs
Rao 2021	USA	Case report	Chronic pain (>6 months)	1	13 years	Female	Osteochondroma	Knee
Rao 2020	USA	Case report	Persistent pain (6 months)	1	13 years	Male	Ewings sarcoma	Hip, Thigh, Knee
Rathleff 2013	Denmark	Cross-sectional population based	Chronic pain (>36 months)	57*	Mean 17.2 years	Female	Patellofemoral pain syndrome	Knee
Rathleff 2013	Denmark	Cross-sectional	Chronic pain (>18 months)	57*	Mean 17 years (SD ±1.1)	Female	Patellofemoral pain syndrome	Knee
Rathleff 2019	Denmark	Prospective longitudinal	Chronic pain (>2 years)	169*	Mean 17 years	Female	Musculoskeletal pain	Knee
Rathleff 2016	Denmark	Prospective longitudinal	Chronic pain (>2 years)	180*	Mean 17 years	Female	Patellofemoral pain syndrome	Knee
Raza	UK	Case report	Chronic pain (>1 year)	1	12 years	Female	Synovial chondromatosis	Hip
Remesal	Spain	Case report	Chronic pain (>1 year)	1	9 years	Female	Chronic infantile neurologic, cutaneous, and articular syndrome (CINCA)	Knee
Rethlefsen	USA	Retrospective medical record review	Chronic pain (>3 years)	46*	Mean 10.5 years (SD±2.1)	NR	Post-op calcaneal lengthening/lengthening osteotomy	Foot
Riaz	UK	Case report	Chronic pain (>9 months)	1	15 years	Male	Osteochondral lesion	Ankle
Richard	USA	Prospective longitudinal	Chronic pain (>12 months)	51	Mean 17.6 years (range 12-21)	32 Female 19 Male	Post-operative hip preservation surgery	Hip
Rodrigo	Sri Lanka	Case report	Chronic pain (>3 months)	1	17 years	Male	Tuberculosis infection	Knee
Roth	Germany	Case report	Pain (12 months)	1	7 years	Female	Oligoarticular juvenile idiopathic arthritis	Leg
Rukavina	Croatia	Case report	Chronic pain (>3 months)	1	13 years at onset	Female	Primary OA w/ spondyloepiphyseal involvement (mutation of type II collagen gene COL2AI)	Hip, Knee, Ankle
Ryan	USA	Case report	Pain (1.5 years)	1	15 years	Female	Sacral osteoid osteoma	Leg, Knee

Sahin	Turkey	Case report	Chronic pain (14 years)	1	17 years	Female	Synovial haemangioma	Knee
Salvati	Italy	Case series	Chronic pain (>6 months)	1	17 years	Male	Osteonecrosis femoral head	Hip
Salzman	USA	Case report	Chronic pain (Undefined)	1	3 years	Female	Tuberculous osteomyelitis	Hip
Sams	USA	Case report	Persistent pain (>12 months)	1	13 years	Male	Developmental dysplasia & dislocation of the patella	Knee
Sanchis-Alfonso	Spain	Case report	Persistent pain (several months)	1	16 years	Female	Localised Pigmented Villonodular Synovitis	Ankle
Santora	USA	Case report	Persistent pain (Undefined and 9 months)	1	11 & 12 years	Female	Intraarticular loose body	Hip
Santos-Pereira	Portugal	Case report	Chronic pain (>6 months)	1	13 years	Female	Tillaux Fracture	Ankle
Sarage	USA	Case series	Chronic pain (>4 months)	1	15 years	Female	Calcaneo-navicular tarsal coalition	Foot
Sasapu	USA	Case report	Persistent pain (5 months)	1	10 years	Female	Osteoid osteoma	Leg
Schejbalova	Czech Republic	Retrospective medical record review	Chronic pain (>3 months)	4*	Ramge 9-18 years of age	NR	Cerebral palsy	Hip
Schils	USA	Retrospective medical record review	Pain (several months)	2*	Range 16-34 years	NR	Medial malleolar stress fracture	Ankle
Schuett	USA	Retrospective medical record review	Chronic pain (>3 months)	32*	Mean 14.4 years (SD ±1.4)	NR	Pelvic apophyseal avulsion fracture	Hip
Scott	USA	Case report	Chronic pain (>3 months)	1	7 years	Female	Multiple epiphyseal dysplasia	Lower limbs
Sekiya	USA	Case report	Chronic pain (>1 year)	1	17 years	Male	Acetabular impingement	Hip
Shabir	Pakistan	Retrospective medical record review	Chronic pain (>6 months)	5*	Range 2-5 years	NR	Congenital dislocation of hip	Hip
Shah (2016)	USA	Case report	Pain (4 months)	1	6 years	Male	Vitamin D deficiency	Lower limb
Shah (2022)	USA	Case report	Persistent pain (several years)	1	13 years	Female	Intra-adipose vascular anomaly	Thigh
Sharma	USA	Case report	Persistent pain (>2 years)	1	12 years	Male	Musculoskeletal pain syndrome	Hip, Knee
Shetty	USA	Case report	Chronic pain (>7 months)	1	7 years	Female	Osteoid osteoma	Hip
Shimomura	Japan	Case report	Persistent pain (undefined)	1	9 years	Female	Chronic non-bacterial osteomyelitis	Knee
Shiner	USA	Case report	Pain (3 months)	1	9 years	Female	Acute lymphoblastic leukemia	Knee, Ankle
Shore	USA	Retrospective medical record review	Pain (12 months)	29*	Mean 17 years	NR	Legg-calve-perthes	Hip
Shtarker	Israel	Retrospective medical record review	Chronic pain (Undefined)	4*	11,12,13,16 years	NR	Angular and rotational deformities of the lower limb	Lower limb
Shukla	UK	Case series	Chronic pain (>3 months)	4*	11, 14,15	1 Female 3 Male	Osteoid osteoma	Foot
Singh 2003	USA	Case report	Pain (2 years)	2	13 & 15 years	Female	Talar patello-scaphoid osteolysis	Knee, Ankle
Singh 2010	USA	Case report	Chronic pain (>5 months)	1	16 years	Female	Chronic synovitis	Knee
Sink	USA	Retrospective review	Chronic pain (>3 months)	35	Mean 16 years (range 13-18)	30 Female 5 Male	Femoroacetabular impingement	Hip

Sitati	Kenya	Case report	Pain (1 year)	1	10 years	Male	Sever disease	Heel
Skelley	USA	Case report	Chronic pain (Undefined)	1	13 years	Male	Slipped capital femoral epiphysis with vitamin D deficiency	Hip
Smedbraten	Norway	Cross-sectional	Bodily pain (undefined)	569	Mean age 10.4 (4th from); 15.5 (9th form)	NR	Musculoskeletal pain	Knee
Somorjai	Netherlands	Case report	Persistent pain (>3 years)	1	16 years	Male	Intra-articular plica	Ankle
Sonobe	Japan	Retrospective	Pain (3 months)	2*	Mean 6 years	Female	Synovial hemangioma	Knee
Sornay-Soares	France	Retrospective	Pain (12 months)	10	Mean 14.9 years	Female	Juvenile idiopathic arthritis	Knee
Speirs	USA	Case series	Chronic pain (>1 year)	1	14 years	Female	Focal periphyseal oedema	Knee
Spencer-Gardner	USA	Retrospective review	Chronic pain (>3 months)	10	Mean 18 years	NR	Ischial tuberosity apophyseal fracture	Hip
Sperotto 2013/2015	Italy	Cohort	Chronic pain (>3 years)	38*	Mean 14 years (range 8-16)	NR	Benign joint hypermobility / idiopathic musculoskeletal pain	Hip, Lower limb
Sredkova-Ruskova	Bulgaria	Case report	Chronic pain (undefined)	1	12	Female	Ehlers-Danlos syndrome and mutation in COL5A1 gene	Knee, Ankle
Stanton	USA	Retrospective medical record review	Chronic (3 months or >)	36*	Mean 13.4 years (range 8-19)	24 Female 12 Male	Complex Sympathetic Dystrophy	Hip, Knee, Ankle
Steel	UK	Case series	Chronic pain (Undefined & 4 years)	2	10 & 11 years	Male	Sacral/pelvic mass (NF1 and Fibroma - both leading to hip dislocation)	Hip
Stein 2010	USA	Case report	Chronic (Undefined)	1	13 years	Male	Cerebral palsy	Hip
Stein 2005	USA	Case report	Chronic (Undefined)	1	13 years	Male	Cerebral palsy	Hip
Styles	USA	Case series	Chronic pain (Undefined)	9*	Range 9-21 years	3 Female 5 Male	Sickle cell disease	Hip
Su	Taiwan	Prospective cohort	Pain (>6 months)	11*	Mean 14.4 years (Range 10-25)	NR	Hip dysplasia	Hip
Suh	Korea	Case report	Persistent pain (7 months)	1	9 years	Male	Osteonecrosis	Foot
Sulko	Poland	Case report	Pain (>12 months)	1	17 years	Male	Osteomyelitis and lymphoma	Hip, Knee
Suzuki	Japan	Cohort	Persistent pain (Undefined)	NR	Mean 8 years (range 5-13)	NR	Perthes disease	Hip
Syu	USA	Case report	Chronic pain (>3 months)	1	11 years	Female	Chronic recurrent multifocal osteomyelitis	Hip, Knee, Ankle
Szer	USA	Cross-sectional observational	Chronic pain (>3 months)	12*	Range 2-15 years	NR	Lyme arthritis	Hip, Knee, Ankle
Szesz	Poland	Prospective non-controlled clinical follow-up	Chronic pain (>8 months)	4	Mean 10 years	NR	Post surgical pain	Foot
Tanir	Turkey	Retrospective medical record review	Chronic pain Symptoms ranging from 2 to 900 days	69*	Mean 9.02 (SD 3.59)(range 1-16)	NR	Brucellosis	Hip, Knee, Ankle
Taniwaki	Japan	Case series	Persistent pain (>3 months)	2	9 years	1 Female 1 Male	Musculoskeletal pain	Toe
Tenuta	USA	Retrospective medical record review	Chronic pain (12-120 months)	10*	Mean 14 years	NR	Cerebral palsy	Hip
Tezel	Turkey	Case report	Chronic pain (>5 years)	1	10 years	Female	Rickets	Lower limb

Thomas	UK	Case report	Chronic pain (>3 months)	1	17 years	Male	Juvenile osteochondritis dissecans	Knee
Timm	USA	Prospective cohort	Chronic pain (at least 6 months)	76*	Mean 13.9 years	NR	Ankle sprain	Ankle
Tippett	USA	Case report	Chronic pain (>3 months)	1	8 years	Male	Perthes disease	Knee
Tiwara	India	Prospective observational	Persistent severe pain (>6 months)	25	Mean 9.08 years (range 4-12)	NR	Legg-calve-perthes	Hip
Tobias	UK	Prospective cohort study	Chronic pain (>3 months)	1299	Mean 13.8 years	776 Female 523 Male	Joint hypermobility	Lower limb
Tompkins	USA	Case series	Chronic pain (>3 months)	3*	15 and 17 years	2 Female 1 Male	Chondral defects of patella	Knee
Tonsoline	USA	Case report	Pain (>6 months)	1	16 years	Male	Adductor tendinitis	Groin
Toro	Italy	Case report	Persistent pain (>3 months)	1	15 years	Male	Femoral neck fracture	Hip
Trager	USA	Case report	Chronic pain (>3 months)	1	15 years	Male	Juvenile osteochondritis dissecans	Knee
Traore	Africa	Case report	Chronic Pain (Undefined)	1	17 years	Female	Juvenile idiopathic arthritis	Knee, Feet
Tripathy (2013)	UK	Case report	Pain (>4 months)	1	12 years	Male	Hoffa fracture	Knee
Tripathy (2020)	India	Case series	Chronic pain (>3 months)	3*	Mean 9 years (range 4-17)	2 Female 1 Male	Fibrous dysplasia (mono-ostotic polyostotic)	Hip, Leg, Tibia
Tsimicalis	Canada	Prospective cohort	Chronic pain (>4 months)	25*	Mean 12 years (8-19 years)	NR	Osteogensis imperfecta	Hip, Ankle
Turati	Italy	Case report	Chronic pain (undefined)	1	11 years	Female	Osteochondroma	Foot
Tuzuner	Turkey	Case report	Chronic pain (>1 year)	1	14 years	Female	Osteoid osteoma	Ankle
Ukarapong	USA	Case report	Chronic pain (Undefined)	1	13 years	Male	Homozygous mutation of ALPL and mild form of hypophosphatasia	Knee
Ulu	Turkey	Prospective cohort	Chronic pain (3 months or >)	8*	Median 12 years (range 3-17)	NR	Chronic non-bacterial osteomyelitis	Ankle
Umrani	Oman	Case report	Persistent pain (>4 months)	1	8 years	Male	Osteosarcoma	Hip
Unadkat	Africa	Case series	Chronic pain (>5 months)	1	2 years	Female	Acute lymphoblastic leukemia	Lower limb
Uwaezuoke	Nigeria	Case report	Chronic pain (3 years)	1	14 years	Male	Osgood-schlatter's disease	Knee
Van Leeuwen	Netherlands	Prospective cohort	Chronic pain (>3 months)	157	13 years	100 Female 57 Male	Musculoskeletal pain	Hip, Knee, Ankle, Foot
Van straalen	Netherlands	Prospective cohort	Chronic pain (>3 months)	196	Range 5-16 years	149 Female 47 Male	Juvenile idiopathic arthritis & chronic musculoskeletal pain	Hip, Knee, Ankle
Vijayan	USA	Case report	Pain (6 months)	1	9 years	Female	Juvenile idiopathic arthritis	Knee
Villalba	Spain	Prospective cohort	Pain (>6 months)	5	Mean 15.2 years (range 12-18)	1 Female 4 Male	Osteochondritis dissecans	Knee
Vukic	Croatia	Case report	Chronic pain (>3 months)	1	15 years	Female	Juvenile fibromyalgia	Hip
Waisel	USA	Case report	Chronic pain (Undefined)	1	13 years	Female	Ehlers-Danlos	Knee, Ankle
Wang 2020	USA	Prospective cohort	Chronic pain (>12 months)	22*	Mean 12.3 years (SD±6.8)	NR	Fibrofadipose vascular anomaly (FAVA)	Hip, Knee, Ankle, Foot

Wang 2021	China	Retrospective medical record review	Chronic pain (post-op follow up 10-71 months)	6 (feet)	Mean 12.8 years (range 11-20)	NR	Sinus tarsi pain following subtalar arthroereisis	Foot
Ward (2004)	Canada	Case report	Chronic pain (Undefined)	1	12 years	Female	Osteopathia striata with cranial sclerosis	Hip, Knee
Ward (2023)	Ireland	Prospective cross-sectional	Chronic pain (>3 months)	80	Mean 11.6 years	54 Female 26 Male	Hypermobility	Knee, Ankle
Washington	Thailand	Case report	Pain (10 months)	1	5 years	Male	Miliary & osteoarticular tuberculosis	Hip
Watanabe	Japan	Case report	Persistent pain (>6 months)	1	3 years	Female	Synovial hemangioma	Knee
Watters	USA	Case report	Chronic (3 months or >)	1	12 years	Male	Ewings sarcoma	Hip
Wei	USA	Case report	Persistent pain (Undefined)	1	17 years	Female	Gorham-stout syndrome	Hip
Wells	USA	Retrospective medical record review	Chronic pain (follow up 6 months op)	6*	11,13,14,17 years	4 Female 2 Male	Osteonecrosis	Hip
Westbom	Sweden	Retrospective medical record review	Chronic pain (>6 months)	185*	Range 4-19 years	80 Female 105 Male	Cerebral palsy	Hip, Knee, Ankle
Widhalm	Austria	Cohort	Permanent pain (Undefined)	20*	Mean 14.2 years (SD±2.7)	9 Female 11 Male	Cartilage lesion	Knee
Wiegerinck	Netherlands	RCT	Chronic pain (4 months)	101	Mean 10.6 years (SD±1.6)	25 Female 76 Male	Calcaneal apophysitis	Ankle
Wobma	USA	Case series	Persistent pain (12 months)	1	10 years	Female	Chronic recurrent multifocal osteomyelitis	Hip
Wong	Hong Kong	Case report	Pain (3 months)	1	7 years	Female	Neuroblastoma	Hip
Wong 2009	USA	Case report	Chronic pain (>3 months)	1	12 years	Male	Iliofemoral pain syndrome & bipartite patella	Knee
Wong 2022a	Denmark	Prospective cohort	Chronic pain (Undefined)	22	Mean 9.1 years (range 2- 17 years)	8 Female 14 Male	Cerebral palsy	Hip, Knee, Ankle
Wong 2022b	USA	Case report	Chronic pain (Undefined)	1	12 years	Female	Avascular necrosis	Hip
Xie	China	Case report	Persistent pain (>9 months)	1	4 years	Male	Post-surgical	Fibular
Yi	China	Case report	Pain (>12 months)	1	6 years	Male	Synovial chondromatosis	Hip
Yokouchi	Japan	Case report	Chronic pain (3 months)	1	10 years	Male	Osteoid osteoma	Mid tibia
Yoshida	Japan	Case report	Persistent pain (Undefined)	1	8 years	Female	Osteosarcoma	Knee
Yothakol	Thailand	Case report	Chronic (5 months)	1	12 years	Female	Synovial chondromatosis	Knee
Yuill	Canada	Case report	Persistent pain (>4 months)	1	14 years	Male	Tibialis posterior tendonopathy	Foot
Yuldashev	Korea	Retrospective medical cord review	Chronic pain >10 years)	1*	9 years	Male	Type I camuratingelmann	Tibia
Zhang	China	Cohort	Chronic pain (Undefined)	*6	Mean 14.3 years (range 13-17)	Male	Haemophilic arthropathy	Knee
Zhu	China	Case report	Chronic pain (>12 months)	4*	Range 12-14 years	1 Female 3 Male	Metaphyseal chondrodysplasia type schmid	Knee

* This is the population that each study described as meeting the inclusion criteria of having chronic lower limb pain

NR – Sex breakdown not reported for subpopulation of the full study

Supplementary Table 3: The 124 conditions found in this review, and whether or not they were associated with the ICD-11 chronic pain manifestation code

Condition	Was there an ICD-11 manifestation code for chronic pain available?
Acute lymphoblastic leukaemia	Yes
Persistent ankle pain subsequent to a strain or sprain	No
Coeliac disease	No
Cerebral Palsy. This also includes pain subsequent to surgical interventions relating to Cerebral Palsy	No
Cystic Fibrosis	No
Persistent hip pain due to femoroacetabular impingements	Yes
Fibrous dysplasia. This includes both mono-ostotic and polyostotic.	No
Haemophilia including FVII deficiency	No
Persistent hip pain due to developmental (congenital) hip dysplasia	No
Inflammatory arthropathies. These include Ankylosing Spondylitis or undifferentiated Spondyloarthropathy	No
Inguinal hernia	No
Joint instability, including hip, knee, patella or ankle	Yes
All types of Juvenile idiopathic arthritis. This includes oligoarthritis, polyarthritis, systemic, psoriatic arthritis, enthesitis-related and undifferentiated	Yes
Lyme Arthritis	Yes
All types of Muscular Dystrophy. This includes Duchene, Becker, fascioscapulohumeral, limb girdle, myotonic.	No
Musculoskeletal pain. This includes primary, idiopathic and chronic widespread pain (Juvenile fibromyalgia).	No
Neurofibromatosis Type 1	No
Dysplasia. This includes conditions such as osteoarthritis with spondyloepiphyseal involvement (mutation of type II collagen gene, COL2AI, Skeletal dysplasia and open physes, Protusio acetabulae Multiple epiphyseal dysplasia Spondyloepimetaphyseal dysplasia, BUT EXCLUDES High or low bone mass or low bone dyspasias"	Yes
Osteomyelitis, including brodies abscess	No
Persistent anterior knee pain due to patellofemoral pain syndrome and chondromalacia patellae	Yes
Henoch-Schoenlein Purpura	No
Spinal Muscular Atrophy	Yes
Persistent lower limb pain subsequent to limb amputation	No
Von Willebrand disorder	No
Stress fracture	No
Arteriovenous Malformation	No
Talipes Equinovarus	No
Brucellosis	No
Hyperimmunoglobulin D Syndrome	No
Hyperparathyroidism, including primary hyperparathyroidism	No
High bone mass dysplasia. This includes Osteopetrosis tarda, Melorheostosis (mesenchymal dysplasia), Camurati-Engelmann (Type I), Osteopathia striata but EXCLUDES general Dysplasia or low bone mass	No
Philadelphia chromosome-positive CML	No
PIK3CA-related disorder	No
Scurvy	No
Slipped capital femoral epiphysis	No
Spina Bifida	No
Cryopyrin-associated periodic syndrome	No
Dermatomyositis	No
Ewing Sarcoma	No

Fibroadipose vascular anomaly (FAVA)	No
Ganglion	No
Klippel-Trenaunay syndrome (vascular malformation)	No
Legg-Calve-Perthes Disease	No
Liposynovitis prepatellaris (Hoffa's syndrome)	No
Myopathy	No
Osteogenesis imperfecta	No
Osteoid osteoma	No
Restless leg syndrome	No
Disorders of the meniscus. This includes symptomatic discoid meniscus, meniscocapsular separation and meniscal ossicle.	Yes
Auto-immune polyendocrinopathy candidiasis ectodermal dystrophy	No
Chondroblastoma	No
Chronic granulomatous disease	No
Coalition. This includes any location in the foot for example talocalcaneal or talonavicular	No
Exertional compartment syndrome	No
Arthritis related to Crohn's disease	No
Enthesopathy	No
Familial Mediterranean fever arthritis	No
Flat foot. Consider only paediatric flexible flat foot, not rigid relating to spasticity or coalition	No
Fracture of the lower limb. This includes femur, ischial tuberosity, pelvis, tibia, fibula, ankle, foot	No
Generalised joint hypermobility syndrome	Yes
Human immunodeficiency virus	No
Hypophosphatasia as a result of Homozygous mutation of ALPL	No
Iliotibial band syndrome	Yes
Ischiofemoral impingement	Yes
Osteochondral lesion & Osteochondritis Dissecans	No
Osteosarcoma	Yes
Pigmented villonodular synovitis	Yes
Persistent lower limb pain post surgery.	No
Septic (pyogenic) arthritis	No
Relapsing Polychondritis	No
Sickle Cell Disease	No
Tuberculosis infection	No
Vitamin D deficiency	No
Wilson disease	No
Beta thalassemia minor	No
Growing pains	No
Pseudotumor (idiopathic intracranial hypertension)	No
Sjogren's syndrome	No
Spinal meningioma	No
Rhabdomyolysis	No
Heterotrophic Ossification	No
Neuroblastoma	No
Metaphyseal Chondrodysplasias type Schmid	No
Accessory bone. This includes Os Subfibulare, navicular, Os subtibiale, Os trigonum, ossicle, subfibular ossicle	No
Activated phosphoinositide 3-kinase (PI3K) delta syndrome	No
Anatomical variants of lower limb. This includes 'Too long' anteromedial calcaneal process, Limb length secondary to ABI, Angular and rotational deformities, Retroversion of acetabular dome	No
Apophysitis	No
Arthritis due to Bancroftian filariasis (Filarial arthritis)	No

Autosomal dominant precocious osteoarthropathy	No
Avascular necrosis (also known as Osteonecrosis)	No
Behcet's disease	No
Benign bone tumour/lesion. This includes osteochondroma, chondroma benign and benign lesion of proximal femur	No
Chondral defects & cartilage pain disorders of the lower limb	No
Chondrolysis	No
Chronic infantile neurologic cutaneous and articular syndrome (CINCA)	No
Cirsoid aneurysm	No
Epiphyseal arrest	No
COPA Syndrome (genetic)	No
Focal periphyseal oedema	No
Gorham-stout syndrome	No
Haploinsufficiency of A20 with new mutation p.W365R	No
Persistent lower limb pain resulting from complications arising post fracture. For example, ankle impingement resulting from bimalleolar fracture.	No
Tarsometatarsal interval injury	No
Intraarticular loose body	Yes
Intra-articular venous malformation of the knee	No
Post infective arthritis including Noro or influenza virus	No
Nuclear factor I type A variant	No
Osteoblastoma	No
Osteochondrosis	No
Osteofibrous dysplasia (ossifying fibroma)	No
Pachydermoperiostosis	No
Paraneoplastic arthritis	No
Patellar Hypertension Syndrome	No
Reactive arthropathy	No
Sting-Associated Vasculopathy (SAVI)	No
Benign tumours of synovium. This includes Synovial chondromatosis, Synovial haemangioma, Intra-articular synovial lipoma	No
Synovitis. This includes both chronic and transient.	Yes
Takayasu arteritis	No
Talo-patello-scaphoid osteolysis	No
Talus Partitus	No
Tendon disorders of the lower limb. This includes tibialis posterior and flexor hallucis longus tendinopathy and adductor tendinitis.	No
Tenosynovitis, inflammatory arthritis	Yes
Traumatic Joint dislocation	No
Recurrent macrophage activation syndrome	No

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The breadth and visibility of children's lower limb chronic musculoskeletal pain: A scoping review.

Emre Ilhan,[1] Luke Davies,[1,2] Verity Pacey,[1,2] Mitchell Smith,[2] Jane Munro,[3,4] Craig Munns,[5,6,] Elizabeth Sturgiss,[2] Nicole Williams,[7,8] Louise Tofts,[1] Vance Locke,[9] Terry Haines,[2] Sue Brennan,[10] Stephen Maloney,[2] Mitchell Sarkies,[11] Ornella Clavisi,[12] Dan Miles,[13] Lisa Nissen;[14] Cylie M. Williams[2]

1. Department of Health Sciences, Faculty of Medicine, Health and Human Sciences, Macquarie University, Sydney, NSW, Australia
2. School of Primary and Allied Health Care, Monash University, Melbourne, VIC Australia
3. Department of Medicine, Royal Children's Hospital, Parkville, VIC, Australia
4. Murdoch Children's Research Institute, Parkville, VIC, Australia.
5. Faculty of Medicine and Child Health Research Centre, The University of Queensland, Brisbane, QLD, Australia.
6. Department of Endocrinology and Diabetes, Queensland Children's Hospital, Brisbane, QLD, Australia
7. Faculty of Health and Medical Sciences, The University of Adelaide, Adelaide, SA, Australia.
8. Department of Orthopaedic Surgery, Women's and Children's Hospital Adelaide, North Adelaide, SA, Australia
9. Western Kids Health, Shenton Park, WA, Australia.
10. School of Public Health & Preventive Medicine, Monash University, Melbourne, Australia.
11. Sydney School of Health Sciences, Faculty of Medicine and Health, The University of Sydney, Sydney, NSW, Australia.
12. Musculoskeletal Australia, Melbourne, VIC, Australia.
13. Australian Podiatry Association, Melbourne, VIC, Australia.

14. Centre for the Business and Economics of Health, The University of Queensland, Brisbane, QLD, Australia

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Corresponding author: Cylie Williams, e-mail: cylie.williams@monash.edu; address: Monash University, School of Primary and Allied Health Care, 47-49 Moorooduc Hwy, Frankston, VIC, 3199, Australia. Ph: +61(3)99044344

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ABSTRACT

Objective

To identify the types of conditions reported in peer-reviewed literature that result in chronic musculoskeletal lower limb pain in children and adolescents and explore alignment of these conditions with the chronic pain reporting codes indexed in the International Classification of Diseases 11th Revision (ICD-11).

Design

This scoping review follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.

Data sources

Five electronic databases were searched (Medline, EMBASE, PsycINFO, CINAHL, and the Cochrane library).

Eligibility criteria

Articles involving children and adolescents under 18 years and reporting on chronic musculoskeletal pain of the lower limb were included.

Data extraction and synthesis

We assigned an ICD-11 code to each condition based on details reported in the study. We recorded whether any of the presenting conditions were linked to an ICD-11 chronic pain manifestation code.

Results

From 12,343 records, 418 papers were included. There were 124 unique conditions associated with chronic lower limb pain, the most commonly reported being chronic widespread musculoskeletal pain (24 studies) and juvenile idiopathic arthritis (26 studies). Only 11.1% of presenting conditions were linked to an ICD-11 chronic pain manifestation code.

Conclusion

Most presenting conditions associated with chronic pain in the lower limb do not have a chronic pain manifestation code in the new global standard for recording health information. This means, chronic pain associated with common lower limb conditions may remain invisible in global statistics.

Strengths and limitations

- We used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews and a registered protocol to guide this review
- We used the ICD-11 for recording diagnostic health information to classify conditions and chronic pain
- Only studies published in English were included
- One reviewer extracted data due to the breadth of data collected
- No studies had a risk of bias or quality assessment

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INTRODUCTION

Chronic pain, defined as pain lasting for more than 3 months, can occur in 20.8% (95% CI 19.2-22.4%) of children and adolescents.[1, 2] Children and adolescents face difficulties as a result of chronic pain including reduced participation in daily activities, such as attending school, playing with their peers, and engaging in physical activity.[3] Chronic pain negatively impacts quality of life and increases the risk of psychological disturbances such as anxiety and depression.[2, 4-6] The lower limb (foot, ankle, leg, knee, thigh, and hip) is one of the most common sites of chronic musculoskeletal pain in children and adolescents, accounting for almost 40% of all childhood chronic disease pain patterns.[3, 7] The onset of chronic lower limb pain in childhood tends to occur before children enter formal schooling,[8] but diagnoses vary considerably. It is likely to persist for up to four years following their first episode.[9]

Children commonly experience chronic pain for 12 months prior to seeing a professional with additional experience in managing chronic pain such as a pain medicine specialist or allied health professional such as a physiotherapist, psychologist, or occupational therapist.[9] Adequate education, identification, and assessment at early stages in the pain journey is pivotal in minimising any pain chronification risk. This is because children and their families initially present to primary care or community-based health professionals such as allied health, well before specialist consultation.[10, 11] To enable adequate care from the outset, primary care clinicians and community-based healthcare professionals may benefit from specific evidence-based guidelines to provide optimal and early diagnosis and treatment of chronic pain in children and adolescents prior to engaging with specialist services.[12]

Population-level research conducted in Australia shows that children and adolescents' musculoskeletal lower limb presentations to general practice are twice as common as spinal and trunk problems.[12] The authors of the study,[12] however, noted that they could not distinguish presentations that were acute or chronic in nature, highlighting the need for a standardised system to collect such data. Recently, the *International Classification of*

Diseases (ICD) framework (https://icd.who.int/en) was revised to include chronic pain as a separate disease category.[13, 14] Incorporating chronic pain classifications into the ICD-11 allows capture of health statistics, hence making chronic pain more visible as a public health issue.[15] This is an important goal to address the under-recognition of chronic pain in children and adolescents and improve health outcomes.[16] While the ICD-11 may better highlight the burden of chronic pain in children and adolescents, its usefulness is yet to be explored in the context of chronic musculoskeletal pain in the lower limb of children and adolescents.[17]

The primary aim of this scoping review was to identify the breadth, and types of conditions reported in peer-reviewed literature that may result in chronic lower limb pain in children and adolescents. The secondary aim was to explore the alignment of these conditions with the new chronic pain reporting codes indexed in the *International Classification of Diseases 11th Revision* (ICD-11). This secondary aim served as an exercise to field test the usefulness of the ICD-11 in capturing cases in which certain health conditions are associated with chronic musculoskeletal pain of the lower limb. Scoping review methodology was chosen to ensure a broad approach guided data capture.

METHODS

This scoping review was conducted in accordance with the Joanna Briggs Institute methodology for scoping reviews.[18] We reported the review in line with Preferred Reporting Items for Systematic Reviews and Meta-Analyses reporting guidelines for scoping reviews (PRISMA – ScR). A protocol for this scoping review was registered on Open Science Framework on 3rd of March 2023 (https://doi.org/10.17605/OSF.IO/2RYV6).

This scoping review was overseen by a steering group of 15 paediatric and methodological experts assembled by the research team. The group comprised 10 paediatric healthcare professionals who routinely support children who experience chronic musculoskeletal lower limb pain. These included a rheumatologist, endocrinologist, general practitioner,

orthopaedic surgeon, paediatrician, psychologist, pharmacist, two physiotherapists/clinical researchers, and a podiatrist/clinical researcher. We also were supported by three methodology experts, and two consumer representatives with an interest in chronic lower limb pain in children and adolescents. The role of the steering group was to provide input into the search strategy and resolve disagreements in the categorisation of conditions according to the ICD-11. This steering group also established which conditions included in this review were musculoskeletal in nature which aligned with the funding directions and aims.

Eligibility criteria

Studies were eligible for inclusion if they were available in English, sampled a paediatric population (<18 years of age or mean or median population <18 years of age)[19] and reported on the presence of chronic or persistent musculoskeletal pain in the lower limb. Chronic or persistent musculoskeletal pain was defined as studies describing pain lasting for longer than 3 months that originates in the joints, bones, muscles, tendons, and related soft tissues.[20] For the purposes of this review, the lower limb included the hip, thigh, knee, leg, ankle, and foot, but excluded the pelvis, pubic symphysis, and sacroiliac joints. This review included randomised controlled trials, observational studies, and case reports and series to ensure study conclusions were based on the primary analysis of human data. This eligibility criteria were chosen to ensure only conditions relevant to chronic musculoskeletal pain were included and aligning to the overall research aim of the funder. Therefore, pain that was dermatological or neuropathic/potentially neuropathic in nature were excluded (e.g. chronic regional pain syndrome), work-related pain or articles describing a region of pain without a diagnostic name (e.g., juvenile idiopathic arthritis) or condition (e.g., primary chronic musculoskeletal pain) were excluded. Papers that were trial protocols, editorials, opinion pieces, or where no data were presented were excluded. In studies with mixed populations (e.g., in terms of age, location of pain, mechanisms of pain such as neuropathic pain), only

data from participants that met this review's eligibility criteria were included: individuals less than 18 years of age with chronic musculoskeletal pain of the lower limb.

Information sources and search strategy

An initial, limited search of PubMed and Google Scholar were conducted to identify any papers on the topic of "chronic lower limb pain", "musculoskeletal pain", and "paediatric pain". To ensure a comprehensive search of the literature, a clinical research librarian assisted in the development of a systematic search strategy for each of the databases. Five electronic databases were then searched, including Medline, EMBASE, PsycINFO, CINAHL, and the Cochrane library using keywords such as "chronic pain", "lower extremity", and "paediatric". The full electronic search strategy for Medline is presented in Table 1 (for all strategies see Supplementary Table 1), which was adapted for the each of the included databases. No limitations were placed on publication date or status. The initial search was conducted from database inception until 4th May 2022, and then updated on the 25th of July 2024. Studies meeting the eligibility criteria were uploaded onto EndNote Version X9 (Clarivate Analytics, PA, USA) then exported to Covidence Systematic Review Software (Veritas Health Innovation, Melbourne, Australia) for de-duplication and screening.

Selection of sources of evidence

Two reviewers (CW and VP) independently screened titles and abstracts of papers based on the eligibility criteria. In the event of disagreements, a third reviewer (EI) was consulted to reach consensus. Full texts were screened independently by two of five reviewers (CW, VP, EI, LD, MS). Any concerns regarding the eligibility of a study were resolved by consensus among the authors first, and then by the steering group in cases where the musculoskeletal nature of the conditions reported was unclear. Extensive efforts were made to retrieve full-text records through multiple physical and digital sources including two university libraries and a hospital library. Due to the data capture strategies, and volume of data, we did not use any citation chaining methods.

Data charting process and data items

Data from eligible studies were extracted into a purpose-built spreadsheet in Microsoft Excel. Data items included first author, year of publication, type of study design, the country/countries in which the study was conducted, the age groups researched, duration of pain described in the study, lower limb location of pain, and the specific condition(s) that were reported to be associated with chronic musculoskeletal pain of the lower limb.

Data were extracted by one reviewer. Following extraction, one reviewer (EI, LD, VP, CW, or MS) independently used the *International Classification of Diseases 11th Revision* (ICD-11) (https://icd.who.int/en) to assign a code to each of the conditions presented in the studies. The ICD-11 browser version 2022.02 release (https://icd.who.int/en) was used for coding. All codes were then discussed during a regular meetings between reviewers (EI, LD, VP, CW, MS) to ensure coding consistency and agreement, where several cases or diagnoses were independently coded differently by reviewers and all similar condition codes were checked to ensure correct alignment and decisions. We did not record the number of disagreements in coding. Coding was done to the level at which the paper provided sufficient detail about the condition. Given the scope of this review, we did not contact authors of papers with the necessary missing information. Disagreements were resolved through discussion, and adjudication by a third reviewer or steering group experts if a resolution could not be found. Using the ICD-11, each study was assigned a 'parent' code (a two-digit code) to facilitate hierarchical organisation of the data. In studies which reported more than one condition, multiple codes were assigned to reflect the number of conditions reported. We also recorded cases which had multiple parent codes. Where a presenting condition was aligned with a secondary chronic pain manifestation code, this was also recorded within the spreadsheet. An ICD manifestation code describes the manifestation, symptoms, or signs of the underlying disease (e.g., pain) rather than the disease itself. Only codes that reflected the primary condition/s and, if different, the pain conditions, were recorded. For example,

FB82.00: Chondromalacia patellae is linked to the manifestation code *MG30.31: Chronic secondary musculoskeletal pain associated with structural changes*. Manifestation codes in the ICD-11 refer to the manifestation of the disease (e.g., chronic pain), not the disease itself. Therefore, all chronic pain manifestation codes refer to chronic secondary pain conditions, not chronic primary pain conditions.

Data synthesis

Data were summarised descriptively using frequencies and percentages to characterise the published literature (e.g., country, study design, sample size, age, and sex of participants). To address the review aims, data were also summarised descriptively to determine types and percentage of conditions associated with chronic lower limb pain in children and adolescents. This was achieved by analysing the ICD-11 parent codes of the relevant conditions, which were then categorised into primary and secondary chronic pain groups, according to the definitions provided by Treede et al.[7] In addition, conditions relating to the same anatomical structure or physiological process were grouped under a single broad heading. For example, conditions associated with joint instability of the hip, patella, ankle were merged and grouped under “joint instability of the lower limb”. Finally, the alignment of these conditions with the new chronic pain classification system was explored by determining whether any presenting conditions (where pain was not a result of chronic primary pain) were indexed with a chronic pain manifestation code in the ICD-11.

Patient and public involvement

There were two consumer representatives. One who had lived experience of a child with chronic lower limb pain and supporting families with chronic lower limb pain. The other provided support and education to health professionals who provide services to children who have chronic lower limb pain.

RESULTS

Characteristics of included studies

A total of 12,343 records were identified through the database searches. After duplicates were removed, records combined where they reported on same data, and titles and abstracts screened, 1,409 papers were downloaded for full text screening, with a final 418 studies (from 422 reports where four described data from the same population) included in the review (Figure 1). A common reason for exclusion was that studies did not report on participants with chronic and/or persistent pain.

Of the 418 studies included in this review (Supplementary Table 2), most studies were case reports (n = 220 studies) or retrospective medical record reviews (n = 54) which were published in the 2010's (n = 220/418), conducted in the United States of America (n = 143/418 studies), and sampled adolescents between 11 and 17 years of age (n = 179/418 studies). Of those studies that reported sex (336 studies), studies sampled more females (n = 4,782) than males (n = 2,556) in total. No paper included in this review sampled infants less than a year old (Table 2).

Conditions related to chronic musculoskeletal pain of the lower limb

Discounting duplicate conditions, this review found 124 unique conditions that were associated with chronic musculoskeletal lower limb pain in children and adolescents (Supplementary Table 3). The most commonly reported health conditions identified resulting in chronic lower limb pain in children and adolescents were juvenile idiopathic arthritis (n = 26/418 studies), chronic widespread musculoskeletal pain (n = 24/418 studies), spasticity-related musculoskeletal pain in cerebral palsy (n = 20/418 studies), post-surgical pain (n = 13/418 studies), osteoid osteoma (n = 14/418 studies), and post-fracture (n = 14/418 studies) (Table 3).

The most common description of pain was having pain for at least 3 months (n = 143/418 studies) or for longer than a year (n = 113/418 studies). Most commonly, studies reported on

pain related to the knee only (n = 111/418 studies), mixed cases of various locations of the lower limb (n = 96 studies), or the hip only (n = 76/418 studies) (Table 3).

Conditions related to chronic musculoskeletal pain of the lower limb based on the ICD-11

All records could be assigned an ICD-11 code. Out of the 27 parent codes available on the ICD-11 classification system (ICD-11 codes: 01-26, V and X), 18 codes were associated with chronic lower limb pain (ICD-11 codes: 1-8, 11-15, 20-23, X) (Table 3). In total, 432 parent codes were assigned to the conditions of participants in the studies (Figure 2). The parent codes that were used most frequently were *15: Diseases of the musculoskeletal system or connective tissue* (n = 165 conditions), *20: Developmental anomalies* (n = 54 conditions), *21: Symptoms, signs, or clinical findings, not elsewhere classified* (n = 43 conditions), *X: Extension codes* (n = 34 conditions), *8: Diseases of the nervous system* (n = 32 conditions), and *22: Injury, poisoning, or certain other consequences of external causes* (n = 24 conditions). Several other parent codes (ICD-11 codes: 6, 7, 11-14, 23) were used for less than 5 conditions.

Alignment of the chronic pain classification with the ICD-11 or condition linked with chronic pain manifestation code

Chronic pain was reported as the presenting condition in 48 conditions in this review and assigned the parent code *21: Symptoms, signs, or clinical findings, not elsewhere classified,* and then the code *MG30: Chronic Pain.* These also included the codes *MG30.2: Chronic post-surgical or post-traumatic pain* (n = 13 conditions), *MG30.0: Chronic primary pain* (n = 9 conditions), and *MG30.Y: Other specified chronic pain* (n = 9 conditions).

For cases in which chronic pain was not the presenting condition (n = 415 conditions, i.e., chronic secondary pain), only 46 conditions (11.1% of 415 conditions, or 13.7% of the 124 unique conditions once duplicates were removed) were linked to a chronic pain manifestation code (MG30) (Additional file 2). These 46 conditions included chronic

secondary musculoskeletal pain associated with structural changes (n = 20), chronic secondary musculoskeletal pain (n = 9), chronic cancer pain (n = 8), chronic secondary musculoskeletal pain from persistent inflammation (n = 6), and chronic musculoskeletal pain due to disease of the nervous system (n = 3) (see Figure 2).

DISCUSSION

This scoping review identified 124 unique conditions reported in the literature that may be associated with chronic musculoskeletal pain of the lower limb in children and adolescents. Most studies reported chronic pain as a symptom (e.g., chronic secondary musculoskeletal pain from juvenile idiopathic arthritis) rather than a disease in its own right (e.g., chronic primary pain such as chronic widespread musculoskeletal pain). The findings of this review suggest that there is considerable variability in the cause of secondary chronic lower limb pain investigated in the peer reviewed literature.[21] The ICD-11 coding system aligned with the plethora of chronic pain conditions presented. However, only 11.1% of all presenting conditions in the review had a manifestation code linked to chronic pain. This highlights the possibility the global burden of chronic musculoskeletal pain of the lower limb in children and adolescents may not be adequately captured by the ICD-11 due to the under-utilisation of manifestation codes.

The number of conditions that result in lower limb musculoskeletal chronic pain was extensive. As a result, this breadth will result in diversity in health professionals who may be involved in care. Given the breadth of conditions the review found that may result in chronic musculoskeletal lower limb pain, there is a need for health professionals to be aware of multiple paediatric musculoskeletal health conditions that may result in chronic pain.[22] This is currently an international focus.[22] This finding also lends itself to consistency in guidelines that are multi-disciplinary and not just focused on a single health profession. These opportunities are in place for conditions such as juvenile idiopathic arthritis, the most commonly reported condition in the literature. This condition has a number of guidelines on

medication management with limited consideration to chronic musculoskeletal lower limb pain.[23]

This review highlights that, due to the lack of manifestation codes, there is potential of the ICD-11 in under-reporting diseases that may result in chronic musculoskeletal pain of the lower limb in children and adolescence. The under-recognition of chronic musculoskeletal pain in children and adolescents[16] may have far-reaching detrimental impacts on children and adolescents,[24] families,[25] and society[16] including the under -assessment and -management of chronic pain. Making chronic musculoskeletal pain of the lower limb in children and adolescents visible first requires capturing the burden in order to facilitate the adequate allocation of funding and resources. While the ICD-11 offers a potential solution for health systems to enable the evaluation of the burden, the problem of chronic pain needs to be made more visible by incorporating manifestation codes in all potential conditions that could lead to chronic pain. Because manifestations codes are linked to primary health conditions, ensuring that chronic pain manifestation codes exist for those health conditions that are associated with pain may ensure that health professionals, researchers, and policy makers are able to select these manifestation codes when inputting data. This presents opportunities for data capture and practice reform.

Limitations of this review arise from the result of the large number of studies included in this review, data from studies were extracted by one reviewer only. We also acknowledge that only English-language papers were included in this review. This may mean that a large number of region-specific conditions resulting in chronic musculoskeletal lower limb pain in children and adolescents were not captured. Another limitation of this review was the inclusion of a large number of case reports. It is important to consider the rate of conditions reported in studies (e.g., rate of studies reporting juvenile idiopathic arthritis) does not correspond with the general population prevalence. Future research reporting on the breadth of conditions resulting in chronic lower limb pain may consider aligning findings with

condition specific prevalence rates. Lastly, the assignment of ICD-11 codes was based on what was reported in papers included in this review and while we extensively consulted with our steering committee, the reported information may have not covered all the required criteria of the that diagnosis.

Conclusion

Many conditions may be associated with chronic musculoskeletal lower limb pain in children and adolescents as investigated in the peer reviewed literature. While the ICD-11 captures chronic pain classifications related to primary and secondary pain conditions, chronic secondary pain must be made more visible by having the ability to link conditions to chronic pain manifestation codes. This may allow clinicians, researchers, and policy makers to better estimate the burden of chronic musculoskeletal pain of the lower limb in children and adolescents. Increasing the visibility of chronic musculoskeletal pain in children and adolescents will allow a more equitable distribution of funding and resources for the development of strategies for the appropriate identification of children and adolescents with chronic musculoskeletal lower limb pain.

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Data availability statement

The dataset generated analysed during the current study are available from the corresponding author on reasonable request. An abbreviated version of the data used for analysis in this review is available in the Additional files 1 and 2.

Ethical approval: This project did not require ethical approval.

Contributor statement

EI, LD, VP and CMW conceptualised the study. EI, LD, VP JM, CM, ES, NW, LT, VL, TH, SB, SM, MS, OC, DM, LN and CMW designed the study methodology. All authors (EI, LD, VP, MS, JM, CM, ES, NW, LT, VL, TH, SB, SM, MS, OC, DM, LN and CMW) substantially contributed to data collection, analysis and coding frameworks. EI, LD, VP and CMW drafted the initial manuscript, and all authors critically reviewed the draft manuscript and revised the manuscript for important intellectual content. All authors (EI, LD, VP, MS, JM, CM, ES, NW, LT, VL, TH, SB, SM, MS, OC, DM, LN and CMW) approved the final manuscript as submitted to be published and agree to be accountable for all aspects of the work. The guarantor of the study is CMW and accepts full responsibility for the finished work, had access to the data, and controlled the decision to publish.

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Figure legends

Figure 1: PRISMA flowchart of records screened and included in the scoping review.

Figure 2: The coding of primary and secondary chronic pain conditions of the lower limb in children and adolescents using the ICD-11 in the peer reviewed literature. N is the number of codes assigned within each category. Parent codes 6 (Mental, behavioural, or neurodevelopmental disorders, n = 1), 14 (Diseases of the skin, n = 1 relating to malformations involving cutaneous blood vessels, Code EF2Z), and 23 (External causes of morbidity and mortality, n = 2) were omitted from this figure for brevity.

Table 1: Full search strategy for Medline

Search	Query
1	Lower Extremity/ or Leg/ or Hip/ or Knee/ or Ankle/ or Foot/
2	(leg* or hip* or knee* or ankle* or foot or feet or lower limb* or lower extremit*).mp.
3	1 or 2
4	Chronic Pain/ or arthralgia/ or musculoskeletal pain/ or nociceptive pain/ or pain, postoperative/ or neuralgia/
5	((persistent or chronic or ongoing or long-term or nociceptive or musculoskeletal or post-operative or joint or neuropathic or nerve) adj3 pain).mp.
6	arthralgia.mp.
7	4 or 5 or 6
8	3 and 7
9	Infant/ or Child/ or Child, Preschool/ or Adolescent/
10	(baby or babies or neonate* or newborn or child* or infant* or toddler* or paediatric* or pediatric* or teen* or adolesc* or pre-pubesc* or prepubesc* or youth* or juvenile).mp.
11	9 or 10
12	8 and 11
13	exp animals/ not humans.sh.

Table 2: Characteristics of included studies

Type of study design	N = 418	%
Case report	220	52.6
Case series	30	7.2
Cohort	40	9.6
Cross-sectional	53	12.7
Longitudinal	9	2.2
Randomised controlled trial	10	2.4
Retrospective medical record review	54	12.9
Review	2	0.5
Country of data collection		
Australia	15	3.6
Canada	8	1.9
China	12	2.9
Denmark	11	2.6
France	10	2.4
Germany	12	2.9
India	19	4.5
Italy	16	3.8
Japan	18	4.3
Spain	8	1.9
Turkey	22	5.3
United Kingdom	20	4.8
United States of America	143	34.2
*Other**	104	24.9
Decade of publication		
1980's	2	0.5
1990's	27	6.5
2000's	76	18.2
2010's	220	52.6
2020-2024	93	22.2
Age groups[1]		
Infancy (0-1 years)	0	0.0
Childhood (2-10 years of age)	79	18.9
Adolescence (11-17 years)	179	42.8
Mixed age groups (0-17 years)	160	38.3
Sex		
Males (total N)	2,556	34.8
Females (total N)	4,782	65.2
Studies in which sex was not reported	79	-

* Algeria (1), Austria (1), Bangladesh (1), Belgium (1), Bolivia (1), Bosnia (1), Brazil (1), Bulgaria (2), Croatia (2), Czech Republic (1), Egypt (1), Finland (4), Greece (5), Hong Kong (1), Hungary (2), Indonesia (1), Iran (2), Ireland (3), Israel (2), Kenya (1), Korea (6), Lebanon (1), Libya (1), Macedonia (1), Malaysia (4), Mexico (2), Nepal (1), Netherlands (6), New Zealand (1), Nigeria (2), Norway (4), Oman (1), Pakistan (3), Poland (4), Portugal (4), Qatar (2), Saudi Arabia (2), South Africa (2), Sri Lanka (1), Sweden (5), Switzerland (3), Taiwan (3), Thailand (5), Ukraine (2), multiple countries in Africa (1)

[1] Based on the *American Academy of Pediatrics*; Adolescence is divided into 3 groups according to this classification but was collapsed into one category for the purposes of this review (>10 years of age). Late adolescence, being 18-21 years of age, was excluded from this study.

Table 3: Chronic musculoskeletal pain of the lower limb

	N = 418 studies	%
Most common conditions reported		
Juvenile idiopathic arthritis	26	6.2
Chronic widespread musculoskeletal pain	24	5.7
Spasticity-related musculoskeletal pain from cerebral palsy	20	4.8
Osteoid osteoma	14	3.3
Fracture	14	3.3
Post-surgical pain	16	3.8
ICD-11 Parent codes	N = 463 cases	
1: Certain infectious or parasitic diseases	11	2.4
2: Neoplasms	24	5.2
3: Diseases of the blood or blood-forming organs	10	2.2
4: Diseases of the immune system	19	4.1
5: Endocrine, nutritional, or metabolic diseases	13	2.8
6: Mental, behavioural, or neurodevelopmental disorders	1	0.2
7: Sleep-wake disorders	1	0.2
8: Diseases of the nervous system	35	7.6
11: Diseases of the circulatory system	1	0.2
12: Diseases of the respiratory system	2	0.4
13: Diseases of the digestive system	2	0.4
14: Diseases of the skin[a]	1	0.2
15: Diseases of the musculoskeletal system or connective tissue	176	38.0
20: Developmental anomalies	55	11.9
21: Symptoms, signs, or clinical findings, not elsewhere classified	48	10.4
22: Injury, poisoning, or certain other consequences of external causes	28	6.0
23: External causes of morbidity and mortality	2	0.4
X: Extension codes	34	7.3
Presence of a chronic pain manifestation code in cases where chronic pain was not the primary condition	46/415 cases	11.1
Duration of pain	N = 418 studies	%
Pain at least ≥3 months	143	34.2
Pain at least ≥6 months	65	15.6
Pain at least ≥12 months	113	27.0
Chronic, but not specified	97	23.2
Location of pain	N = 418	
Hip	73	17.5
Thigh/groin	7	1.7
Knee	111	26.6
Leg	9	2.6
Ankle	42	10.0
Foot (including toes)	32	7.7
Widespread lower limb	44	10.5
Mixed cases	96	23.0

[a]This referred to one case related to “malformations involving cutaneous blood vessels” (Code EF2Z).

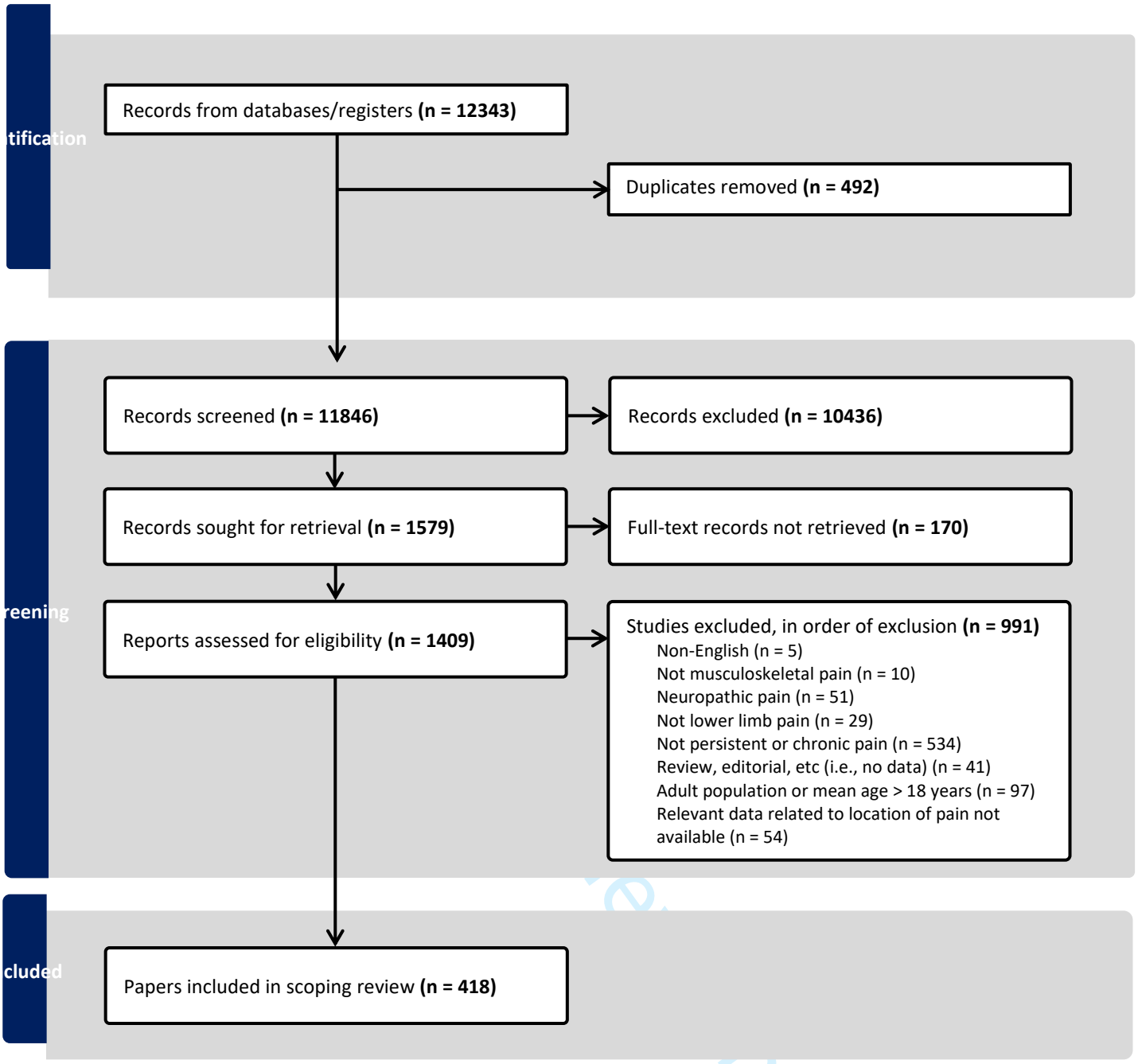
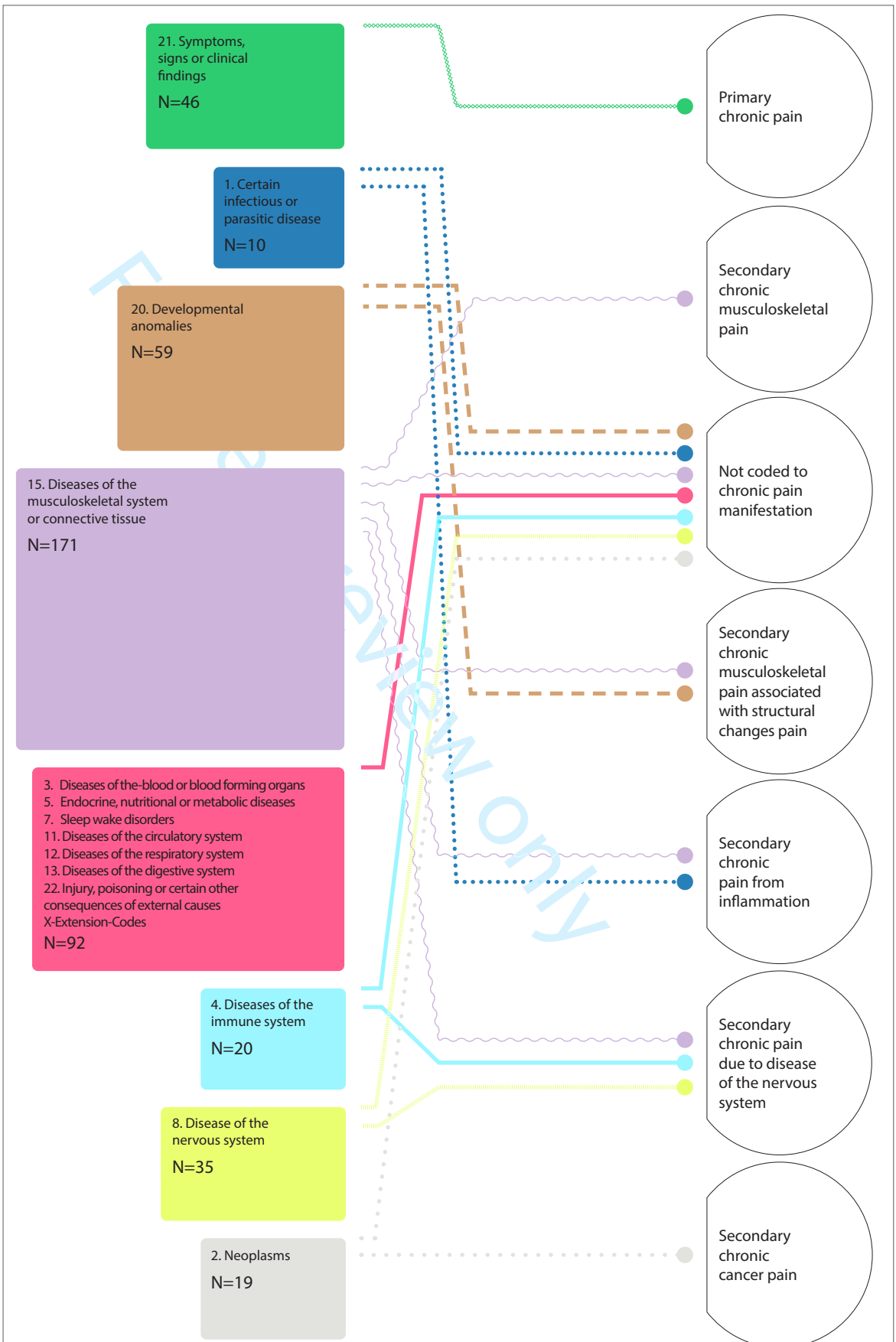


Figure 1: PRISMA flowchart of records screened and included in the scoping review.



Supplementary Table 1: Full search strategies

A. Full search strategy for Embase

Search	Query
1	Lower Limb/ or Leg/ or Hip/ or Knee/ or Ankle/ or Foot/
2	(leg* or hip* or knee* or ankle* or foot or feet or lower limb* or lower extremit*).mp.
3	1 or 2
4	Chronic Pain/ or arthralgia/ or musculoskeletal pain/ or nociceptive pain/ or postoperative pain/ or neuropathic pain/
5	((persistent or chronic or ongoing or long-term or nociceptive or musculoskeletal or post-operative or joint or neuropathic or nerve) adj3 pain).mp.
6	arthralgia.mp.
7	4 or 5 or 6
8	3 and 7
9	infant/ or child/ or adolescent/
10	(baby or babies or neonate* or newborn or child* or infant* or toddler* or paediatric* or pediatric* or teen* or adolesc* or pre-pubesc* or prepubesc* or youth* or juvenile).mp.
11	9 or 10
12	8 and 11
13	exp animals/ not humans.sh.
14	12 not 13

B. Full search strategy for PsycINFO

Search	Query
1	Lower Limb/ or Leg/ or Hip/ or Knee/ or Ankle/ or Foot/
2	(leg* or hip* or knee* or ankle* or foot or feet or lower limb* or lower extremit*).mp.
3	1 or 2
4	Chronic Pain/
5	((persistent or chronic or ongoing or long-term or nociceptive or musculoskeletal or post-operative or joint or neuropathic or nerve) adj3 pain).mp.
6	4 or 5
7	(baby or babies or neonate* or newborn or child* or infant* or toddler* or paediatric* or pediatric* or teen* or adolesc* or pre-pubesc* or prepubesc* or youth* or juvenile).mp.
8	3 and 6 and 7
9	exp animals/ not humans.sh.
10	8 not 9

C. Full search strategy for CINAHL

Search	Query
S1	(MH "Chronic Pain")
S2	"(persistent OR chronic OR ongoing OR long-term OR nociceptive OR musculoskeletal OR post-operative OR joint OR neuropathic OR nerve) AND pain"
S3	(MH "Lower Extremity+")
S4	(MH "Leg"+)
S5	(MH "Hip"+)
S6	(MH "Knee"+)
S7	(MH "Ankle"+)
S8	(MH "Foot+")
S9	"leg* OR hip* OR knee* OR ankle* OR foot OR feet OR lower limb* OR lower extremit*"
S10	S1 OR S2
S11	S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9
S12	(MH "Infant+")
S13	(MH "Child+")
S14	(MH "Adolescence+")
S15	""(baby or babies or neonate* or newborn or child* or infant* or toddler* or paediatric* or pediatric* or teen* or adolesc* or pre-pubesc* or prepubesc* or youth* or juvenile)""
S16	S12 OR S13 OR S14 OR S15
S17	S10 AND S11 AND S16

D. Full search strategy for Cochrane Library

Search	Query
#1	MeSH descriptor: [Lower Extremity] explode all trees
#2	(leg* or hip* or knee* or ankle* or foot or feet or lower limb* or lower extremit*
#3	#1 OR #2
#4	MeSH descriptor: [Chronic Pain] explode all trees
#5	(persistent or chronic or ongoing or long-term or nociceptive or musculoskeletal or post-operative or joint or neuropathic or nerve) AND pain
#6	#4 OR #5
#7	MeSH descriptor: [Infant] explode all trees
#8	MeSH descriptor: [Child] explode all trees
#9	MeSH descriptor: [Adolescent] explode all trees
#10	baby OR babies OR neonate* OR newborn or child* OR infant* OR toddler* OR paediatric* OR pediatric* OR teen* OR adolesc* OR pre-pubesc* OR prepubesc* OR youth* OR juvenile
#11	#7 OR #8 OR #9 OR #10
#12	#3 AND #6 AND #11 in Trials

E. Full search strategy for Medline

Search	Query
1	Lower Extremity/ or Leg/ or Hip/ or Knee/ or Ankle/ or Foot/
2	(leg* or hip* or knee* or ankle* or foot or feet or lower limb* or lower extremit*).mp.
3	1 or 2
4	Chronic Pain/ or arthralgia/ or musculoskeletal pain/ or nociceptive pain/ or pain, postoperative/ or neuralgia/
5	((persistent or chronic or ongoing or long-term or nociceptive or musculoskeletal or post-operative or joint or neuropathic or nerve) adj3 pain).mp.
6	arthralgia.mp.
7	4 or 5 or 6
8	3 and 7
9	Infant/ or Child/ or Child, Preschool/ or Adolescent/
10	(baby or babies or neonate* or newborn or child* or infant* or toddler* or paediatric* or pediatric* or teen* or adolesc* or pre-pubesc* or prepubesc* or youth* or juvenile).mp.
11	9 or 10
12	8 and 11
13	exp animals/ not humans.sh.

Supplementary Table 2: Expanded characteristics of studies included in the review

First author	Country	Study type	Definition and average length of chronic pain	Included sample size*	Age (measure of central tendency, range, and measure of variance (SD)	Sex	Primary condition described as resulting in chronic lower limb pain	Location(s) of pain in the lower limb
Abdullah	Malaysia	Case report	Pain (>2 years)	1	17 years	Male	Pachydermoperiostosis	Knee, Ankle
Abe	Japan	Case report	Chronic (3months or longer)	1	14 years	Female	Bilateral navicular stress fracture	Foot
Abiodun	Ukraine	Cross-sectional	Chronic (3 years)	84	2-18 years	51 Female 33 Male	Juvenile idiopathic arthritis	Hip, Knee, Ankle
Abousamra	USA	Cross-sectional	Chronic (at least 1-year post op)	13	3-15 years	6 Female 4 Male	Hip instability	Hip
Abramowicz	USA	Cross-sectional retrospective	Average 4.6 years	65	Mean 11.7 (SD 3.8)	48 Female 17 Male	Systemic Arthritis (, psoriatic arthritis, enthesitis)	Knee, Ankle
Abushhaiwia	Libya	Case report	Chronic pain >3 years	1	14 years	Male	Chronic recurrent multifocal osteomyelitis	Leg
Accadbled	France	Case report	Pain >2 years	1	13 years	Male	Post - surgical Subtotal lateral meniscectomy	Knee
Adba	Qatar	Case report	Chronic Pain (>1 year)	2	3 and 6	Male	Juvenile idiopathic arthritis	Knee
Adiguzel	Turkey	Case report	8 months	1	14 years	Female	Traumatic brain injury (heterotrophic ossification associated)	Knee
Agarwal (2015)	India	Case report	Pain 4 months	1	15 years	Male	Juvenile-onset ankylosing spondylitis	Hip
Agrawal (2018)	India	Case report	Pain (>6 months)	1	13 years	Male	Pachydermoperiostosis	Hip/knee/Large joints
Aiyer	India	Case report	Pain for 3 months	1	14 years	Female	Dysplasia / Tuberculous infection	Hip
Alkadumi	USA	Case report	Pain >12months	1	16 years	Male	Chondroblastoma	Knee
Allessandrella	Spain	Case report	Chronic (5 years)	1	17 years	Male	Pachydermoperiostosis (genetic)	Knee, Ankle
Alpigiana	Italy	Case report	Chronic (>1 year)	1	15 years	Male	Juvenile idiopathic arthritis	Hip
Alqanatish	Saudi Arabia	Case report	Chronic pain (>3 months)	1	12 years	Male	Scurvy	Lower limb
Anderson	Switzerland	Case series	Chronic (Undefined)	4*	Mean 16.3 years	4 Female	Pseudotumor	Ankle
Andias	Portugal	Cross-sectional	Chronic (3months or longer)	1249*	Mean 16.4 years	819 Female	Musculoskeletal pain	Lower Limb/multiregional
Andreucci	Denmark	Cross-sectional secondary analysis	Chronic Pain (undefined)	323	Mean 14.4	237 Female 86 Male	Patellofemoral pain and Osgood-Schlatter disease	Knee
Anghelescu	USA	Retrospective review	Pain (>6 months)	129*	Mean 14 years (range 6-21)	63 Female	Post surgical pain	Thigh, shin
Arici	Turkey	Case report	Chronic (3 months or longer)	1	11 years	Female	Chronic recurrent multifocal osteomyelitis	Legs
Assafiri	USA	Case report	Pain (>3 months)	1	13 years	Male	Osteoid osteoma	Ankle
Auvinen	Finland	Cohort (two year follow up)	Pain in last 6 months	86*	15-18 years	43 Female 43 Male	Musculoskeletal pain	Knee, Ankle
Awan	USA	Case report	Chronic (6 months)	1	17 years	Male	Cuboid-navicular coalition	Foot
Azabagic	Bosnia	Longitudinal study	Chronic pain (>1 year)	310	Mean 11.3 years (range 7-14)	NR	Musculoskeletal pain	Knee, Ankle
Baghdadi	Iran	Retrospective medical record review	Chronic pain (>1 year)	13	1-18 years of age	7 Female 6 Male	Septic Arthritis	Hip
Baima	USA	Case report	Chronic pain (>3 months)	1	6 years	Male	Prosthesis-related pain (post chopart amp)	Knee, Ankle

Bakkaloglu	Turkey	Case report	Persistent pain 8 months	1	8 years	Female	ilial Mediterranean fever arthritis	Knee
Banskota	Nepal	Retrospective case series	Pain (>12 months)	30	Mean 8.5 years (range 2-16)	9 Female 21 Male	raumatic hip dislocation	Hip
Barfield	USA	Case report	Chronic pain (no time frame mentioned)	1	17 years	Female	Celiac disease	Achillies tendon/bilateral thigh and calf
Bari	Pakistan	Case report	Pain (condition gradually worsened over a few months)	1	4 years	Female	Scurvy	Lower limbs
Barut	Turkey	Cross-sectional observational	Chronic	168	16 years (IQR 9)	87 Female 81 Male	venile idiopathic arthritis	Hip, Knee, Ankle, Foot
Bauer	France	Case series	Chronic pain (15 months)	1*	16 years	Male	ngement from bimalleolar fracture	Ankle
Baydogan (2012, 2015)	Turkey	RCT	Chronic pain (no definition provided)	30	9.3 (1.4) years 6-18 years	21 Female 9 Male	venile idiopathic arthritis	Knee
Bazette-Jones	USA	Cross sectional survey	Pain frequency (ranges from daily to rarely)	437*	10-18 years	NR	Musculoskeletal pain	Hip, Knee, Ankle
Behzadi	Norway	Case report	> 2 years	1	14	Female	hiofemoral impingement	Hip
Belke	Germany	Case report	Chronic (at least 3 months)	1	12 years	Male	habdomyolysis (diabetic ketoacidosis)	Lower leg, Foot
Benaroch	USA	Case series	> 6 years	7*	15.5 years	Male	Post operative pain	Knee
BenEliyahu	USA	Case report	Chronic (Undefined)	1	17 years	Female	Exer onal compartment syndrome	Calf
Berend	USA	Case series	Chronic pain (>3 months)	8	14.9 years	NR	gg-calve-perthes-disease	Hip
Bettin	Germany	Case report	Persistent pain	1	12 years	Male	moral neck stress fracture	Hip
Bica	Brazil	Case report	Chronic pain (>1 year)	1	10 years	Male	emoral osteochondrosis	Knee
Biddeci	Italy	Cross-sectional observational	Persistent pain (Undefined)	19*	10+ years (all paediatric)	10 Female 9 Male	A ular osteonecrosis secondary to treatment for acute mphoblastic leukaemia	Hip, Knee, Ankle
Black	USA	Secondary analysis	Chronic pain (Undefined)	36	Range 12-18 years	Female	enile Fibromyalgia and Joint hypermobility	Hip, Knee, Ankle
Blackman	USA	Retrospective case series	Persistent pain (Undefined)	71	Mean 15.5 years (range 11.7-19.8)	66 Female 5 Male	l patellofemoral ligament	Knee
Blatnik	USA	Case report	Persistent pain (Undefined)	1	12 years	Female	B eral distal femur salter-harris ty fracture / persistent osgood-schlatter disease	Knee
Bloch	USA	Case report	Chronic (Undefined)	1	2 years	Male	Recurrent cervical lymphadenopathy	Bilateral leg
Bloomfield	USA	Case report	Chronic (>6 years)	1	13 years	Female	Periosteal tumour	Lower Limb
Bonfiglio	USA	Case report	Chronic pain	1	13 years	Female	ogenic bone abscess / osteomyelitis (brodies abscess)	Ankle
Boulter	Australia	Retrospective medical review	Chronic pain (>3 months)	26	3-17 years	14 Female 12 Male	ystic fibrosis, reactive arthropathy, widespread musculoskeletal pain, chondromalacia patellae osteochondrosis, osteonecrosis, steochondritis dissecans	Lower limb

Bout-tabaku	Qatar	Prospective cohort	Chronic pain	219	Mean 17 years (SD 1.6 years)	167 Female 52 Male	Musculoskeletal pain	Hip, Knee, Ankle, Feet
Boyer	USA	Retrospective cohort	Chronic (at least 9 months)	86	10 years (range 4-17 years)	41 Female 45 Male	Cerebral palsy (post operative)	Hip, Knee, Ankle, Feet
Brandao	Portugal	Retrospective cohort	Chronic pain (.3 months)	143*	13 years	67 Female 76 Male	Musculoskeletal pain	Lower limb
Brix	Denmark	Retrospective cohort	Chronic pain (Undefined)	53*	3-10 years of age	30 Female 23 Male	e lymphoblastic leukaemia	Hip, Knee, Ankle
Brizini	China	Case report	Persistent pain (>3 months)	1	13 years	Male	Slipped capital femoral epiphysis / FGFR TKI inhibitor	Knee
Broström	Sweden	Cross-sectional observational study	Chronic pain (>1 year)	18	Mean 10 years (SD 3.1)	15 Female 3 Male	venile idiopathic arthritis	Hip, Knee, Ankle
Bueso	USA	Case report	Chronic pain (>6 months)	1	7 years	Male	Juvenile idiopathic arthritis	Knee
Buoncristiani	USA	Case series	Chronic pain	8	3-10 years	3 Female 2 Male	ury to tarsometatarsal joint	Foot
Burgos-Vargas	Mexico	Secondary analysis of RCT	Chronic pain (mean 4.2 years)	33	11 years	6 Female 27 Male	Enthesopathy due to spondyloarthropathy	Hip, Knee, Ankle
Busconia	USA	Case report	Chronic pain (Undefined)	10*	13 years (range 10-17)	6 Female 4 Male	hronic ankle instability	Ankle
Caldonazzi	Italy	Cross-sectional observational study	Persistent pan (Undefined)	7	Mean 11 years	6 Female 1 Male	Vitamin D deficiency	Foot
Cappuccio	Italy	Case report	Chronic pain	1	10 years	Female	PPP2A-related disorder (genetic)	Lower limb
Carozza	Australia	Cross-sectional	Chronic pain (>3months)	27	Mean 13.7	16 Female 8 Male	Cerebral palsy	Hips, knee, ankle, foot
Castle	Australia	Phenomenological study	Chronic pain (>3months)	4*	Mean 17.6 years	4 Male	Cerebral palsy	Hip
Catli (2011)	Turkey	Case report	Pain for 6 months	1	8 years	Female	Osteopetrosis tarda	Ankle
Catli (2022)	Turkey	Case report	Chronic pain (Undefined)	1	26 months	Female	Hypophosphatasia	Legs
Ceglie	Italy	Case report	Chronic pain (>7 months)	1*	4.5 years	Male	Scurvy	Leg
Ceroni	Switzerland	Case report	Chronic pain (Undefined)	1	13 years	Female	ccessory ossicle of foot	Ankle
Champion (2020)	Australia	Cross-sectional questionnaire	Chronic (3 months or longer)	104*	3-18 years	NR	Restless leg syndrome	Leg
Champion (2022)	Australia	Cross- sectional	Persistent pain (undefined)	857*	Mean 10.5 years	NR	Growing pains	Lower Limb
Chang	Taiwan	Case report	Persistent pain (>2 months)	1	14 years	Male	Juvenile idiopathic arthritis	Hip
Chaturvedi	India	Retrospective medical record review	Chronic pain (Undefined)	17*	4-14 years	14 Female 5 Male (whole sample)	hritis due to bancroftian ariasis (Filarial arthritis)	Knee, Ankle
Chollet	USA	Prospective cohort	Chronic pain (Undefined)	10*	2-14 years	NR	Osteonecrosis due to chemotherapy for ALL or non-hodgkins lymphoma	Ankle
Chua	Malaysia	Case report	Chronic pain (>3 months)	1	7 years	Female	Melorheostosis (Mesenchymal dysplasia)	Hip, Knee
Cibulka	USA	Case report	Chronic pain (>8 months)	1	15 years	Female	Patellofemoral pain syndrome	Knee
Cilliers	South Africa	Case series	Chronic pain (since infancy)	NR	NR	NR	Beukes familial hip dysplasia (autosomal dominant condition)	Hip

Cirakli	Turkey	Cross-sectional observational	Chronic (> 12 months)	16*	Mean 11 years (2-17 years)	NR	Brucellosis	Leg
Clohisy	USA	Prospective cohort	Persistent pain (Undefined)	NR	17.6 years (range 13-31.8)	NR	Acetabular dysplasia	Hip
Colgan	Ireland	Case report	Persistent pain (>3 months)	1	14 years	Male	Slipped upper femoral epiphysis	Knee
Constantinou	Australia	Case report	Chronic pain (>3 months)	1	16 years	Male	Non-union distal fibula avulsion fracture	Ankle
Corominas	Spain	Case report	Pain (18 months)	1	14 years	Male	Osteochondritis dissecans	Foot
Craig	USA	Case report	Chronic pain (Undefined)	1	9 years	Male	Activated phosphoinositide 3-kinase (PI3K) delta syndrome	Hip
Crosby	USA	Retrospective review	Pain (>12 months)	4*	Mean 12.9 years (range 8-17)	NR	Femoral shaft fracture	Hip
Curtin 2005	Ireland	Case report	Pain (18 months)	1	12 years	Male	Osteochondritis of medial lallucial sesamoid	Foot
Curtin 2010	USA	Case report	Pain (3 months)	1	16 years	Male	Bucket handle medial plica	Knee
Dagher	Lebanon	Case report	Chronic (>1 year)	1	5 years	Female	Juvenile idiopathic arthritis	Knee, Ankle
Dartnell	UK	Retrospective review	Persistent pain (Undefined)	4*	Mean 14.7 years	NR	Hip dislocation or subluxation in cerebral palsy	Hip
Das	India	Cross-sectional observational	Chronic pain (Follow up 1.6-3 years)	14	11-16 years	3 Female 11 Male	Post operative cerebral palsy	Knee
de Rooy	Netherlands	Case report	Chronic pain (6 months)	14	14 years	Female	Growth arrest at secondary growth plate	Knee
Deere	UK	Longitudinal study	Pain (>3 months)	845	Mean 17.8 years	550 Female 295 Male	Musculoskeletal pain	Hip, Thigh, Knee, Ankle, Foot
Demir (2019)	Turkey	Case series	Pain 2 years	3	<18 years	NR	Takayasu arteritis	Knee
Demir (2014	Turkey	Case report	Chronic (undefined)	1	11 years	Female	Juvenile idiopathic arthritis	Ankle
Den Hoed	Netherlands	Prospective evaluation	Persistent pain (Undefined)	30*	> 4 years osteonecrosis subgroup (range 4-18 years)	16 Female 14 Male	Osteonecrosis	Hip, Knee, Ankle
Deniz	Turkey	Case report	Pain 6 months	1	10 years	Female	Iselins disease	5th metatarsal
DePhillipo	USA	Case report	Persistent pain (Undefined)	1	11 years	Male	Osteochondral defect	Knee
Derfalvi 2022/2014	Hungary	Cross-sectional observational	Persistent pain (Undefined)	82	Mean 13.7 years (SD 3.2)	37 Female 45 Male	Crohn's disease	Hip, Knee, Ankle
Dicaprio	USA	Case report	Persistent pain (>4 months)	1	14 years	Female	Osteosarcoma	Knee
Dimitrovska	Macedonia	Case series	Chronic	49	3-14 years	23 Female 26 Male	Brucellosis	Big joints of lower limb
Doyle	USA	Case series	Pain (>4 months)	3	2.5 years, 14 years, 8 years	3 Female	Talonavicular coalition	Foot
Duan	China	Case report	>2 year history of pain	1	11 years	Female	Talonavicular coalition	Foot
Duckers	Germany	Case report	Chronic pain (8 years)	1	11 years	Female	Purpura schoenlein hennoch	Ankle

Ece	Turkey	Follow up	Chronic pain (Undefined)	111*	Mean 10 years (Range 1.5-18 years)	NR	Juvenile idiopathic arthritis	Hip, Knee, Ankle, Foot
Eichenbaum	USA	Case report	Pain (>12 months)	2	14 years 16 years	2 Male	Talus partitus	Ankle
Eisenstein	USA	Case report	Chronic pain (6 months)	1*	12 years	Female	Chronic recurrent multifocal osteomyelitis	Hip, Ankle, Foot
Ekinci	Turkey	Case report	Chronic pain (3months or longer)	1	13 years	Female	Multifocal AVN (neuropsychiatric SLE)	Knee
Eliasberg	USA	Case report	Persistent pain (Undefined)	1	17 years	Male	Meniscal ossicle	Knee
Emad	Saudi Arabia	Case study	Chronic pain (3 years)	1	12 years	Male	Lipomovitis prepatellaris (Hoffa's syndrome)	Knee
Encinas	Bolivia	Case report	Pain (15 months)	1	12 years	Female	Bechet's disease	Knee
Endo	Japan	Case report	Chronic pain (12 months)	1	16 years	Female	Chondroblastoma	Knee
Eng	USA	RCT	Pain (> 6months)	20	13-17 years	20 Female	Patellofemoral pain syndrome	Knee
Engel	USA	Cross-section observational	Chronic (>3 months)	23*	8-20 years	NR	Neuromuscular disease (e.g., DMD)	Leg, Feet
Ergen	Turkey	Case report	Pain (5 months)	1	13 years	Male	Overuse injury – triradiate cartilage	Hip
Farsetti	Italy	Case report	Chronic pain (>3 months)	1	11 years	Female	Osteochondrosis	Ankle
Fellas	Australia	RCT	Chronic pain (>3 months)	66	Mean 12 years	45 Female 21 Male	Juvenile idiopathic arthritis	Foot
Ferguson	Canada	Case report	Chronic pain (>3 months)	1	13 years	Female	Chronic recurrent multifocal osteomyelitis	Ankle
Ferrada	USA	Cross-sectional Survey	Persistent pain (Undefined)	NR	Mean 14.6 years	NR	Relapsing polychondritis	Knee, Ankle
Fisher	UK	Longitudinal	Chronic pain (>3 months)	118	Range 8-16 years	57 Female 61 Male	Lower limb injury	Hip, Knee, Lower leg, Ankle, Foot, Toe
Ford (2009)	USA	Case report	Chronic pain (2 years)	1	9 years	Female	Autoimmune polyendocrinopathy candidiasis ectodermal dystrophy	Knee, Ankle
Ford (2021)	USA	Case report	Chronic pain (Undefined)	1	16 years	Female	Patellar sleeve fracture	Knee
Foxen-craft	USA	Cross-sectional survey	Chronic pain (>6 months)	21	Mean 14.3 years	NR	Musculoskeletal pain	Hip, Knee, Ankle
Fuglkjaer	Denmark	Prospective longitudinal study	Chronic pain (>12 weeks)	NR	8-17 years	NR	Musculoskeletal pain (traumatic/non traumatic)	Thigh, Knee, Lower leg, Ankle, Foot
Funk	USA	Case report	Chronic pain (Undefined)	1	12 years	Male	Type 3 von willebrand disease	Ankle
Gallagher	USA	Case report	Chronic pain (>4 months)	1	3 years	Female	Avoidant restrictive intake disorder	Hip, Knee
Gamble	USA	Cross-sectional	Chronic pain (Undefined)	77	0-19 years	48 Female 28 Male	Pseudoachondroplasia	Hip, Knee
Garg	UK	Case report	Pain (>7 months)	1	15 years	Female	Primary diaphyseal tuberculosis	Leg
Geiduschek	USA	Cross-sectional observational study	Persistent pain (Undefined)	55	3-22 years (Median 5 years)	20 Female 25 Male	Spasticity related to cerebral palsy	Lower extremity
Gemulla	Germany	Case series	Pain (5 months)	1*	15 months	Female	Coxsackie or influenza virus	Ankle
George 2019	India	Case report	Pain (> 12 months)	1	15 years	Male	Slipped capital femoral epiphysis with hyperparathyroidism	Hip
George 2008	UK	Case report	Persistent pain (undefined)	2	14-16 years (Mean age 15 years)	1 Female 1 Male	Benign lesion of proximal femur	Femur
Georgoulis	Greece	Case series	Persistent pain (Undefined)	NR	13-24 years of age (mean 18 years)	NR	Osteoid osteoma	Knee

Gerberg	USA	Case report	Chronic pain	1	8 years	Male	Legg-calve-perthes disease	Hip
Gerbino	USA	Cross-sectional observational	Chronic pain (3 months)	NR	Mean age 16.9 years	NR	Patellofemoral pain syndrome	Knee
Gibbons	Canada	Case series	Chronic pain (unspecified)	1*	NR	NR	Chronic ankle pain following lateral ankle sprain	Ankle
Glard	France	Retrospective review	Pain (>10 months)	4	11-17 years	4 Female 1 Male	Os trigonum	Ankle
Gokhale	UK	Case report	Pain (>7 months duration)	1	9 years	Female	Ganglion	Hip/groin
Goraya	India	Case report	Chronic pain (3 months or >)	1	9 years	Female	Arteriovenous malformation of the knee	Knee
Gottesman	USA	Case report	Chronic pain (Undefined)	1	16 years	Female	Spondyloepimetaphyseal dysplasia	Knee
Greenberg	USA	Case report	Chronic Pain (>3 months)	1	15 years	Male	Fibular stress fracture	Lower leg
Guizar-Sanchez	Mexico	Retrospective case-matched control study	Chronic pain (Undefined)	21*	Mean 7 years	8 Female 12 Male	Cerberal Palsy	Hip
Gupta	India	Cohort study	Pain (>12 months)	1*	Mean 12.6 years	NR	Contusio acetabulae / septic arthritis	Hip
Gutierrez	Spain	Retrospective medical record review	Chronic pain (>2 years)	22*	Mean 9.4 years (SD 0.3)	NR	Flat foot	Foot
Hadef	Algeria	Case report	Chronic pain (Undefined)	1	9 yearrs	Male	Bechets disease	Hip, Knee
Hanna	UK	Case series	Pain (12 months)	2	13 years 17 years	Male	Femoral condylar osteochondritis dissecans	Knee
Harlewijn	Belgium	Case report	Pain (> 6 months)	1	14 years	Male	Haemophilic A	Foot
Hashkes	USA	Cross-sectional observational	Chronic pain (mean 1.4 years)	11	4-15 years	3 Female 8 Male	Growing pains	Lower leg (shin, calf)
Hayat	UK	Case report	Pain (>12 months)	1	16 years	Male	Subchiofemoral impingement	Groin
Hayyun	Malaysia	Case report	Persistent pain (>5 months)	1	10 years	Male	Femoral neck stress fracture	Hip
Heinemann	Germany	Longitudinal	Chronic pain (>3 months)	10	<15 at age of diagnosis	NR	Ewing sarcoma	Lower limb
Heinen	Germany	Prospective cohort	Chronic pain (Undefined)	278*	2-17 years		Cerebral palsy (spasticity related pain)	Hip, Knee, Ankle, Foot
Helenius	Finland	Case series	Chronic pain (undefined)	28*	15.7 years (Range 3.7 - 32.8 years)	NR	Avascular bone necrosis, slipped capital femoral epiphysis, Osteochondritis dissecans of the medial femoral condyle, Osteoarthritis, meniscal tear,	Hip
Hensley	USA	Case report	Chronic pain (>6 months)	1	15 years	Male	Navicular fracture (non-displaced)	Foot
Hetsroni	USA	Retrospective office chat review	Chronic pain (>3 months, >1 year)	6	Range 14-18 years	5 Female 1 Male	Medial meniscocapsular separation	Knee
Hevesi	USA	Retrospective geographic database review	Persistent pain (Undefined)	4*	Mean 12.5 years	NR	Osteochondritis dissecans	Knee
Higuchi 2016	Japan	Case report	Persistent pian (>5 months)	1	14 years	Female	Familial neurofibromatosis type 1	Hip, Leg
Higuchi 2019	Japan	Case report	Persistent pain (3 months)	1	14 years	Male	Osteoid osteoma	Knee
Ho	USA	Case report	Pain (>8 years)	1	15 years	Male	Skeletal dysplasia and open physes	Knee

Holden	Denmark	Prospective longitudinal	Persistent pain (Mean 24 months)	220*	Median 17 years	NR	Musculoskeletal pain	Knee
Holm	Norway	Cohort	Pain (2.5 years)	21*	Mean 11.7 (range 5.5-22.4)	NR	Hip Dysplasia	Hip
Holzheimer	Germany	Case report	Chronic pain (Undefined)	1	10 years	Female	Inguinal hernia	Groin
Hong	China	Case report	Chronic pain (Undefined)	1	7 years	Male	Perthes Disease	Hip
Hori	Japan	Case series	Chronic pain (>4 years)	1*	10 years	Female	[illegible]-adipose vascular anomaly	Thigh
Hornsby	Australia	Single case experimental design	Chronic pain (>3 months)	3	Mean 10.6 years	1 Female 2 Male	Generalised joint hypermobility / chronic musculoskeletal pain	Hip, Knee, feet
Hosny	Egypt	Cohort	Consistent pain (Undefined)	3*	8-14 years	NR	Legg-calve-perthes disease	Hip
Houx	France	Cross-sectional observational	Chronic pain	33*	NR	NR	Pyrin-associated periodic syndrome	Lower limb
Howe	USA	Case report	Chronic pain (>3 months)	1	9 years	Female	Discoid lateral meniscus	Knee
Huppertz	Germany	Cross-sectional	Chronic (3 months or >)	2	Median 11 years (Range 3-16 years)	NR	Lyme arthritis	Hip, Knee, Ankle
Huang	China	Cross-sectional	Chronic (3 months or >)	18*	Mean 10 years	Male	Becker muscular dystrophy	Hip, Leg, Feet
Huynh	USA	Case series	Pain (4 month and 2-year history)	2	3 years 4 years	2 Male	Tendonitis, Juvenile idiopathic arthritis	Lower limb, Knees, Ankle
Ifedic	USA	Case report	Chronic pain (at least 3 months)	1	11 years	Male	Chronic recurrent multifocal osteomyelitis	Knee
Iliev	Bulgaria	Case report	Pain (several months)	1	18 years	Male	Os subtibiale	Ankle
Ismail	USA	Case report	Chronic pain (>2 years)	1	14 years	Female	Osteochondroma	Ankle
Issever	Germany	Case report	Chronic pain (>1 year)	1	10 years	Female	Accessory navicular bone	Ankle, Foot
Iwaasa	Japan	Case report	Persistent pain (>6 months)	1	16 years	Female	Plica syndrome	Knee
Jain	India	Case report	Pain (6 months)	1	13 years	Female	Primary sjogrens syndrome with distal renal tubular acidosis and metabolic disease	Hip, Knee
James 2017	USA	Case report	Pain (7 years)	1	11 years	Female	Recurrent ankle sprain	Ankle
James 2015	Australia	Cross-sectional	Paim (mean10 months)	124	Mean 10.8 years	52 Female 72 Male	Calcaneal apophysitis	Heel
Jasiexicz	Poland	Retrospective medical record review	Persistent pain (5.6 years)	1*	Mean 14 years (range 9-22 years)	NR	Accessory navicular bone	Foot
Jiang	China	Care report	Persistent pain (Undefined)	1	16 years	Female	Hoffa's fracture	Knee
Jimenez	USA	Prospective cohort	Chronic pain (>2 years)	39*	Mean 16 years	35 Female 4 Male	Femoroacetabular impingement	Hip
Johnson	USA	Retrospective medical record review	Chronic pain (>7 months)	7*	Mean 12 years (Range 2-23)	2 Female 5 Male	Klippel-trenaunay syndrome (vascular malformation)	Knee
Kalra	UK	Case report	Chronic pain (5 years)	1	9 years	Female	Recurrent rhabdomyolysis	Calves

Kamal	Indonesia	Case report	Persistent pain (>2 years)	1	10 years	Female	Osteofibrous dysplasia	Tibia
Kaplan	USA	Case report	Chronic pain (Undefined)	1	16 years	Female	Chondrolysis	Hip
Karadag	Tirkey	Case report	Pain (>3 months)	1*	3 years	Female	Hyperimmunoglobulin D syndrome	Leg
Kaser	USA	Case report	Chronic pain (>3 months)	1	11 years	Female	Chondroblastoma	Knee
Kashikar-Zuck	USA	Clinical trial	Chronic pain (undefined)	135	Mean 15.6 years	120 Female 11 Male 4 Trangender /Non binary	Primary chronic musculoskeletal pain	Lower limb
Kaspiris	Greece	Retrospective	Chronic pain (Undefined)	130*	Mean 8.6 years (SD 2.5)	69 Female 63 Male	Growing pain	Leg
Kawaji	Japan	Case report	Chronic pain (>3 months)	1*	16 years	Female	Autosomal dominant precocious osteoarthropathy	Hip
Kawakami	Japan	Case report	Chronic pain (>2 years)	1	9 years	Male	Extraskeletal para-articularosteochondroma	Ankle
Kaymaz	Turkey	Case report	Pain (3 months)	1	16 years	Male	Patella chondroma	knee
Keeratisiroj	Thailand	Cross-sectional observational	Pain (7days, 12 months)	270*	Range 10-19 years	NR	Musculoskeletal pain	Hip, Knee, Ankle
Kehoe	USA	Case series	Chronic pain (>11 months)	1*	11 years	Male	Os sustentaculum tali fracture adjacent to talocalcaneal tarsal coalition Kempert	Foot
Kempert	USA	Cross-sectional observational	Chronic pain (at least 3 months)	109	8-19 years	73 Female 15 Male	Musculoskeletal pain	Lower limb
Kernbach	USA	Case series	Chronic pain (>16 months)	6	12-17 years	NR	Middle facet talocalcaneal coalition	Ankle
Khan 2014	UK	Case report	Chronic pain (10 months)	1	14 years	Male	Iliopsoas iliacus haematoma after apophyseal injury	Hip
Khan 2018	USA	Case report	Chronic pain (several months)	1	11 years	Female	Septic arthritis	Hip
Kizilkaya	Turkey	Case report	Pain (3 years)	1	7 Years	Male	Skeletal dysplasia	Knee, Ankle
Knaus	Norway	Retrospective medical record review	Chronic pain (>3 months)	4*	Mean 15 years (Range 3-27)	Male	Post operative proximal femoral resection arthroplasty	Hip
Kramer	USA	Case series	Chronic pain (>3 months)	14	9-18 years	NR	Osteochondritis dissecans	Knee
Kreetapirom	Thailand	Case report	Pain (>3 months)	1	15 years	Male	Hyperthyroidism	Hip
Krishnamoorthy	USA	Case report	Severe pain (2 years)	1	17 years	Female	Primary hyperthyroidism	Knee
Krutzke	Germany	Case report	Chronic pain (>3 months)	1	15 years	Female	COPA syndrome	Knee, Ankle, Foot
Kumar (2001)	India	Retrospective study	Pain (9 months)	7	Mean 15 years	NR	Undifferentiated spondyloarthropathy	Hip, Knee, Ankle
Kumar (2017)	India	Cross-sectional observational	Chronic pain (>3 months)	94*	5-16 years	NR	Primary chronic musculoskeletal pain	Lower limb
Labotka	USA	Observational	Pain (undefined)	49	Mean 18 years	NR	Sickle cell disease	Leg
Lager	Sweden	Cross-sectional	Chronic (3 months or >)	38*	15 years	NR	Spinal muscular atrophy, duchenne and becker muscular dystrophy	Leg
Lambrechts	USA	Case report	Chronic pain (>12 months)	1	15 years	Male	Heterotopic ossification of rectus femoris post AIIS avulsion fracture	Hip

LaMont	USA	Retrospective chart review	Persistent pain (>12 months)	19	Mean 15 years (range 9.5-17)	5 Female 14 Male	Injured discoid meniscus segment	Knee
Larson	USA	Cross-sectional	Chronic (>1 year)	28*	Mean 13 years (range 6-17)	NR	Slipped capital femoral epiphysis	Hip, Knee
Lavoie	USA	Case report	Chronic (4 years)	1	11 years	Male	Philadelphia chromosome-positive CML	Leg
Lee 2015	Korea	Cross-sectional observational	Chronic (6 months)	20	Mean 11 years (SD 2)	8 Female 12 Male	Symptomatic flexible flat foot	Foot
Lee 2015	Korea	Cross-sectional observational	Chronic (6 months)	20	Mean 9.1 years (SD 2.32)	13 Female 7 Male	Growing pain	Lower limb
Lefkir	Algeria	Case series	Pain (>3 months)	1*	14 years	Female	Juvenile angio-bechet's disease	Knee
Lepore	Canada	Case report	Persistent pain (5 months & >3 years)	2*	9 years 14 years	Female	Polyarticular juvenile arthritis	Groin, Knee
Lequang	USA	Case report	Pain (>3 years)	1	15 years	Female	Von Willebrand factor I type A variant	Knee
Lescot	France	Prospective cohort	Persistent pain (undefined)	4*	Median 13 years (range 10-15)	NR	Post-surgical pain	Foot
Li	China	Case report	Pain (6 months)	1	13 years	Female	Wilson disease	Knee
Liu	Taiwan	Case report	Chronic pain (>4 months)	2	2 months & 2 years	Male	Spinal meningioma	Knee
Logan (2021)	USA	Retrospective review	Pain (11 months)	51*	Mean 11 years	NR	Symptomatic discoid meniscus	Knee
Logan (2010)	USA	Case report	Pain (>3 years)	1	8 years	Female	Limb length secondary to ABI	Hip
Lolekha	Thailand	Prospective cohort	Chronic pain (>3 months)	4*	Range 4-11 years	NR	Human immunodeficiency virus	Lower limb
Lu	China	Case report	Pain (3 years)	1	9 years of age	Male	Pyogenic arthritis	Knee, Ankle
Luhmann	USA	Retrospective review	Chronic pain (>12 months)	9	Mean 14.6 years (range 10.3-19.9)	1 Female 8 Male	Painful idiopathic rigid flatfoot	Foot
Luthi	Switzerland	Case report	Chronic pain (>3 months)	1	16 years	Male	Complication of oral retinoids	Knee
Lyback	Finland	Cross-sectional observational	Chronic pain (>3 months)	15*	Range 1.5-16 years	NR	Juvenile rheumatoid arthritis	Knee
Macdonald	USA	Case report	Chronic pain (Undefined)	1	7 years	Female	Post fibular fracture	Ankle
Maj	Malaysia	Case report	Chronic pian (>6 months)	1	11 years	Female	Anterior horn deficient discoid meniscus	Knee
Majumder	India	Case report	Chronic pain (>3 months)	1	5 years	Male	Pigmented villonodular synovitis	Knee
Malec	USA	Case report	Persistent pain (several months)	1	14 years	Female	FVII deficiency	Knee
Mardanpour	Iran	Case report	Pain (4 month history)	1	11 years	Female	Calcaneus osteosarcoma	Ankle
Mariani	Italy	Retrospective review	Chronic pain (>1 year)	1*	Mean 15 years	Male	Chronic patella instability	Knee
Maru	Japan	Case report	Chronic pain (>3 months)	1	12 years	Female	Chondroblastoma	Hip
Masiero	Italy	Cohort	Persistent pain (>3 months)	2584	Mean 15 years (SD 1.21)	NR	Musculoskeletal pain	Hip, Knee, Ankle
Maslon	Poland	Observational	Permanent pain (Undefined)	11*	Mean 9.6 years	NR	Cerebral palsy	Hip
Masud	Bangladesh	Case report	Chronic pain (>2 years)	1	15 years	Female	Giant cell tumour	Tibia

Matava	USA	Retrospective review	Pain (4 months, 12months)	3*	Mean 12.7 years	NR	Slipped capital femoral epiphysis	Hip, Leg, Knee
Mattila	Finland	Retrospective review	Chronic pain (>2 years)	14	Mean 6 years	6 Female 8 Male	Intra-articular venous malformation of the knee	Knee
Mauro (2018)	Italy	Case report	Chronic pain (6 months)	1	16 years	Female	Pigmented villonodular synovitis	Knee
Mauro (2018a)	Italy	Case series	Chronic pain (several months)	1	7 years	Female	Beta thalassemia minor	Hip, Knee, Ankle
Maximen	France	Case report	Chronic pain (6 months)	1	17 years	Male	Hemangioendothelioma	Knee
May	USA	Retrospective review	Chronic pain (>6 months)	52	Mean 12.5 years (range 3-19)	NR	Osteoid osteoma	Hip, Thigh, Knee
Mazzella	Australia	Cross-sectional cohort	Pain (>2 years)	28*	Mean 14.31years	12 Female 16 Male	Patellofemoral pain	Knee
McKinnon	Australia	Cross-sectional observational	Chronic pain (>3 months)	75	Range 5-18 years	NR	Cerebral palsy	Lower limb
Mehdinasab	Pakistan	Case report	Chronic pain (1.5 years)	1	15 years	Female	Osteoid osteoma patella	Knee
Menge	USA	Case report	Chronic pain (>3 months)	1	14 years	Male	Distal malleolar stress fracture	Ankle
Mensink	Netherlands	Cross-sectional case control	Chronic pain (Undefined)	16	Mean 14.8 years	12 Female 4 Male	Juvenile idiopathic arthritis	Knee
Messia	Italy	Case report	Chronic (>1 year)	1	4 years	Female	Aging associated vasculopathy (SAVI)	Knee, Ankle
Messner	Sweden	Case series	Chronic pain (>12 months)	1	18 years	1 Female 1 Male	Chondral damage due to trauma	Knee
Miettunen	Canada	Prospective	Chronic pain (>3 months)	40	Range 0-18 years	NR	Osteonecrosis related to chemotherapy (ALL)	Hip, Knee
Miltner	Germany	Prospective cohort	Chronic pain (>6 months)	27	Range 13-18 years	24 Female 3 Male	Patellar hypertension syndrome	Knee
Mir	India	Case report	Chronic pain (2 years)	1	17 years	Male	Osteoblastoma of talus body	Ankle
Miro	Spain	Cross-sectional	Chronic pain (Undefined)	115	Mean 14 years (SD 3)	44 Female 56 Male	Chronic pain in context of physical disability (Cerebral palsy, Neuromuscular disease, Spina bifida),	Hips, Leg, Feet
Miyazaki	Japan	Case report	Chronic (9 months)	1	16 years	Female	Chondroblastoma	Knee
Moore	Canada	Case report	Chronic (3 years)	1	8 years	Male	Lyme arthritis	Knee
Morris	USA	Case report	Chronic pain (>6 months)	1	11 years	Male	Osteoid osteoma	Ankle, Foot
Mortensen	USA	Case report	Chronic pain (6 months)	1	15 years	Male	Ischial osteoid osteoma	Hip
Motsis	Greece	Case report	Chronic pain (2 years)	1	16 years	Female	Intra-articular synovial lipoma	Knee
Moukoko	France	Cohort	Chronic pain (>12 months)	36	Mean 8 years	26 Female 10 Male	Subfibular ossicle	Ankle
Muramastsu	Japan	Case series	Chronic pain (>3 months)	8*	Range 0-17 years	3 Female 5 Male	Synovial hemangioma	Knee
Muschol	USA	Case report	Pain (5 months)	1	5.5 years	Male	Hypertrophic medial plica / medial femoral condyle damage	Knee
Naranje	India	Case report	Chronic pain (>6 months)	1	10 years	Male	Cirsoid aneurysm	Knee

Nayak	USA	Case report	Chronic pain (Undefined)	1	12 years	Female	Chronic dislocated hip	Hip
Nemcovaf	Denmark	Retrospective medical record review	Chronic pain 2-84 months)	21	Mean 10.5 years	12 Female 9 Male	Chronic recurrent multifocal osteomyelitis	Lower extremities
Nevins	USA	Case report	Pain (>6 months)	1	10 years	Male	Lipoma arborescence	Knee
Ningegowda	India	Case report	Chronic pain (>1 year)	1	13 years	Male	Chondroblastoma	Ankle
Novaczyk	USA	Retrospective cohort	Chronic (months or >)	265	Range 9-11 years	NR	Cerebral palsy	Hip, Knee, Ankle, Foot
Novais	USA	Prospective cohort	Chronic (Undefined)	13*	Range 9-18 years	2 Female 11 Male	Osteonecrosis of femoral head	Hip
Nwachukwu	USA	Retrospective medical record review	Chronic pain (post-op, >6 months f/u)	11*	Mean 16.2 years (range 13-18)	NR	Arthrofibrosis following ACL reconstruction	Knee
Nwankwo	Nigeria	Case report	Chronic pain (>3 months)	1	11 years	Female	Dermatomyositis	Lower limbs
Oh	Korea	Retrospective with single follow up	Chronic (6 months)	10	Mean 15.6 years (range 10-22)	5 Female 5 Male	Idiopathic flat foot	Ankle, Foot
Oshlyanska	Ukraine	Case report	Chronic pain (>3 months)	1	14 years	Male	Paraneoplastic arthritis	Knee
Pacey 2014	Australia	Intervention	Chronic pain (Undefined)	9*	Mean 11.6 years	NR	Joint hypermobility syndrome	Knee
Pacey 2013	Australia	RCT	Chronic pain (Undefined)	265	Mean 12.04 years (SD 2.93)	18 Female 8 Male	Generalised joint hypermobility	Knee
Padeh	Israel	Cross-sectional observational	Chronic pain (Undefined)	61	Mean 9.4 years	47 Female 24 Male	Juvenile rheumatoid arthritis	Hip, Knee, Ankle
Padhye	Australia	Retrospective medical record review	Persistent pain (undefined)	20	Mean 13 years	NR	Osteonecrosis	Hip, Knee, Ankle
Paluska	USA	Case report	Persistent pain (3 months)	1	11 years	Male	Osteomyelitis	Thigh
Papakonstantinou	Greece	Retrospective review	Persistent pain (Undefined)	5	Median 12 years	3 Female 2 Male	Osteonecrosis	Hip, Knee
Park	Korea	Case report	Chronic pain (>1 year)	1	16 years	Male	Recurrent macrophage activation syndrome	Ankle
Paruk	South Africa	Case series	Chronic pain (>3 months)	2	13 years 17 years	Male	Primary hyperthyroidism	Knee, Ankle
Patel	India	Case report	Chronic pain (>3 years)	1	12 years	Male	Wilsons disease	Knee
Perez	Spain	Case report	Pain (>3 years)	1	7 years	Male	Haploinsufficiency of A20 with new mutation p.W365R	Lower limbs
Pietrzak	Australia	Case report	Chronic pain (>6 months)	1	16 years	Female	Patellofemoral pain syndrome and iliotibial band syndrome	Knee
Pilbury	UK	Case report	Pain (>4 years)	1	12 years	Male	Cystic fibrosis	Knee
Pill	USA	Retrospective case series	Chronic pain (Undefined)	23	Mean 10.4 years (range 8-13)	15 Female 8 Male	Symptomatic os subfubare	Foot
Pinto (data combined with Paredes)	Portugal	Cross-sectional	Chronic pain (3 months or >)	18*	Range 10-17 years	NR	Haemophilia	Knee, Ankle
Poirot	France	Cohort study	Pain (Long duration)	65*	Mean 6.79 (SD±1.93)	NR	Cerebral palsy	Hip, Knee, Feet
Porter-Bishop	New Zealand	Case report	Chronic pain (Undefined)	1	12 years	Male	Von Willebrand disorder	Ankle
Portin	USA	Case report	Chronic (3 months or >)	1	7 years	Male	Juvenile idiopathic arthritis	Ankle

Pouliquen	France	Retrospective medical record review	Chronic pain (>2 years)	25	Range 6-16 years	20 Female 5 Male	Anatomical variant “Too long” posteromedial calcaneal process	Foot
Pountney	UK	Randomised trail	Chronic pain (>6 months)	6	Mean 12.1 years	2 Female 4 Male	Cerebral palsy	Hip
Pourbordbari	Denmark	Cross-sectional population	Chronic pain (median pain 5 months)	56*	Median 13 years (IQR 12-16.5)	NR	Musculoskeletal pain	Knee, Ankle, Foot, Heel
Poutoglidou	Greece	Case report	Chronic Pain (4 months)	1	10 years	Male	Pigmented villonodular synovitis	Knee
Powell	USA	RCT	Persistent pain (>1 month, less than 24 months)	25*	Mean 12.4 years	NR	Juvenile idiopathic arthritis	Foot, Ankle
Prakash	India	Case report	Chronic pain (>6 months)	1	8 years	Male	Metatarsal tubercular osteomyelitis	Foot
Prigent	France	Case report	Chronic pain (>18 months)	1	13 years	Male	Traumatic lower limb amputation	Foot
Provenzano	Sweden	Cross-sectional	Chronic pain (Undefined)	27	Median 11 years	NR	Osteogenesis imperfecta	Hip, Knee, Foot
Pybus	UK	Case report	Chronic pain (>3 months)	1	4 years	Female	Takayasu arteritis	Lower limbs
Rao 2021	USA	Case report	Chronic pain (>6 months)	1	13 years	Female	Osteochondroma	Knee
Rao 2020	USA	Case report	Persistent pain (6 months)	1	13 years	Male	Ewings sarcoma	Hip, Thigh, Knee
Rathleff 2013	Denmark	Cross-sectional population based	Chronic pain (>36 months)	57*	Mean 17.2 years	Female	Patellofemoral pain syndrome	Knee
Rathleff 2013	Denmark	Cross-sectional	Chronic pain (>18 months)	57*	Mean 17 years (SD ±1.1)	Female	Patellofemoral pain syndrome	Knee
Rathleff 2019	Denmark	Prospective longitudinal	Chronic pain (>2 years)	169*	Mean 17 years	Female	Musculoskeletal pain	Knee
Rathleff 2016	Denmark	Prospective longitudinal	Chronic pain (>2 years)	180*	Mean 17 years	Female	Patellofemoral pain syndrome	Knee
Raza	UK	Case report	Chronic pain (>1 year)	1	12 years	Female	Synovial chondromatosis	Hip
Remesal	Spain	Case report	Chronic pain (>1 year)	1	9 years	Female	Chronic infantile neurologic, cutaneous, and articular syndrome (CINCA)	Knee
Rethlefsen	USA	Retrospective medical record review	Chronic pain (>3 years)	46*	Mean 10.5 years (SD±2.1)	NR	Post-op calcaneal lengthening/lengthening osteotomy	Foot
Riaz	UK	Case report	Chronic pain (>9 months)	1	15 years	Male	Osteochondral lesion	Ankle
Richard	USA	Prospective longitudinal	Chronic pain (>12 months)	51	Mean 17.6 years (range 12-21)	32 Female 19 Male	Post-operative hip preservation surgery	Hip
Rodrigo	Sri Lanka	Case report	Chronic pain (>3 months)	1	17 years	Male	Tuberculosis infection	Knee
Roth	Germany	Case report	Pain (12 months)	1	7 years	Female	Oligoarticular juvenile idiopathic arthritis	Leg
Rukavina	Croatia	Case report	Chronic pain (>3 months)	1	13 years at onset	Female	Primary OA w/ spondyloepiphyseal involvement (mutation of type II collagen gene COL2AI)	Hip, Knee, Ankle
Ryan	USA	Case report	Pain (1.5 years)	1	15 years	Female	Sacral osteoid osteoma	Leg, Knee

Sahin	Turkey	Case report	Chronic pain (14 years)	1	17 years	Female	Synovial haemangioma	Knee
Salvati	Italy	Case series	Chronic pain (>6 months)	1	17 years	Male	Osteonecrosis femoral head	Hip
Salzman	USA	Case report	Chronic pain (Undefined)	1	3 years	Female	Tuberculous osteomyelitis	Hip
Sams	USA	Case report	Persistent pain (>12 months)	1	13 years	Male	Developmental dysplasia & dislocation of the patella	Knee
Sanchis-Alfonso	Spain	Case report	Persistent pain (several months)	1	16 years	Female	Localised Pigmented Villonodular Synovitis	Ankle
Santora	USA	Case report	Persistent pain (Undefined and 9 months)	1	11 & 12 years	Female	Intraarticular loose body	Hip
Santos-Pereira	Portugal	Case report	Chronic pain (>6 months)	1	13 years	Female	Tillaux Fracture	Ankle
Sarage	USA	Case series	Chronic pain (>4 months)	1	15 years	Female	Calcaneo-navicular tarsal coalition	Foot
Sasapu	USA	Case report	Persistent pain (5 months)	1	10 years	Female	Osteoid osteoma	Leg
Schejbalova	Czech Republic	Retrospective medical record review	Chronic pain (>3 months)	4*	Ramge 9-18 years of age	NR	Cerebral palsy	Hip
Schils	USA	Retrospective medical record review	Pain (several months)	2*	Range 16-34 years	NR	Medial malleolar stress fracture	Ankle
Schuett	USA	Retrospective medical record review	Chronic pain (>3 months)	32*	Mean 14.4 years (SD ±1.4)	NR	Pelvic apophyseal avulsion fracture	Hip
Scott	USA	Case report	Chronic pain (>3 months)	1	7 years	Female	Multiple epiphyseal dysplasia	Lower limbs
Sekiya	USA	Case report	Chronic pain (>1 year)	1	17 years	Male	Acetabular impingement	Hip
Shabir	Pakistan	Retrospective medical record review	Chronic pain (>6 months)	5*	Range 2-5 years	NR	Congenital dislocation of hip	Hip
Shah (2016)	USA	Case report	Pain (4 months)	1	6 years	Male	Vitamin D deficiency	Lower limb
Shah (2022)	USA	Case report	Persistent pain (several years)	1	13 years	Female	Intra-adipose vascular anomaly	Thigh
Sharma	USA	Case report	Persistent pain (>2 years)	1	12 years	Male	Musculoskeletal pain syndrome	Hip, Knee
Shetty	USA	Case report	Chronic pain (>7 months)	1	7 years	Female	Osteoid osteoma	Hip
Shimomura	Japan	Case report	Persistent pain (undefined)	1	9 years	Female	Chronic non-bacterial osteomyelitis	Knee
Shiner	USA	Case report	Pain (3 months)	1	9 years	Female	Acute lymphoblastic leukemia	Knee, Ankle
Shore	USA	Retrospective medical record review	Pain (12 months)	29*	Mean 17 years	NR	Legg-calve-perthes	Hip
Shtarker	Israel	Retrospective medical record review	Chronic pain (Undefined)	4*	11,12,13,16 years	NR	Angular and rotational deformities of the lower limb	Lower limb
Shukla	UK	Case series	Chronic pain (>3 months)	4*	11, 14,15	1 Female 3 Male	Osteoid osteoma	Foot
Singh 2003	USA	Case report	Pain (2 years)	2	13 & 15 years	Female	Talar patello-scaphoid osteolysis	Knee, Ankle
Singh 2010	USA	Case report	Chronic pain (>5 months)	1	16 years	Female	Chronic synovitis	Knee
Sink	USA	Retrospective review	Chronic pain (>3 months)	35	Mean 16 years (range 13-18)	30 Female 5 Male	Femoroacetabular impingement	Hip

Sitati	Kenya	Case report	Pain (1 year)	1	10 years	Male	Sever disease	Heel
Skelley	USA	Case report	Chronic pain (Undefined)	1	13 years	Male	Slipped capital femoral epiphysis with vitamin D deficiency	Hip
Smedbraten	Norway	Cross-sectional	Bodily pain (undefined)	569	Mean age 10.4 (4th from); 15.5 (9th form)	NR	Musculoskeletal pain	Knee
Somorjai	Netherlands	Case report	Persistent pain (>3 years)	1	16 years	Male	Intra-articular plica	Ankle
Sonobe	Japan	Retrospective	Pain (3 months)	2*	Mean 6 years	Female	Synovial hemangioma	Knee
Sornay-Soares	France	Retrospective	Pain (12 months)	10	Mean 14.9 years	Female	Juvenile idiopathic arthritis	Knee
Speirs	USA	Case series	Chronic pain (>1 year)	1	14 years	Female	Focal periphyseal oedema	Knee
Spencer-Gardner	USA	Retrospective review	Chronic pain (>3 months)	10	Mean 18 years	NR	Ischial tuberosity apophyseal fracture	Hip
Sperotto 2013/2015	Italy	Cohort	Chronic pain (>3 years)	38*	Mean 14 years (range 8-16)	NR	Benign joint hypermobility / idiopathic musculoskeletal pain	Hip, Lower limb
Sredkova-Ruskova	Bulgaria	Case report	Chronic pain (undefined)	1	12	Female	Ehlers-Danlos syndrome and mutation in COL5A1 gene	Knee, Ankle
Stanton	USA	Retrospective medical record review	Chronic (3 months or >)	36*	Mean 13.4 years (range 8-19)	24 Female 12 Male	Complex Sympathetic Dystrophy	Hip, Knee, Ankle
Steel	UK	Case series	Chronic pain (Undefined & 4 years)	2	10 & 11 years	Male	Sacral/pelvic mass (NF1 and Fibroma - both leading to hip dislocation)	Hip
Stein 2010	USA	Case report	Chronic (Undefined)	1	13 years	Male	Cerebral palsy	Hip
Stein 2005	USA	Case report	Chronic (Undefined)	1	13 years	Male	Cerebral palsy	Hip
Styles	USA	Case series	Chronic pain (Undefined)	9*	Range 9-21 years	3 Female 5 Male	Sickle cell disease	Hip
Su	Taiwan	Prospective cohort	Pain (>6 months)	11*	Mean 14.4 years (Range 10-25)	NR	Hip dysplasia	Hip
Suh	Korea	Case report	Persistent pain (7 months)	1	9 years	Male	Osteonecrosis	Foot
Sulko	Poland	Case report	Pain (>12 months)	1	17 years	Male	Osteomyelitis and lymphoma	Hip, Knee
Suzuki	Japan	Cohort	Persistent pain (Undefined)	NR	Mean 8 years (range 5-13)	NR	Perthes disease	Hip
Syu	USA	Case report	Chronic pain (>3 months)	1	11 years	Female	Chronic recurrent multifocal osteomyelitis	Hip, Knee, Ankle
Szer	USA	Cross-sectional observational	Chronic pain (>3 months)	12*	Range 2-15 years	NR	Lyme arthritis	Hip, Knee, Ankle
Szesz	Poland	Prospective non-controlled clinical follow-up	Chronic pain (>8 months)	4	Mean 10 years	NR	Post surgical pain	Foot
Tanir	Turkey	Retrospective medical record review	Chronic pain Symptoms ranging from 2 to 900 days	69*	Mean 9.02 (SD 3.59)(range 1-16)	NR	Brucellosis	Hip, Knee, Ankle
Taniwaki	Japan	Case series	Persistent pain (>3 months)	2	9 years	1 Female 1 Male	Musculoskeletal pain	Toe
Tenuta	USA	Retrospective medical record review	Chronic pain (12-120 months)	10*	Mean 14 years	NR	Cerebral palsy	Hip
Tezel	Turkey	Case report	Chronic pain (>5 years)	1	10 years	Female	Rickets	Lower limb

Thomas	UK	Case report	Chronic pain (>3 months)	1	17 years	Male	Juvenile osteochondritis dissecans	Knee
Timm	USA	Prospective cohort	Chronic pain (at least 6 months)	76*	Mean 13.9 years	NR	Ankle sprain	Ankle
Tippett	USA	Case report	Chronic pain (>3 months)	1	8 years	Male	Perthes disease	Knee
Tiwara	India	Prospective observational	Persistent severe pain (>6 months)	25	Mean 9.08 years (range 4-12)	NR	Legg-calve-perthes	Hip
Tobias	UK	Prospective cohort study	Chronic pain (>3 months)	1299	Mean 13.8 years	776 Female 523 Male	Joint hypermobility	Lower limb
Tompkins	USA	Case series	Chronic pain (>3 months)	3*	15 and 17 years	2 Female 1 Male	Chondral defects of patella	Knee
Tonsoline	USA	Case report	Pain (>6 months)	1	16 years	Male	Adductor tendinitis	Groin
Toro	Italy	Case report	Persistent pain (>3 months)	1	15 years	Male	Femoral neck fracture	Hip
Trager	USA	Case report	Chronic pain (>3 months)	1	15 years	Male	Juvenile osteochondritis dissecans	Knee
Traore	Africa	Case report	Chronic Pain (Undefined)	1	17 years	Female	Juvenile idiopathic arthritis	Knee, Feet
Tripathy (2013)	UK	Case report	Pain (>4 months)	1	12 years	Male	Hoffa fracture	Knee
Tripathy (2020)	India	Case series	Chronic pain (>3 months)	3*	Mean 9 years (range 4-17)	2 Female 1 Male	Fibrous dysplasia (mono-ostotic polyostotic)	Hip, Leg, Tibia
Tsimicalis	Canada	Prospective cohort	Chronic pain (>4 months)	25*	Mean 12 years (8-19 years)	NR	Osteogensis imperfecta	Hip, Ankle
Turati	Italy	Case report	Chronic pain (undefined)	1	11 years	Female	Osteochondroma	Foot
Tuzuner	Turkey	Case report	Chronic pain (>1 year)	1	14 years	Female	Osteoid osteoma	Ankle
Ukarapong	USA	Case report	Chronic pain (Undefined)	1	13 years	Male	Homozygous mutation of ALPL and mild form of hypophosphatasia	Knee
Ulu	Turkey	Prospective cohort	Chronic pain (3 months or >)	8*	Median 12 years (range 3-17)	NR	Chronic non-bacterial osteomyelitis	Ankle
Umrani	Oman	Case report	Persistent pain (>4 months)	1	8 years	Male	Osteosarcoma	Hip
Unadkat	Africa	Case series	Chronic pain (>5 months)	1	2 years	Female	Acute lymphoblastic leukemia	Lower limb
Uwaezuoke	Nigeria	Case report	Chronic pain (3 years)	1	14 years	Male	Osgood-schlatter's disease	Knee
Van Leeuwen	Netherlands	Prospective cohort	Chronic pain (>3 months)	157	13 years	100 Female 57 Male	Musculoskeletal pain	Hip, Knee, Ankle, Foot
Van straalen	Netherlands	Prospective cohort	Chronic pain (>3 months)	196	Range 5-16 years	149 Female 47 Male	Juvenile idiopathic arthritis & chronic musculoskeletal pain	Hip, Knee, Ankle
Vijayan	USA	Case report	Pain (6 months)	1	9 years	Female	Juvenile idiopathic arthritis	Knee
Villalba	Spain	Prospective cohort	Pain (>6 months)	5	Mean 15.2 years (range 12-18)	1 Female 4 Male	Osteochondritis dissecans	Knee
Vukic	Croatia	Case report	Chronic pain (>3 months)	1	15 years	Female	Juvenile fibromyalgia	Hip
Waisel	USA	Case report	Chronic pain (Undefined)	1	13 years	Female	Ehlers-Danlos	Knee, Ankle
Wang 2020	USA	Prospective cohort	Chronic pain (>12 months)	22*	Mean 12.3 years (SD±6.8)	NR	Fibrofadipose vascular anomaly (FAVA)	Hip, Knee, Ankle, Foot

Wang 2021	China	Retrospective medical record review	Chronic pain (post-op follow up 10-71 months)	6 (feet)	Mean 12.8 years (range 11-20)	NR	Sinus tarsi pain following subtalar arthroereisis	Foot
Ward (2004)	Canada	Case report	Chronic pain (Undefined)	1	12 years	Female	Osteopathia striata with cranial sclerosis	Hip, Knee
Ward (2023)	Ireland	Prospective cross-sectional	Chronic pain (>3 months)	80	Mean 11.6 years	54 Female 26 Male	Hypermobility	Knee, Ankle
Washington	Thailand	Case report	Pain (10 months)	1	5 years	Male	Miliary & osteoarticular tuberculosis	Hip
Watanabe	Japan	Case report	Persistent pain (>6 months)	1	3 years	Female	Synovial hemangioma	Knee
Watters	USA	Case report	Chronic (3 months or >)	1	12 years	Male	Ewings sarcoma	Hip
Wei	USA	Case report	Persistent pain (Undefined)	1	17 years	Female	Gorham-stout syndrome	Hip
Wells	USA	Retrospective medical record review	Chronic pain (follow up 6 months op)	6*	11,13,14,17 years	4 Female 2 Male	Osteonecrosis	Hip
Westbom	Sweden	Retrospective medical record review	Chronic pain (>6 months)	185*	Range 4-19 years	80 Female 105 Male	Cerebral palsy	Hip, Knee, Ankle
Widhalm	Austria	Cohort	Permanent pain (Undefined)	20*	Mean 14.2 years (SD±2.7)	9 Female 11 Male	Cartilage lesion	Knee
Wiegerinck	Netherlands	RCT	Chronic pain (4 months)	101	Mean 10.6 years (SD±1.6)	25 Female 76 Male	Calcaneal apophysitis	Ankle
Wobma	USA	Case series	Persistent pain (12 months)	1	10 years	Female	Chronic recurrent multifocal osteomyelitis	Hip
Wong	Hong Kong	Case report	Pain (3 months)	1	7 years	Female	Neuroblastoma	Hip
Wong 2009	USA	Case report	Chronic pain (>3 months)	1	12 years	Male	Iliofemoral pain syndrome & bipartite patella	Knee
Wong 2022a	Denmark	Prospective cohort	Chronic pain (Undefined)	22	Mean 9.1 years (range 2- 17 years)	8 Female 14 Male	Cerebral palsy	Hip, Knee, Ankle
Wong 2022b	USA	Case report	Chronic pain (Undefined)	1	12 years	Female	Avascular necrosis	Hip
Xie	China	Case report	Persistent pain (>9 months)	1	4 years	Male	Post-surgical	Fibular
Yi	China	Case report	Pain (>12 months)	1	6 years	Male	Synovial chondromatosis	Hip
Yokouchi	Japan	Case report	Chronic pain (3 months)	1	10 years	Male	Osteoid osteoma	Mid tibia
Yoshida	Japan	Case report	Persistent pain (Undefined)	1	8 years	Female	Osteosarcoma	Knee
Yothakol	Thailand	Case report	Chronic (5 months)	1	12 years	Female	Synovial chondromatosis	Knee
Yuill	Canada	Case report	Persistent pain (>4 months)	1	14 years	Male	Tibialis posterior tendonopathy	Foot
Yuldashev	Korea	Retrospective medical cord review	Chronic pain >10 years)	1*	9 years	Male	Type I camuratingelmann	Tibia
Zhang	China	Cohort	Chronic pain (Undefined)	*6	Mean 14.3 years (range 13-17)	Male	Haemophilic arthropathy	Knee
Zhu	China	Case report	Chronic pain (>12 months)	4*	Range 12-14 years	1 Female 3 Male	Metaphyseal chondrodysplasia type schmid	Knee

* This is the population that each study described as meeting the inclusion criteria of having chronic lower limb pain

NR – Sex breakdown not reported for subpopulation of the full study

Supplementary Table 3: The 124 conditions found in this review, and whether or not they were associated with the ICD-11 chronic pain manifestation code

Condition	Was there an ICD-11 manifestation code for chronic pain available?
Acute lymphoblastic leukaemia	Yes
Persistent ankle pain subsequent to a strain or sprain	No
Coeliac disease	No
Cerebral Palsy. This also includes pain subsequent to surgical interventions relating to Cerebral Palsy	No
Cystic Fibrosis	No
Persistent hip pain due to femoroacetabular impingements	Yes
Fibrous dysplasia. This includes both mono-ostotic and polyostotic.	No
Haemophilia including FVII deficiency	No
Persistent hip pain due to developmental (congenital) hip dysplasia	No
Inflammatory arthropathies. These include Ankylosing Spondylitis or undifferentiated Spondyloarthropathy	No
Inguinal hernia	No
Joint instability, including hip, knee, patella or ankle	Yes
All types of Juvenile idiopathic arthritis. This includes oligoarthritis, polyarthritis, systemic, psoriatic arthritis, enthesitis-related and undifferentiated	Yes
Lyme Arthritis	Yes
All types of Muscular Dystrophy. This includes Duchene, Becker, fascioscapulohumeral, limb girdle, myotonic.	No
Musculoskeletal pain. This includes primary, idiopathic and chronic widespread pain (Juvenile fibromyalgia).	No
Neurofibromatosis Type 1	No
Dysplasia. This includes conditions such as osteoarthritis with spondyloepiphyseal involvement (mutation of type II collagen gene, COL2AI, Skeletal dysplasia and open physes, Protusio acetabulae Multiple epiphyseal dysplasia Spondyloepimetaphyseal dysplasia, BUT EXCLUDES High or low bone mass or low bone dyspasias"	Yes
Osteomyelitis, including brodies abscess	No
Persistent anterior knee pain due to patellofemoral pain syndrome and chondromalacia patellae	Yes
Henoch-Schoenlein Purpura	No
Spinal Muscular Atrophy	Yes
Persistent lower limb pain subsequent to limb amputation	No
Von Willebrand disorder	No
Stress fracture	No
Arteriovenous Malformation	No
Talipes Equinovarus	No
Brucellosis	No
Hyperimmunoglobulin D Syndrome	No
Hyperparathyroidism, including primary hyperparathyroidism	No
High bone mass dysplasia. This includes Osteopetrosis tarda, Melorheostosis (mesenchymal dysplasia), Camurati-Engelmann (Type I), Osteopathia striata but EXCLUDES general Dysplasia or low bone mass	No
Philadelphia chromosome-positive CML	No
PIK3CA-related disorder	No
Scurvy	No
Slipped capital femoral epiphysis	No
Spina Bifida	No
Cryopyrin-associated periodic syndrome	No
Dermatomyositis	No
Ewing Sarcoma	No

Fibroadipose vascular anomaly (FAVA)	No
Ganglion	No
Klippel-Trenaunay syndrome (vascular malformation)	No
Legg-Calve-Perthes Disease	No
Liposynovitis prepatellaris (Hoffa's syndrome)	No
Myopathy	No
Osteogenesis imperfecta	No
Osteoid osteoma	No
Restless leg syndrome	No
Disorders of the meniscus. This includes symptomatic discoid meniscus, meniscocapsular separation and meniscal ossicle.	Yes
Auto-immune polyendocrinopathy candidiasis ectodermal dystrophy	No
Chondroblastoma	No
Chronic granulomatous disease	No
Coalition. This includes any location in the foot for example talocalcaneal or talonavicular	No
Exertional compartment syndrome	No
Arthritis related to Crohn's disease	No
Enthesopathy	No
Familial Mediterranean fever arthritis	No
Flat foot. Consider only paediatric flexible flat foot, not rigid relating to spasticity or coalition	No
Fracture of the lower limb. This includes femur, ischial tuberosity, pelvis, tibia, fibula, ankle, foot	No
Generalised joint hypermobility syndrome	Yes
Human immunodeficiency virus	No
Hypophosphatasia as a result of Homozygous mutation of ALPL	No
Iliotibial band syndrome	Yes
Ischiofemoral impingement	Yes
Osteochondral lesion & Osteochondritis Dissecans	No
Osteosarcoma	Yes
Pigmented villonodular synovitis	Yes
Persistent lower limb pain post surgery.	No
Septic (pyogenic) arthritis	No
Relapsing Polychondritis	No
Sickle Cell Disease	No
Tuberculosis infection	No
Vitamin D deficiency	No
Wilson disease	No
Beta thalassemia minor	No
Growing pains	No
Pseudotumor (idiopathic intracranial hypertension)	No
Sjogren's syndrome	No
Spinal meningioma	No
Rhabdomyolysis	No
Heterotrophic Ossification	No
Neuroblastoma	No
Metaphyseal Chondrodysplasias type Schmid	No
Accessory bone. This includes Os Subfibulare, navicular, Os subtibiale, Os trigonum, ossicle, subfibular ossicle	No
Activated phosphoinositide 3-kinase (PI3K) delta syndrome	No
Anatomical variants of lower limb. This includes 'Too long' anteromedial calcaneal process, Limb length secondary to ABI, Angular and rotational deformities, Retroversion of acetabular dome	No
Apophysitis	No
Arthritis due to Bancroftian filariasis (Filarial arthritis)	No

Autosomal dominant precocious osteoarthropathy	No
Avascular necrosis (also known as Osteonecrosis)	No
Behcet's disease	No
Benign bone tumour/lesion. This includes osteochondroma, chondroma benign and benign lesion of proximal femur	No
Chondral defects & cartilage pain disorders of the lower limb	No
Chondrolysis	No
Chronic infantile neurologic cutaneous and articular syndrome (CINCA)	No
Cirsoid aneurysm	No
Epiphyseal arrest	No
COPA Syndrome (genetic)	No
Focal periphyseal oedema	No
Gorham-stout syndrome	No
Haploinsufficiency of A20 with new mutation p.W365R	No
Persistent lower limb pain resulting from complications arising post fracture. For example, ankle impingement resulting from bimalleolar fracture.	No
Tarsometatarsal interval injury	No
Intraarticular loose body	Yes
Intra-articular venous malformation of the knee	No
Post infective arthritis including Noro or influenza virus	No
Nuclear factor I type A variant	No
Osteoblastoma	No
Osteochondrosis	No
Osteofibrous dysplasia (ossifying fibroma)	No
Pachydermoperiostosis	No
Paraneoplastic arthritis	No
Patellar Hypertension Syndrome	No
Reactive arthropathy	No
Sting-Associated Vasculopathy (SAVI)	No
Benign tumours of synovium. This includes Synovial chondromatosis, Synovial haemangioma, Intra-articular synovial lipoma	No
Synovitis. This includes both chronic and transient.	Yes
Takayasu arteritis	No
Talo-patello-scaphoid osteolysis	No
Talus Partitus	No
Tendon disorders of the lower limb. This includes tibialis posterior and flexor hallucis longus tendinopathy and adductor tendinitis.	No
Tenosynovitis, inflammatory arthritis	Yes
Traumatic Joint dislocation	No
Recurrent macrophage activation syndrome	No