

Defining Growing Pains: A Scoping Review

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BACKGROUND AND OBJECTIVES: Up to one third of children may be diagnosed with growing pains, but considerable uncertainty surrounds how to make this diagnosis. The objective of this study was to detail the definitions of growing pains in the medical literature. abstract

METHODS: Scoping review with 8 electronic databases and 6 diagnostic classification systems searched from their inception to January 2021. The study selection included peer-reviewed articles or theses referring to “growing pain(s)” or “growth pain(s)” in relation to children or adolescents. Data extraction was performed independently by 2 reviewers.

RESULTS: We included 145 studies and 2 diagnostic systems (ICD-10 and SNOMED). Definition characteristics were grouped into 8 categories: pain location, age of onset, pain pattern, pain trajectory, pain types and risk factors, relationship to activity, severity and functional impact, and physical examination and investigations. There was extremely poor consensus between studies as to the basis for a diagnosis of growing pains. The most consistent component was lower limb pain, which was mentioned in 50% of sources. Pain in the evening or night (48%), episodic or recurrent course (42%), normal physical assessment (35%), and bilateral pain (31%) were the only other components to be mentioned in more than 30% of articles. Notably, more than 80% of studies made no reference to age of onset in their definition, and 93% did not refer to growth. Limitations of this study are that the included studies were not specifically designed to define growing pains.

CONCLUSIONS: There is no clarity in the medical research literature regarding what defines growing pain. Clinicians should be wary of relying on the diagnosis to direct treatment decisions.



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Growing pains are proposed to be 1 of the most common causes of recurrent musculoskeletal pain in children.¹ The term first emerged in 1823 in a book called “Maladies de la Croissance” (“diseases of growth”).² Reported estimates of the prevalence of growing pains range from 3.5% to 36.9%, depending on the country, setting, and definition.³⁻⁷

Although growing pains appears a popular diagnostic label in children and adolescents, there is uncertainty about what constitutes growing pain.¹ Critically, it is unclear if growing pains is a diagnosis of exclusion for nonspecific musculoskeletal pain presentations, or if it is intended as an explanation for a specific musculoskeletal condition or pathology. Many causes of growing pains have been proposed. These include anatomic causes (eg, hypermobility, genu valgum, low bone mineral density),¹⁰ psychological causes (eg, stress),^{4,11} vascular causes (eg, skeletal vascular perfusion),⁸ and metabolic causes (eg, low vitamin D levels).¹² All of these causes are either unsupported by research, or underpinned by inconsistent evidence.^{9,12-14} This uncertainty means there is a lack of guidance for clinicians as to when the label growing pains might be appropriate for a patient.

To our knowledge, there is no systematic exploration of how growing pains are defined or diagnosed in the literature. Given the lack of clarity around this popular clinical term, a comprehensive synthesis of how growing pains are currently defined, may progress knowledge of the “condition.” The aim of this scoping review was to identify how growing pain(s) are defined in the peer-reviewed clinical literature

and diagnostic systems such as the International Classification of Diseases (ICD).

METHODS

Data Sources

This review was prospectively registered on International Prospective Register for Systematic Reviews (PROSPERO CRD42019117495) and is reported in accordance with the PRISMA extension for scoping reviews (PRISMA-ScR).¹⁵ We collected data from 2 distinct sources, medical journals and disease classification systems. For studies in medical journals, we searched Medline, Embase, CINAHL, AMED, PEDro, PsycINFO, Scopus and Dissertations and Theses from their inception to January 29, 2021. We used the search term “grow* pain*” in each database. We examined reference lists and performed citation tracking of included studies to identify further studies. Two authors independently screened records by titles and abstracts in Covidence. Two authors read full-texts of potentially eligible studies to determine eligibility. Disagreements were resolved through discussion. For disease classification systems, we searched six databases: READ,¹⁶ ICD (International Classification of Diseases (ICD)-1017, ICD-11,¹⁸ Systematised Nomenclature of Medicine (SNOMED),¹⁹ The Diagnostic and Statistical Manual of Mental Disorders (DSM)-5²⁰ and the International Classification of Primary Care (ICPC)-2.²¹ We searched each database with the search terms growing pain(s) or ‘growth pain(s)’.

Study Selection

We included any peer-reviewed, full-length article, thesis, or dissertation that contained text referring to the terms growing pain(s) or growth pain(s) in relation to children or adolescents. Conference abstracts, studies with an available abstract

only and studies written in non-English languages where a translation could not be arranged were excluded. No non-English studies were deemed eligible for inclusion. We included any medical code referring to growing pain(s) or growth pain(s) in the 6 disease classification systems.

Data Extraction and Synthesis

Two authors independently extracted data from the studies and disease classification systems. Where necessary, we contacted study authors by e-mail to obtain information not reported in the articles – 13 authors were emailed for information. The following data were extracted from each study: study author, publication year and country, study design, population and setting description, study aims, definition and/or diagnostic description for growing pains. The following information was extracted from the disease classification systems: database name, medical record diagnosis code and definition.

Our outcome was the definition of growing pains reported.

We did not conduct risk of bias assessment of included studies. We did not deem risk of bias (quality) assessment applicable since this review focused on reporting the definitions and diagnostic criteria.

We defined 8 components of the definitions and reported summary statistics of characteristics within each category.

RESULTS

Our search identified 2967 unique studies (after removal of duplicates). Following screening of study titles and abstracts, we retained 167 studies for full-text assessment, 145 studies met our inclusion criteria and were included in the review (Fig 1).

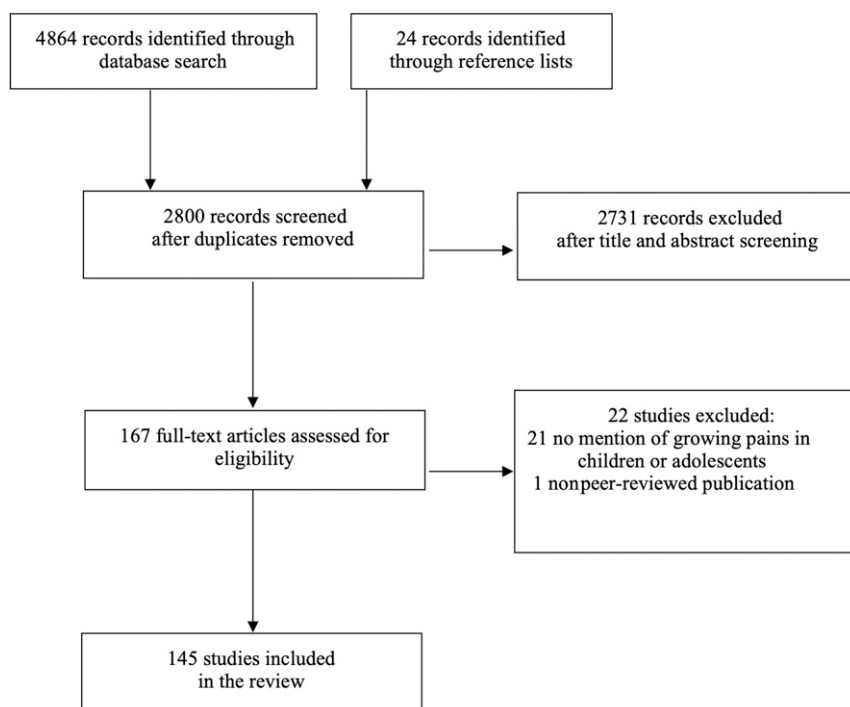


FIGURE 1
Flowchart of the included studies.

We included cross-sectional studies ($n = 45$),^{9-11,13,22-62} review articles ($n = 36$),^{1,8,14,63-94} editorials, commentaries, and perspectives ($n = 17$),^{3,95-110} retrospective observational studies ($n = 12$),^{4,111-121} case reports ($n = 8$),¹²²⁻¹²⁹ prospective observational studies ($n = 13$),^{7,12,42,130-139} case-control studies ($n = 3$),¹⁴⁰⁻¹⁴² systematic reviews ($n = 2$),^{143,144} case series ($n = 2$),^{145,146} a thesis,¹⁴⁷ a content analysis,¹⁴⁸ a randomized trial,¹⁴⁹ a reliability and validity study,³⁰ a before and after study,¹⁵⁰ a quasi-

experimental study,¹⁵¹ and a qualitative focus group study¹⁵² ($n = 1$ each). Our search of the 6 disease classification systems¹⁶⁻²¹ retrieved 3 diagnostic codes for growing pains, 2 systems (ICD-10 and SNOMED) provided a definition or criteria (Table 1).

Forty-one included studies (28%) did not provide a definition or criteria for growing pain.^{7,10,25,32,33,49,50,59-61,64,71,72,84,85,88,97,98,105,109-113,115,117,119,121-124,126-131,137,139,148,152}

Characteristics of the definitions in the other 104 studies (72%) were categorized into 8 components: pain location, age of onset, pain pattern, pain trajectory, pain type and risk factors, relationship to activity, severity and functional disability, and physical examination and investigations. Table 2 provides a summary of the most commonly mentioned characteristics and Fig 2 provides a visual overview of the characteristics in the 8 categories. A detailed overview of each study is provided in the Supplemental Table 3.

Definitions and Diagnostic Criteria

Please see Table 2 for summary and Fig 2 for a detailed overview of results.

1. Pain Location

Forty-five studies (31%) stated that growing pain are bilateral in nature, and 1 study stated that growing pains were usually unilateral. The remaining 99 studies (68%) did not specify bilateral or unilateral.

Seventy-two studies (50%) stated that growing pains mainly affect the lower limbs or legs, and of these, 27 studies specifically mentioned the popliteal fossa and 13 the knees and shins. Other locations mentioned were arms ($n = 8$), shoulder, back, groin, or ligaments and tendons (all $n = 1$). Fifty-seven studies (39%) did not mention the location of growing pains.

Forty studies (28%) stated that growing pains were not joint-related (ie, nonarticular), and 3 claimed that they were. There were 102 studies (70%) that did not refer to joint involvement. Thirty-nine studies (27%) stated that growing pains were muscular, whereas 106 studies (73%) did not refer to muscular involvement.

TABLE 1 Disease Classification System Codes and Definitions

Database	Diagnosis Code	Definition
READ	None	None
ICD-10	Growing pains, children	Other and unspecified symptoms and signs involving the nervous and musculoskeletal systems
ICD-11	Growth pain disorder	None
SNOMED	Growing pains, growing pains in limbs	Episodic childhood musculoskeletal pain, usually brief (a few minutes), intense, nocturnal, involving both legs, with no identifiable cause or sequelae
DSM-5	None	None
ICPC-2	None	None

TABLE 2 Most Commonly Mentioned Characteristics of Growing Pains

^a Component of the Definition	Characteristic
Pain location	Bilateral pain Lower limb pain No joint pain Muscular pain
Pain pattern	Evening or night pain Absence of morning pain
Pain trajectory	Episodic or recurrent
Physical examination and investigations	Normal physical examination Normal radiography or laboratory findings

^aCharacteristic mentioned in at least 20% of definitions.

One diagnostic system specified bilateral, lower limb symptoms (SNOMED).

2. Age of Onset

Twelve studies (8%) stated that growing pains occur between 3 and 12 years old, and most other studies reported within that same range with only 3 studies extending the age range to 13, 14, and 15 years old, respectively. 122 studies (83%) did not refer to the age of onset.

3. Pain pattern

Seventy studies (48%) stated that growing pains occur only in the evening or nighttime, 75 studies (52%) did not mention evening or night pain. Thirty-one studies (21%) stated that growing pains are absent in the morning, whereas only 1 stated possible morning presence. There were 113 studies (78%) that made no reference to the morning time.

There was wide variation regarding duration of episodes, ranging from minutes to hours ($n = 3^{13,35,136}$), 30 to 60 minutes ($n = 1$), 30 minutes to 2 hours ($n = 1$), under 72 hours ($n = 5$), and over 72 hours ($n = 1$).

One diagnostic system described growing pain as nocturnal and usually lasting for a few minutes (SNOMED).

4. Pain Trajectory

Sixty-one studies (42%) stated that growing pains are episodic or recurrent, 21 (14%) stated that they are often persistent in nature, and

16 of these stated that a diagnosis of growing pains can only be made if the child or adolescent has pain for over 3 months. Seven studies (5%) specifically stated that growing pains are not persistent in nature.

Four studies (3%) stated that growing pains occur daily, whereas 2 studies (1%) stated that growing pains present once or twice a week. Single studies stated that growing pains occur at least monthly and at least twice in 1 year.

Three studies (2%) mentioned that growing pains resolve with time and maturity. Seventy-one studies (49%) did not refer to the trajectory of growing pains.

One diagnostic system described growing pain as episodic (SNOMED).

5. Pain Type and Risk Factors

Nineteen studies (13%) referred to the vague or unknown nature of growing pains.

Seven studies (5%) stated that growing pains are or can be related to growth, 2 studies (1%) stated that they are unlikely to be caused by growth, and 1 study stated that growing pains occur during a period of declining growth. The remaining 135 studies (93%) did not refer to the relationship between growth and growing pains.

Ninety-six studies (66%) did not refer to pain type or possible causes of growing pains.

One diagnostic system described growing pain as of “other cause” or “unspecified cause” (ICD-10), and 1 as of “no cause” (SNOMED).

6. Relationship to Activity

Fourteen studies (10%) stated that growing pains do not interfere with ability to engage in physical activity, and 120 studies (83%) did not refer to the relationship between activity and growing pains.

7. Severity and Functional Impact

Seventeen studies (12%) stated that pain intensity can vary from mild to severe, and 128 studies (88%) did not refer to pain intensity.

Twenty-four studies (17%) stated that individuals with growing pains do not present with limitations in walking or exercise ability, whereas 4 studies (3%) stated that individuals may experience walking difficulties. There were 117 studies (81%) that did not refer to functional limitations.

Fifteen studies (10%) mentioned that individuals with growing pains may have difficulty sleeping or they may wake at night, and 130 studies (90%) did not refer to sleep.

One diagnostic system describes the severity of growing pain as “intense” (SNOMED).

8. Physical Examination and Investigations

Fifty-one studies (35%) stated that individuals with growing pains present with a normal physical examination, defined as an absence of swelling, infection, range of motion deficits, gait abnormalities, and musculoskeletal impairments, and 93 studies (64%) did not refer to physical examination findings.

Thirty-one studies (21%) stated that individuals with growing pains present with normal radiography (eg, x-ray) and laboratory investigations (eg, rheumatoid factor

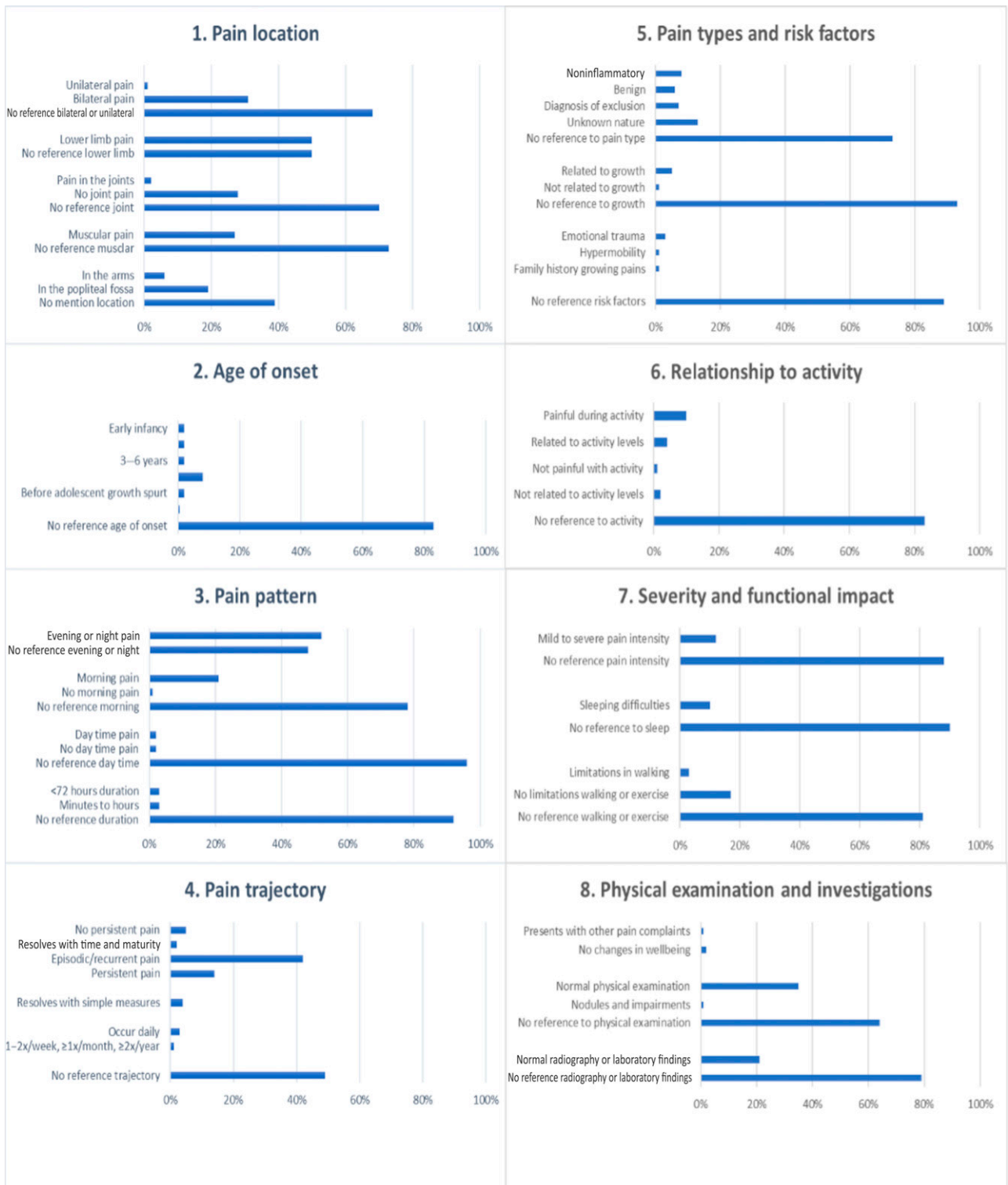


FIGURE 2 Characteristics of growing pain definitions. Note: percentages refer to the proportion of studies that specified this feature.

or complete blood count), and 114 (79%) studies did not refer to radiography or laboratory findings.

DISCUSSION

This scoping review shows there is no consensus about how to define

growing pains and how the diagnosis can be made in clinical practice. Relevant literature is

characterized by contradictions, eg, specifically in the arms versus in the lower limbs and absence of reference to specific defining features, eg, location, age of onset, relationship with activity. Lower limb pain (50% of studies), evening or night pain (48%), episodic or recurrent pattern (42%), normal physical assessment (35%) and bilateral pain (31%) were the only specific indicators mentioned in at least 30% of the references. It is particularly noteworthy that more than 80% of studies made no reference to age of onset in their definition, and 93% did not refer at all to growth in their definition of growing pains.

The strength of this review is that we included all study designs and performed a sensitive search in a number of databases and disease classification systems. Two independent reviewers extracted data. We conducted the review in line with current recommendations for scoping reviews. A limitation of the review is that the included studies were not specifically designed to define growing pains so some articles may not have explicitly reported definitions or criteria that were used by researchers in a particular study. Sixteen different study designs featured in our review. The specific aims of these studies varied, and this may explain some of the variability in definitions. Conversely, it might be considered a strength that our study captures how the diagnosis is reported in research and as such describes what is available to consumers of research evidence in the field.¹⁵³⁻¹⁵⁵

Although the most comprehensive overview of the way growing pains are defined and used in research, ours is not the first study to point out some important issues with the concept. Several authors have noted that growing pains is used as a

diagnosis of exclusion,^{1,156} and further, that etiology is unknown.^{87,144} Perhaps the most striking finding from our review is the disturbing inconsistency in definitions; a result that reinforces calls from Walters et al⁹⁰ for standardized diagnostic criteria.

Interestingly, very few studies refer to the relationship between growth and growing pain, which reflects uncertainty as to the role of growth as a contributing factor. Further, from this scoping review we are unable to draw a conclusion about the affectation of growing pain, whether the origin is in joints or muscles. This is because although 40 of our included studies (28%) stated that growing pains were not joint-related, 102 studies (70%) did not refer to joint involvement. We see a similar picture for muscular involvement; 39 studies (27%) stated that growing pains were muscular, but 106 studies (73%) did not refer to muscular involvement. This lack of clarity along with the generally accepted view that pathophysiology is unknown raises the possibility that growing pains is a misnomer. Several of the included studies expressed this issue.^{14,26,78,81,103} These studies proposed a number of alternative terms: "recurrent limb pain in childhood," "benign nocturnal limb pains of childhood," "benign leg ache in children," and "idiopathic limb pain."

From a clinical perspective, there may be value in better understanding the decision-making process around the labels clinicians use with children and adolescents with musculoskeletal pain. We did not locate any qualitative studies on this topic. One survey study showed that physicians feel it is important to order investigations to exclude other provisional diagnoses before assigning a diagnosis of growing pains.⁴¹ Literature from other health areas (eg, low back pain, cancer,

conjunctivitis, polycystic ovary syndrome, or gastroesophageal symptoms) show that labels provided to patients to explain health conditions or symptoms can influence beliefs and treatment preferences.¹⁵⁷⁻¹⁶¹ We currently do not know the relative benefits and harms of providing a diagnosis of growing pains.

Given that prevalence may be as high as 37%, the fact that pathophysiology is unknown and compelling evidence of substantial variance in application of the label, point to a clear need for better understanding of pain in children. This echoes previous calls for research to provide clearer guidance for clinical practice. Specifically, researchers should not use the diagnostic term growing pains by itself to categorize study participants or as an explanatory variable. The term is used in such a heterogenous manner that it will render their study uninterpretable. If the diagnosis is to be used, we recommend clear description of the clinical characteristics used to define growing pains in that particular study.

Absence of a clear definition of growing pains may lead to misclassification of patients and result in specific causes of musculoskeletal pain in children or adolescents being missed. Interestingly, the Peterson criteria does not refer to growth as a feature of growing pains. The Peterson criteria say that the pain usually occurs once or twice per week. Most of the studies included in our review did not document this. The Peterson criteria say that growing pains are neither related to activity nor affect activity. Most of the studies included in this review did not comment on activity. So, we are left asking the question why is the word "growing" used in the first place?

CONCLUSIONS

There is substantial variability and lack of clarity in how growing pains are defined in the literature.

Clinicians and researchers using the term should clearly describe the clinical criteria they use to define

growing pains, because the diagnosis itself means different things to different people.

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REFERENCES

1. Lehman PJ, Carl RL. Growing pains. *Sports Health*. 2017;9(2):132–138
2. Duchamp R-G. *Maladies de la croissance*. Paris:Chez L’auteur; 1823
3. Hawksley JC. Race, rheumatism and growing pains. *Arch Dis Child*. 1931;6(35):303–306
4. Naish JM, Apley J. “Growing pains”: a clinical study of non-arthritic limb pains in children. *Arch Dis Child*. 1951;26(126):134–140
5. Evans AM, Scutter SD. Prevalence of “growing pains” in young children. *J Pediatr*. 2004;145(2):255–258
6. Øster J. Recurrent abdominal pain, headache and limb pains in children and adolescents. *Pediatrics*. 1972;50(3):429–436
7. de Inocencio J. Musculoskeletal pain in primary pediatric care: analysis of 1000 consecutive general pediatric clinic visits. *Pediatrics*. 1998;102(6):E63
8. Evans AM. Growing pains: contemporary knowledge and recommended practice. *J Foot Ankle Res*. 2008;1(1):4
9. Evans AM, Scutter SD. Are foot posture and functional health different in children with growing pains? *Pediatr Int*. 2007;49(6):991–996
10. Friedland O, Hashkes PJ, Jaber L, et al. Decreased bone speed of sound in children with growing pains measured by quantitative ultrasound. *J Rheumatol*. 2005; 32(7):1354–1357
11. Oberklaid F, Amos D, Liu C, Jarman F, Sanson A, Prior M. “Growing pains”: clinical and behavioral correlates in a community sample. *J Dev Behav Pediatr*. 1997;18(2):102–106
12. Vehapoğlu A, Turel O, Turkmen S, et al. Are growing pains related to vitamin D deficiency? efficacy of vitamin D therapy for resolution of symptoms. *Med Princ Pract*. 2015;24(4):332–338
13. Hashkes PJ, Gorenberg M, Oren V, Friedland O, Uziel Y. “Growing pains” in children are not associated with changes in vascular perfusion patterns in painful regions. *Clin Rheumatol*. 2005;24(4):342–345
14. Al-Khattat A, Campbell J. Recurrent limb pain in childhood (‘growing pains’). *Foot*. 2000;10(3):117–123
15. Tricco AC, Lillie E, Zarin W, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med*. 2018; 169(7):467–473
16. Read Codes NHS. Retirement of read version 2 and clinical terms version 3. Available at: [https://digital.nhs.uk/services/terminology-and-classifications/read-codes#:~:text=Read%20Codes%20are%20a%20coded,3%20\(CTV3%20or%20v3\)](https://digital.nhs.uk/services/terminology-and-classifications/read-codes#:~:text=Read%20Codes%20are%20a%20coded,3%20(CTV3%20or%20v3)). Accessed January 10, 2020
17. World Health Organization. International statistical classification of diseases and related health problems 10th revision (ICD-10). Available at: <https://icd.who.int/browse10/2019/en> Accessed January 10, 2020
18. World Health Organization. International statistical classification of diseases and related health problems 11th revision (ICD-11). Available at: <https://icd.who.int/en>. Accessed January 10, 2020
19. SNOMED. SNOMED International. Available at: <https://www.snomed.org/> Accessed January 10, 2020
20. American Psychiatric Association. Diagnostic and statistical manual of mental disorders (DSM-5). Available at: <https://www.psychiatry.org/psychiatrists/practice/dsm>. Accessed January 10, 2020
21. World Health Organization. International classification of primary care (ICPC)-2. Available at: <https://www.who.int/standards/classifications/other-classifications/international-classification-of-primary-care> Accessed January 10, 2020
22. Abujam B, Mishra R, Aggarwal A. Prevalence of musculoskeletal complaints and juvenile idiopathic arthritis in children from a developing country: a school-based study. *Int J Rheum Dis*. 2014;17(3): 256–260
23. Altuğ-Gücenmez Ö, Makay B, Kaçar A, Ünsal E. Evaluation of restless legs syndrome and growing pains in children with familial Mediterranean. *Turk J Pediatr*. 2018;60(2): 159–164
24. Apley J, Perry CB. A six-year survey of the cases seen at a school cardiac clinic. *Arch Dis Child*. 1954; 29(146):317–322

25. Aromaa M, Sillanpää M, Rautava P, Helenius H. Pain experience of children with headache and their families: a controlled study. *Pediatrics*. 2000; 106(2 Pt 1):270–275
26. Abu-Arafeh I, Russell G. Recurrent limb pain in schoolchildren. *Arch Dis Child*. 1996;74(4):336–339
27. Barraclough D, Russell AS, Percy JS. Diagnosis and follow-up of children referred to a rheumatic disease unit. *Med J Aust*. 1977;1(25):920–923
28. Champion D, Pathirana S, Flynn C, et al. Growing pains: twin family study evidence for genetic susceptibility and a genetic relationship with restless legs syndrome. *Eur J Pain*. 2012; 16(9):1224–1231
29. Donnelly TJ, Bott A, Bui M, et al. Common pediatric pain disorders and their clinical associations. *Clin J Pain*. 2017;33(12):1131–1140
30. Evans AM, Scutter SD. Development of a questionnaire for parental rating of leg pain in young children: internal validity and reliability testing following triangulation. *Foot*. 2004;14(1):42–48
31. Evans AM, Scutter SD, Lang LM, et al. “Growing pains” in young children: a study of the profile, experiences and quality of life issues of four to six year old children with recurrent leg pain. *Foot*. 2006;16(3):120–124
32. Gamaldo CE, Benbrook AR, Allen RP, Scott JA, Henning WA, Earley CJ. Childhood and adult factors associated with restless legs syndrome (RLS) diagnosis. *Sleep Med*. 2007;8(7–8): 716–722
33. Gedalia A, Press J, Klein M, Buskila D. Joint hypermobility and fibromyalgia in schoolchildren. *Ann Rheum Dis*. 1993;52(7):494–496
34. Haque M, Laila K, Islam MM, et al. Assessment of growing pain and its risk factors in school children. *Am J Clin Exp Med*. 2016;4:151–155
35. Hashkes PJ, Friedland O, Jaber L, Cohen HA, Wolach B, Uziel Y. Decreased pain threshold in children with growing pains. *J Rheumatol*. 2004; 31(3):610–613
36. Hutchinson S, Crossland DS, Chaudhry B, Coats L. Leg pains in CHD: a distressing symptom of a wider problem. *Cardiol Young*. 2018;28(10):1099–1104
37. Kaspiris A, Zafiropoulou C. Growing pains in children: epidemiological analysis in a Mediterranean population. *Joint Bone Spine*. 2009; 76(5):486–490
38. Kaspiris A, Zafiropoulou C, Tsadiria O, Petropoulos C. Can breastfeeding avert the appearance of growth pains during childhood? *Clin Rheumatol*. 2007;26(11):1909–1912
39. Kaspiris A, Chronopoulos E, Vasiladias E. Perinatal risk factors and genu valgum conducive to the onset of growing pains in early childhood. *Children (Basel)*. 2016;3(4):34
40. Marcolin A, Cardin S, Magalhães C. Muscle strength assessment among children and adolescents with growing pains and joint hypermobility. *Braz J Phys Ther*. 2009;13(2):110–115
41. Macarthur C, Wright JG, Srivastava R, Rosser W, Feldman W. Variability in physicians’ reported ordering and perceived reassurance value of diagnostic tests in children with ‘growing pains’. *Arch Pediatr Adolesc Med*. 1996;150(10):1072–1076
42. Oster J. Growing pain. a symptom and its significance. (A review). *Dan Med Bull*. 1972;19(2):72–79
43. Pathirana S, Champion D, Jaaniste T, Yee A, Chapman C. Somatosensory test responses in children with growing pains. *J Pain Res*. 2011;4:393–400
44. Qamar S, Akbani S, Shamim S, Khan G. Vitamin D levels in children with growing pains. *J Coll Physicians Surg Pak*. 2011;21(5):284–287
45. Rafique H, Ahmed A, Shafique W, et al. Frequency of growing pains among children of Lahore, Pakistan. *Rawal Med J*. 2018;43(4):673–676
46. Rajaram S-S, Walters AS, England SJ, Mehta D, Nizam F. Some children with growing pains may actually have restless legs syndrome. *Sleep*. 2004; 27(4):767–773
47. Rathleff CR, Baird WN, Olesen JL, Roos EM, Rasmussen S, Rathleff MS. Hip and knee strength is not affected in 12-16 year old adolescents with patellofemoral pain—a cross-sectional population-based study. *PLoS One*. 2013;8(11):e79153
48. Rogers VE, Marcus CL, Jawad AF, et al. Periodic limb movements and disrupted sleep in children with sickle cell disease. *Sleep (Basel)*. 2011; 34(7):899–908
49. Sabui TK, Samanta M, Mondal RK, Banerjee I, Saren A, Hazra A. Survey of musculoskeletal abnormalities in school-going children of hilly and foothill regions of eastern Himalayas using the pediatric Gait, Arms, Legs, Spine screening method. *Int J Rheum Dis*. 2018;21(5):1127–1134
50. Scalco RS, Morrow JM, Booth S, Chatfield S, Godfrey R, Quinlivan R. Misdiagnosis is an important factor for diagnostic delay in McArdle disease. *Neuromuscul Disord*. 2017; 27(9):852–855
51. Sharma SS, Verma S, Sachdeva N, et al. Association between the occurrence of growing pains and vitamin-D deficiency in Indian children aged 3-12 years. *Sri Lanka J Child Health*. 2018;47(4):306–310
52. Smith PJ, Moisan A, Sawyer JR, et al. Is there a correlation between growing pains and parent-child bed-sharing? *Curr Orthop Pract*. 2018;29(3):218–222
53. Spahn G, Schiele R, Langlotz A, Jung R. Hip pain in adolescents: results of a cross-sectional study in German pupils and a review of the literature. *Acta Paediatr*. 2005;94(5):568–573
54. Sperotto F, Balzarini M, Parolin M, et al. Joint hypermobility, growing pains and obesity are mutually exclusive as causes of musculoskeletal pain in schoolchildren. *Clin Exp Rheumatol*. 2014;32(1):131–136
55. van Dijk A, McGrath P, Pickett W, VanDenKerkhof EG. Pain prevalence in nine- to 13-year-old schoolchildren. *Pain Res Manag*. 2006;11(4):234–240
56. Vähäsarja V. Prevalence of chronic knee pain in children and adolescents in northern Finland. *Acta Paediatr*. 1995;84(7):803–805
57. Vasilopoulou M, Spathis A, Myriokefalitakis N, Zaferopoulou F, Paspati I, Tsolia M. Development of a screening tool for children’s growing pains: validation, reliability control and

- clinical evaluation. *Turk J Pediatr*. 2015;57(5):467–474
58. Viswanathan V, Khubchandani RP. Joint hypermobility and growing pains in school children. *Clin Exp Rheumatol*. 2008;26(5):962–966
 59. Walters AS, Hickey K, Maltzman J, et al. A questionnaire study of 138 patients with restless legs syndrome: the 'Night-Walkers' survey. *Neurology*. 1996;46(1):92–95
 60. Westling L, Mattiasson A. Background factors in craniomandibular disorders: reported symptoms in adolescents with special reference to joint hypermobility and oral parafunctions. *Scand J Dent Res*. 1991;99(1):48–54
 61. Wolff N, Rubia K, Knopf H, et al. Reduced pain perception in children and adolescents with ADHD is normalized by methylphenidate. *Child Adolesc Psychiatry Ment Health*. 2016;10:24
 62. Zhao Q, Jung LK. Frequency of CD19⁺CD24^{hi}CD38^{hi} regulatory B cells is decreased in peripheral blood and synovial fluid of patients with juvenile idiopathic arthritis: a preliminary study. *Pediatr Rheumatol Online J*. 2018;16(1):44
 63. Atar D, Lehman WB, Grant AD. Growing pains. *Orthop Rev*. 1991; 20(2):133–136
 64. Baeza-Velasco C, Grahame R, Bravo JF. A connective tissue disorder may underlie ESSENCE problems in childhood. *Res Dev Disabil*. 2017; 60:232–242
 65. Baeza-Velasco C, Sinibaldi L, Castori M. Attention-deficit/hyperactivity disorder, joint hypermobility-related disorders and pain: expanding body-mind connections to the developmental age. *Atten Defic Hyperact Disord*. 2018; 10(3):163–175
 66. Balan S. Approach to joint pain in children. *Indian J Pediatr*. 2016;83(2): 135–139
 67. Bennie PB. Growing pains. *Arch Paediatr*. 1894;11(337)
 68. Beyitler I, Kavukcu S. Approach to growing pains in childhood in a familial Mediterranean fever endemic region. *Iran J Pediatr*. 2017;27(6)
 69. Bowyer SL, Hollister JR. Limb pain in childhood. *Pediatr Clin North Am*. 1984;31(5):1053–1081
 70. Calabro JJ, Wachtel AE, Holgerson WB, Repice MM. Growing pains: fact or fiction? *Postgrad Med*. 1976;59(2): 66–72
 71. Cassidy JT. Progress in diagnosis and understanding chronic pain syndromes in children and adolescents. *Adolesc Med*. 1998; 9(1):101–114, vi
 72. Castori M, Morlino S, Celletti C, et al. Re-writing the natural history of pain and related symptoms in the joint hypermobility syndrome/Ehlers-Danlos syndrome, hypermobility type. *Am J Med Genet A*. 2013;161A(12):2989–3004
 73. Davies K, Copeman A. The spectrum of paediatric and adolescent rheumatology. *Best Pract Res Clin Rheumatol*. 2006;20(2):179–200
 74. Haines KA. The approach to the child with joint complaints. *Pediatr Clin North Am*. 2018;65(4):623–638
 75. Hakim A, Grahame R. Joint hypermobility. *Best Pract Res Clin Rheumatol*. 2003;17(6):989–1004
 76. Junnila JL, Cartwright VW. Chronic musculoskeletal pain in children: part I. Initial evaluation. *Am Fam Physician*. 2006;74(1):115–122
 77. Lavigne JV, Schulein MJ, Hahn YS. Psychological aspects of painful medical conditions in children. II. personality factors, family characteristics and treatment. *Pain*. 1986;27(2):147–169
 78. Leung AK, Robson WLM. Growing pains: how to manage this benign condition successfully. *Can Fam Physician*. 1991;37:1463–1467
 79. Lowe RM, Hashkes PJ. Growing pains: a noninflammatory pain syndrome of early childhood. *Nat Clin Pract Rheumatol*. 2008;4(10):542–549
 80. McNaughten B, Speirs L, Moriarty P, Thompson A. Question 2: Is vitamin D useful in the treatment of growing pains? *Arch Dis Child*. 2018;103(2): 203–205
 81. Mohanta MP. Growing pains: practitioners' dilemma. *Indian Pediatr*. 2014; 51(5):379–383
 82. Murray KJ. Hypermobility disorders in children and adolescents. *Best Pract Res Clin Rheumatol*. 2006;20(2): 329–351
 83. Simakajornboon N, Dye TJ, Walters AS. Restless legs syndrome/Willis-Ekbom disease and growing pains in children and adolescents. *Sleep Med Clin*. 2015;10(3):311–322, xiv
 84. Simmonds JV, Keer RJ. Hypermobility and the hypermobility syndrome. *Man Ther*. 2007;12(4):298–309
 85. Smith EM, Ramanan AV. Fifteen-minute consultation: a structured approach to the management of hypermobility in a child. *Arch Dis Child Educ Pract Ed*. 2013;98(6):212–216
 86. Tse SM, Laxer RM. Approach to acute limb pain in childhood. *Pediatr Rev*. 2006;27(5):170–179, quiz 180
 87. Uziel Y, Hashkes PJ. Growing pains in children. *Pediatr Rheumatol Online J*. 2007;5:5
 88. Wahezi DM, Ilowite N, Adam HM. Joint problems and hypermobility. *Pediatr Rev*. 2009;30(5):187–189
 89. Walters AS. Is there a subpopulation of children with growing pains who really have restless legs syndrome? a review of the literature. *Sleep Med*. 2002; 3(2):93–98
 90. Walters AS, Gabelia D, Frauscher B. Restless legs syndrome (Willis-Ekbom disease) and growing pains: are they the same thing? a side-by-side comparison of the diagnostic criteria for both and recommendations for future research. *Sleep Med*. 2013;14(12):1247–1252
 91. Weiser P. Approach to the patient with noninflammatory musculoskeletal pain. *Pediatr Clin North Am*. 2012;59(2): 471–492
 92. Weiss JE, Stinson JN. Pediatric pain syndromes and noninflammatory musculoskeletal pain. *Pediatr Clin North Am*. 2018;65(4):801–826
 93. Weller EB, Weller RA. Depression in adolescents growing pains or true morbidity? *J Affect Disord*. 2000; 61(Suppl 1):9–13
 94. Wolf M. Knee pain in children, part III: stress injuries, benign bone tumors, growing pains. *Pediatr Rev*. 2016;37(3):114–118, quiz 119

95. Benbir G, Guilleminault C. Pramipexole: new use for an old drug - the potential use of pramipexole in the treatment of restless legs syndrome. *Neuropsychiatr Dis Treat*. 2006;2(4):393–405
96. Brockbank EM. "Growing pains" as a symptom of rheumatism. *BMJ*. 1900;1(2052):1020–1021
97. Brown LT. Growing pains; a possible mechanical explanation. *Boston Med Surg J*. 1910;162(13):424–426
98. Chauhan A, Weiss J, Warriar R. Effective management of pain in pediatric hematology and oncology. *Asian Pac J Cancer Prev*. 2010;11(2):577–579
99. Craft A. Curbside consult: do growing pains exist? *West J Med*. 1999;170(6):362
100. de Permentier P. An anatomical perspective on growing pains in children. *J Aust Tradit-Med Soc*. 2012;18(1):33
101. Goodyear-Smith F, Arroll B. *Growing Pains*. United Kingdom: British Medical Journal Publishing Group; 2006
102. Hawksley JC. Growing pains in relation to rheumatism. *BMJ*. 1939;1(4073):155–157
103. Kanta P, Gopinathan NR. Idiopathic growing pains in pediatric patients: review of literature. *Clin Pediatr (Phila)*. 2019;58(1):5–9
104. Makay B. Is there a role of melatonin in the development of growing pains? *Med Hypotheses*. 2009;72(2):225
105. McCarville MB. The child with bone pain: malignancies and mimickers. *Cancer Imaging*. 2009;9(Special issue A):S115
106. Gabrhel J, Popracová Z, Tauchmannová H, et al. The relationship between thermographic and musculoskeletal ultrasound findings in the—painful knee syndrome. *Thermol Int*. 2012;12(2):43–52
107. Seham M, Hilbert EH, Harris E. Muscular rheumatism in childhood. *Am J Dis Child*. 1933;46(4):826–853
108. Shapiro M. Differential diagnosis of nonrheumatic "growing pains" and subacute rheumatic fever. *J Pediatr*. 1939;14(3):315–322
109. Szer IS. Musculoskeletal pain in adolescents: 'growing pains' or something else? *Consultant*. 2000;40(3):481–81
110. Williams MF. Rheumatic conditions in school-children. an investigation into growing pains and nodules (grains). *Lancet*. 1928;211(5458):720–721
111. Edmonds EW, Bathen M, Bastrom TP. Normal parameters of the skeletally immature knee: developmental changes on magnetic resonance imaging. *J Pediatr Orthop*. 2015;35(7):712–720
112. Lidove O, Zeller V, Chicheportiche V, et al. Musculoskeletal manifestations of Fabry disease: a retrospective study. *Joint Bone Spine*. 2016;83(4):421–426
113. Murray RO, Duncan C. Athletic activity in adolescence as an etiological factor in degenerative hip disease. *J Bone Joint Surg Br*. 1971;53(3):406–419
114. Park MJ, Lee J, Lee JK, Joo SY. Prevalence of vitamin D deficiency in Korean children presenting with nonspecific lower-extremity pain. *Yonsei Med J*. 2015;56(5):1384–1388
115. Picchietti DL, Walters AS. Moderate to severe periodic limb movement disorder in childhood and adolescence. *Sleep*. 1999;22(3):297–300
116. Picchietti DL, Stevens HE. Early manifestations of restless legs syndrome in childhood and adolescence. *Sleep Med*. 2008;9(7):770–781
117. Song WS, Jeon D-G, Cho WH, et al. Plain radiologic findings and chronological changes of incipient phase osteosarcoma overlooked by primary physicians. *Clin Orthop Surg*. 2014;6(2):230–235
118. Szalay EA, Tryon EB, Pleacher MD, Whisler SL. Pediatric vitamin D deficiency in a southwestern luminous climate. *J Pediatr Orthop*. 2011;31(4):469–473
119. Wager J, Ruhe A, Hirschfeld G, et al. Influence of parental occupation on access to specialised treatment for paediatric chronic pain: a retrospective study. *Schmerz*. 2013;27(3):305–311
120. Wong MW, Williamson BD, Qiu W, Champion D, Teng A. Growing pains and periodic limb movements of sleep in children. *J Paediatr Child Health*. 2014;50(6):455–460
121. Zernikow B, Wager J, Hechler T, et al. Characteristics of highly impaired children with severe chronic pain: a 5-year retrospective study on 2249 pediatric pain patients. *BMC Pediatr*. 2012;12(1):54
122. Dashti AS, Abdolkarimi B, Safaei A, et al. Bilateral irritable hip: a rare presentation of leukemia in children. *Arch Pediatr Infect Dis*. 2016;4(3)
123. Ekblom KA. Growing pains and restless legs. *Acta Paediatr Scand*. 1975;64(2):264–266
124. Hanna SA, Aston WJ, Gikas PD, Briggs TW. Bicondylar osteochondritis dissecans in the knee: a report of two cases. *J Bone Joint Surg Br*. 2008;90(2):232–235
125. Meier PW, Bianchetti MG. An 8-year-old boy with a 4-day history of fever, cough and malaise, and a 2-day history of painful calves and difficulty walking. *Eur J Pediatr*. 2003;162(10):731–732
126. Walters AS, Picchietti DL, Ehrenberg BL, Wagner ML. Restless legs syndrome in childhood and adolescence. *Pediatr Neurol*. 1994;11(3):241–245
127. Waseem M, Raja A, Al-Husayni H. Hip pain in a child: myositis or appendicitis? *Pediatr Emerg Care*. 2010;26(6):431–433
128. Williams J, Bergmann T. Probable inflammatory bowel disease in a child: assessment and conservative management. *J Chiropr Med*. 2003;2(4):157–162
129. Yilmaz AE, Atalar H, Tag T, Bilici M, Kara S. Knee joint pain may be an indicator for a hip joint problem in children: a case report. *Malays J Med Sci*. 2011;18(1):79–82
130. Andreucci A, Campbell P, Mundy LK, et al. Sleep problems increase the risk of musculoskeletal pain in boys but not girls: a prospective cohort study. *Eur J Pediatr*. 2020;179(11):1711–1719
131. Bishop JL, Northstone K, Emmett PM, Golding J. Parental accounts of the prevalence, causes and treatments of limb pain in children aged 5 to 13 years: a longitudinal cohort study. *Arch Dis Child*. 2012;97(1):52–53

132. Chervin RD, Hedger KM. Clinical prediction of periodic leg movements during sleep in children. *Sleep Med*. 2001;2(6):501–510
133. Piano LP, Golmia RP, Golmia AP, et al. Diagnosis of growing pains in a Brazilian pediatric population: a prospective investigation. *Einstein (Sao Paulo)*. 2010;8(4):430–432
134. Morandi G, Maines E, Piona C, et al. Significant association among growing pains, vitamin D supplementation, and bone mineral status: results from a pilot cohort study. *J Bone Miner Metab*. 2015;33(2):201–206
135. Pavone V, Lionetti E, Garçano V, Evola FR, Costarella L, Sessa G. Growing pains: a study of 30 cases and a review of the literature. *J Pediatr Orthop*. 2011;31(5):606–609
136. Saha SK, Modak A, Chowdhury K, et al. Diagnosis of growing pain in Bangladeshi pediatric population. *J Shaheed Suhrawardy Med Coll*. 2013;5(1):46–48
137. Sperotto F, Brachi S, Vittadello F, Zulian F. Musculoskeletal pain in schoolchildren across puberty: a 3-year follow-up study. *Pediatr Rheumatol Online J*. 2015;13:16
138. Uziel Y, Chapnick G, Jaber L, Nemet D, Hashkes PJ. Five-year outcome of children with “growing pains”: correlations with pain threshold. *J Pediatr*. 2010;156(5):838–840
139. Widhe T. Spine: posture, mobility and pain. a longitudinal study from childhood to adolescence. *Eur Spine J*. 2001;10(2):118–123
140. Asadi-Pooya AA, Bordbar MR. Are laboratory tests necessary in making the diagnosis of limb pains typical for growing pains in children? *Pediatr Int*. 2007;49(6):833–835
141. Evans AM, Berde T, Karimi L, Ranade P, Shah N, Khubchandani R. Correlates and predictors of paediatric leg pain: a case-control study. *Rheumatol Int*. 2018;38(7):1251–1258
142. Golding J, Northstone K, Emmett P, Steer C, Hibbeln JR. Do ω -3 or other fatty acids influence the development of ‘growing pains’? a prebirth cohort study. *BMJ Open*. 2012;2(4):e001370
143. Angriman M, Cortese S, Bruni O. Somatic and neuropsychiatric comorbidities in pediatric restless legs syndrome: a systematic review of the literature. *Sleep Med Rev*. 2017;34:34–45
144. Pavone V, Vescio A, Valenti F, Sapienza M, Sessa G, Testa G. Growing pains: what do we know about etiology? a systematic review. *World J Orthop*. 2019;10(4):192–205
145. Alcantara J, Davis J. The chiropractic care of children with “growing pains”: a case series and systematic review of the literature. *Complement Ther Clin Pract*. 2011;17(1):28–32
146. Evans AM. Relationship between “growing pains” and foot posture in children: single-case experimental designs in clinical practice. *J Am Podiatr Med Assoc*. 2003;93(2):111–117
147. Visram F. *Development of Conceptual and Process Models of Growing Pains: A Mixed-Method Research Design*. Saskatoon, Saskatchewan: University of Saskatchewan; 2009
148. Modica RF, Lomax KG, Batzel P, Cassanas A. Impact of systemic juvenile idiopathic arthritis/Still’s disease on adolescents as evidenced through social media posts. *Open Access Rheumatol*. 2018;10:73–81
149. Baxter MP, Dulberg C. “Growing pains” in childhood—a proposal for treatment. *J Pediatr Orthop*. 1988;8(4):402–406
150. Lee H-J, Lim K-B, Yoo J, Yoon SW, Jeong TH. Effect of foot orthoses on children with lower extremity growing pains. *Ann Rehabil Med*. 2015;39(2):285–293
151. De Beer D, Bester CM. The effect of lumbosacral manipulation on growing pains. *Health SA Gesondheid*. 2015;20(1):75–82
152. Persson S, Warghoff A, Einberg EL, et al. Schoolchildren’s experience of pain—a focus group interview study. *Acta Paediatr*. 2021;110(3):909–913
153. Brown DC. Arthralgia in children. *Can Fam Physician*. 1983;29:2149–2151
154. Uziel Y, Friedland O, Jaber L, et al. Living with children with growing pains: How does it affect the parents? *J Musculoskeletal Pain*. 2007;15(2):19–23
155. ØSTER J, NIELSEN A. Growing pains: a clinical investigation of a school population. *Acta Paediatr*. 1972;61(3):329–334
156. Peterson H. Growing pains. *Pediatr Clin North Am*. 1986;33(6):1365–1372
157. Nickel B, Barratt A, Copp T, Moynihan R, McCaffery K. Words do matter: a systematic review on how different terminology for the same condition influences management preferences. *BMJ Open*. 2017;7(7):e014129
158. Spence MT, Roy R, Beller E. A randomised on-line survey exploring how health condition labels affect behavioural intentions. *PLOS ONE*. 2020;15(10):e0240985
159. Copp T, Hersch J, Muscat DM, et al. The benefits and harms of receiving a polycystic ovary syndrome diagnosis: a qualitative study of women’s experiences. *Hum Reprod Open*. 2019;2019(4):hoz026
160. Hirschfeld-Dicker L, Samuel RD, Tiram Vakrat E, Dubnov-Raz G. Preferred weight-related terminology by parents of children with obesity. *Acta Paediatr*. 2019;108(4):712–717
161. O’Keeffe M, Ferreira GE, Harris IA, et al. Effect of diagnostic labelling on management intentions for non-specific low back pain: A randomized scenario-based experiment. *Eur J Pain*. 2022;