

## PEDIATRIC REVIEW

## Musculoskeletal pain in overweight and obese children

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This review seeks to provide a current overview of musculoskeletal pain in overweight and obese children. Databases searched were Academic Search Complete, CINAHL, Medline, Proquest Health and Medical Complete, Scopus, Google Scholar, SPORTDiscuss and Trove for studies published between 1 January 2000 and 30 December 2012. We used a broad definition of children within a 3- to 18-year age range. The search strategy included the following terms: obesity, morbid obesity, overweight, pain, musculoskeletal pain, child, adolescent, chronic pain, back pain, lower back pain, knee pain, hip pain, foot pain and pelvic pain. Two authors independently assessed each record, and any disagreement was resolved by the third author. Data were analysed using a narrative thematic approach owing to the heterogeneity of reported outcome measures. Ninety-seven records were initially identified using a variety of terms associated with children, obesity and musculoskeletal pain. Ten studies were included for thematic analysis when predetermined inclusion criteria were applied. Bone deformity and dysfunction, pain reporting and the impact of children being overweight or obese on physical activity, exercise and quality of life were the three themes identified from the literature. Chronic pain, obesity and a reduction in physical functioning and activity may contribute to a cycle of weight gain that affects a child's quality of life. Future studies are required to examine the sequela of overweight and obese children experiencing chronic musculoskeletal pain.

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## INTRODUCTION

Worldwide childhood obesity has increased by 50% in the past 30 years, with ~43 million children under the age of five being reported as overweight.<sup>1</sup> The WHO defines overweight and obesity as abnormal or excessive fat accumulation that may impair health.<sup>1</sup> In Australia, obesity, as defined by WHO, continues to be a major public health problem with over 20% of school children being either overweight or obese<sup>2</sup> and children from low socioeconomic areas being 70% more likely to be either overweight or obese.<sup>3</sup> Central obesity, as measured by waist circumference, is thought to be a more reliable indicator of health problems than total body mass for people with a body mass index (BMI) of less than 35.<sup>4</sup> Studies into obesity tend to report indices such as BMI and waist circumference. However, a definition of obesity and its clinical diagnosis is often difficult and remains controversial, with waist circumference, BMI and skin folds being the more common non-invasive measurements used.<sup>5</sup> A number of reports suggest that overweight and obese children have subsequently developed short- and long-term health problems that continue into adult life.<sup>5,6</sup> In particular, psychological comorbidities associated with being overweight or obese during childhood and adolescence are well documented.<sup>7,8</sup> These health problems include social isolation, depression, loneliness and low self-esteem, and more recently depressive symptoms have been linked with cardiorespiratory fitness in obese adolescents.<sup>9,10</sup> Obesity in children is a significant public health problem, and it has the potential to have an impact on a child's osteoarticular health, resulting in ongoing chronic pain.

In adults, obesity is associated with physiological disability, in particular joint and chronic conditions such as cardiovascular

disease, diabetes and some cancers.<sup>1</sup> Degenerative osteoarthritis and cartilage breakdown along with musculoskeletal pain have been reported as part of the disability spectrum related to obesity.<sup>11</sup> These conditions significantly reduce a person's ability to exercise, and in addition chronic pain has been reported to negatively influence a person's quality of life.<sup>12</sup> Given that being overweight or obese in adult life affects health and well-being, the potential for deleterious effects on the musculoskeletal system from being overweight or obese in childhood requires further attention.

Chronic nonspecific musculoskeletal pain in children and adolescents has been reported as a common occurrence.<sup>13–15</sup> Children affected by chronic musculoskeletal pain have been found to have increased levels of anxiety and depression, as well as lower levels of activity.<sup>16</sup> Recent reviews on general musculoskeletal pain identified the most frequent site of nonspecific musculoskeletal pain in children in the lower limbs, with some estimates suggesting that this affects 24% of children aged between 6 and 10 years of age.<sup>17,18</sup> Interestingly, Tanamas and co-workers<sup>19</sup> found that an increase in adiposity and fat distribution across the body is related to foot pain, and yet this relationship is not evident with an increase in muscle mass. Although psychological wellness in children can be linked with increased levels of activity, an understanding of the role of musculoskeletal pain on the activity levels of overweight and obese children appears to be limited. The aim of this review was to provide a current overview of musculoskeletal pain in overweight and obese children with a focus on osteoarticular changes and joint health, reporting of musculoskeletal pain and the impact of pain on activity, exercise and quality-of-life indices.

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## MATERIALS AND METHODS

This literature review was carried out using a systematic method<sup>20</sup> described in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guideline. We developed a detailed protocol with prescribed inclusion and exclusion criteria to support the quality and consistency within the literature review process. Studies associated with children who were defined as overweight or obese had to meet the following criteria to be included: written in English, published after January 2000; age range of 2–18 years; and report musculoskeletal pain. The types of studies included in this review were randomised control trials, cohort studies, quasi-experimental studies, controlled before and after studies and patient reports. We excluded discussion papers, reviews, opinions and policy reports. A predefined search strategy was used to examine databases for publications; after excluding records that did not meet the eligibility criteria, ten studies were included for synthesis, and themes associated with musculoskeletal pain and overweight or obese children were generated.

### Search strategy and selection criteria

Academic Search Complete, Cinahl, Google Scholar, Medline, Proquest Health and Medical Complete, Scopus, SPORTDiscuss and Trove databases were searched for studies published between 1 January 2000 and 30 December 2012. The literature review search strategy (Table 1) used a combination of MESH terms in the title/abstract for obesity and pain, limiting to children and teenagers, and used the following terms: obesity, morbid obesity, overweight, pain, musculoskeletal pain, child, adolescent, chronic pain, back pain, lower back pain, knee pain, hip pain, foot pain and pelvic pain.

### Participants and definitions

For this literature review, a broad definition of childhood to include children and adolescents within a range from 3 years to 18 years of age was used. For musculoskeletal pain, terms such as joint pain and muscle pain either objectively or subjectively reported were accepted. For example, joint pain may include shoulder pain, foot pain and knee pain.

### Search outcome

By searching the electronic databases, 70 records were retrieved. The reference list of each of the identified reports, reviews and original research articles were manually searched for additional studies, with a further 27 studies identified. Only manuscripts in English were considered for assessment. Three records were removed as duplicates. Abstracts for each of the 94 records had the inclusion criteria applied separately by two of the authors. The review flowchart outlines the records identified or excluded at each phase of the review process (Figure 1). Two authors

(BS and KD) independently assessed each abstract, and any disagreement was resolved by the third author (SMS). Heterogeneity of reported outcome measures was identified, and subsequently a qualitative analytic process of thematic analysis was undertaken. Braun and Clarke<sup>21</sup> (p 79) suggest that thematic analysis is a process for 'identifying, analysing and reporting patterns (themes) within data'.

### Data abstraction

On completion of the independent review of abstracts, full texts of the remaining ten manuscripts were sourced (Table 2). Each manuscript was critically appraised by each individual author and the data were summarised to develop the themes. Consensus on the themes was achieved by the three authors. This review, however, did not assess interventions for weight loss and/or general pain reduction; rather, it focused specifically on the ultimate goal of providing a current understanding of musculoskeletal pain associated with overweight and obese children. Three central themes associated with musculoskeletal pain in overweight and obese children were generated, and they comprised musculo-skeletal health, joint alignment and dysfunction, pain reporting and the impact of pain on physical activity, exercise and quality of life.

## RESULTS

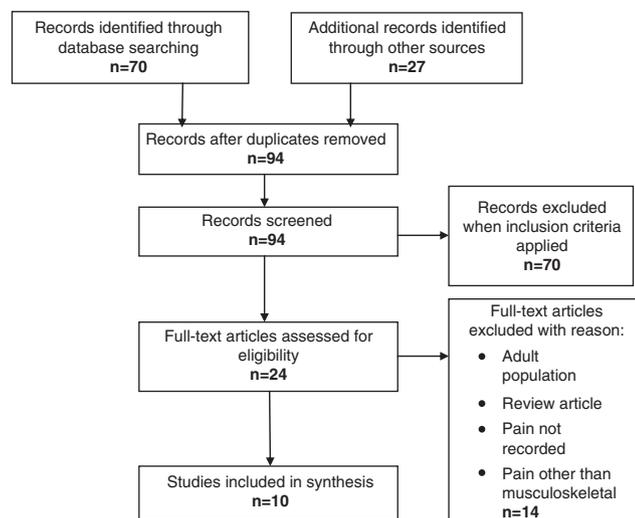
### Impact of being overweight or obese on musculoskeletal health, joint alignment and dysfunction

Numerous studies report the significant impact of being overweight or obese on bone and joint health in adults.<sup>22–24</sup> Key issues are primarily bone demineralisation, deformity, dysfunction and the associated pain due to these changes in body structures. In this review, we were able to identify three studies that reported dysfunction and/or deformity of bone structure in overweight or obese children who report pain. The first study examined orthopaedic complications in overweight children and adolescents and found a significantly higher prevalence of skeletal fractures compared with non-overweight subjects.<sup>25</sup> Similarly, a Dutch study identified that overweight and obese children self-reported ankle and foot problems<sup>26</sup> and potentially impacted on their ongoing joint health. More concerning was de Sá Pinto's study that reports the osteoarticular alterations in obese children who had a BMI above the 95th percentile with significantly higher reports of pain when compared with normal-weight children.<sup>27</sup> The study also found a higher frequency of genu valgum, commonly called 'knock-knee', (55.1%) and a higher frequency of genu recurvatum, which is an excessive extension of

**Table 1.** Strategies used to search the literature on musculoskeletal pain in overweight and obese children

Specific search elements	Steps in search process	Term combination
'Characteristic'	1	*Obesity/
	2	'obes*':ab,ti.
	3	*Obesity, Morbid/
	4	*Overweight/
	5	'overweight'.ab,ti.
Combining characteristic terms	6	1 or 2 or 3 or 4 or 5
'Population'	7	limit 6 to ('child (6 to 12 years)' or 'adolescent (13 to 18 years)')
'Symptom'	8	*Pain/
	9	'pain'.ab,ti.
'Body region'	10	*Chronic Pain/
	11	*Back Pain/
	12	*Low Back Pain/
	13	('knee' adj3 'pain').ab,ti.
	14	('hip' adj3 'pain').ab,ti.
	15	('foot' adj3 'pain').ab,ti.
	16	('musculoskeletal' adj3 'pain').ab,ti.
	17	*Pelvic pain/
	18	('pelvi*' adj3 'pain').ab,ti.
	Final search	19

β, final search was limited to English text human subjects, age range and undertaken between 1 January 2000 and 30 December 2012. α, \* before the MESH term means focused and not exploded. μ, ab,ti limits search to abstract and title. φ, indicates searching for term within three words of each other regardless of order.



**Figure 1.** Retrieval of published studies process flow diagram.

the knee-joint, in obese children (24.2%) compared with the control group of normal-weight children (2%). These studies highlight a serious risk to the skeletal system of a child who is either overweight or obese and the pain associated with musculoskeletal dysfunction and deformity.

Musculoskeletal pain reporting in overweight and obese children Pain reporting is central to this review, and we sought to understand from the literature the most common sites of musculoskeletal pain, how pain is reported and any differences that occur within the studied populations of overweight and obese children. Of the studies reviewed, musculoskeletal pain was identified through medical chart review and/or self-report by parents and/or children. Two retrospective medical chart reviews of children and adolescents used musculoskeletal pain as the primary inclusion criterion in two differing patient populations: a paediatric clinical trial unit and paediatric pain clinic.<sup>25,28</sup> Six prospective studies recorded pain from participating overweight and obese children and adolescents compared with normal-weight children in a variety of settings. Two of these studies included participants from obesity clinics.<sup>27,29</sup> One study was in a specialised orthopaedic service<sup>30</sup> and in primary care,<sup>26</sup> and the remaining two studies assessed children<sup>31,32</sup> in a primary school setting.

The sites of pain in these overweight and obese paediatric populations differ in each study. Four studies reported musculoskeletal pain sites, for example, lower back, knees, ankles and feet,<sup>25–27,31</sup> and one study reported neck pain.<sup>26</sup> However, three studies reported nonspecific musculoskeletal pain without specifying the pain site.<sup>28,30,32</sup> Interestingly, children who reported musculoskeletal pain in the back, hip, knee and/or ankle were found to have a significantly higher BMI than those without pain, with the odds of having joint pain increased by 10% for every 10-kg increase of weight and an increase of 3% for every unit increase in BMI.<sup>29</sup> Recently, a study that sought to estimate overall and age-specific associations between obesity and musculoskeletal pain in children found a significant increase in pain in the lower extremities of extremely obese children across three age ranges encompassing children aged between 2 and 19 years compared with normal-weight children.<sup>33</sup>

During this review, we identified only one scale (other than a quality-of-life tool) that was specifically used to examine the impact of pain in obese children. Podeszwa<sup>30</sup> used the Pediatric Outcomes Data Collection Instrument to determine obese

children's overall health, pain and their ability to participate in activities of daily life and vigorous exercise. They found that older obese girls (age >11 and <18) had significant reduction in function, mobility and happiness, with a substantial increase in pain; however, obese boys had a greater reduction in mobility without an increase in pain compared with normal-weight boys. This evidence highlights the potential for significant disability in adult life, apart from chronic illnesses such as diabetes type 2 and heart disease, should these children continue to remain overweight or obese.

#### Impact of pain on activity, exercise and quality of life

Health-related quality-of-life tools have been extensively used in adult obesity studies; however, very little research on overweight and obese children has been reported in terms of quality-of-life indices. Recently, a small number of studies have sought to describe the impact of musculoskeletal dysfunction using the health-related quality-of-life tools. Taylor *et al.*<sup>25</sup> identified overweight children through chart audit, dual X-ray absorptiometry scans and data from the impact of weight on quality-of-life adolescent questionnaire as having more musculoskeletal discomfort, impaired mobility and lower-extremity malalignment. These three health issues may have an impact on a child's quality of life and have been linked with a reduction in the likelihood of physical activity when compared with non-overweight children. Hainsworth *et al.*<sup>28</sup> studied the health impacts on children who experience chronic pain using the health-related quality-of-life tool and identified that 48% of obese children experience musculoskeletal pain more than other types of pain such as headache or abdominal pain. The premise that a combination of chronic pain and obesity reduces physical functioning was a significant finding of Hainsworth's study, as was the finding that obesity and impaired physical functioning was six times higher than obesity alone in this chronic pain paediatric population. This research suggests that there may be a cyclic inter-relatedness between chronic pain, obesity and levels of physical activity.

Wilson *et al.*<sup>34</sup> confirm the association between physical activity and obesity as reported in Hainsworth's study. Wilson *et al.* found, in a population of obese children who were receiving treatment for musculoskeletal pain, that the parents often reported limitations in the child being able to participate in exercise and sports. Specifically, when parents are asked to report on their children's activity, the parents relate the child's activity levels to the child's weight, whereas children associate their activity level with their level of pain. Wilson *et al.* found that the relationship between being overweight or obese and pain may be partially mediated by physical activity levels. Both studies suggest a spiralling effect in which overweight and obese children with musculoskeletal pain reduce their activity, potentially contributing to further weight gain. With few studies in this area, clearly more research is required to develop a greater understanding of the impact of activity and exercise on overweight and obese children who cope with ongoing musculoskeletal pain and the effect on their short- and long-term quality of life.

#### DISCUSSION

There is substantive evidence from many countries that an increasing number of children are becoming overweight and obese.<sup>35</sup> Most of the studies identified through this review were within specialist chronic pain or obesity paediatric clinic populations, and a small number of studies based in primary care or used electronic health records addressed the issue of obesity and musculoskeletal pain in children and adolescents.

The impact of being overweight or obese on a child's skeletal system has been reported in terms of joint health and dysfunction

**Table 2.** Studies included in the review

First author	Age (years)	Country	Year	Sample size	Type of study and measurement	Results	Determinant of overweight and obesity
Podeszwa, DA	2–18	USA	2006	50	Prospective PODCI validation study using BMI, PODCI and life satisfaction question	Recorded impairment in sports and pain in obese children compared with normative data. Data for this difference not provided	BMI for age exceeding 95th percentile (based on growth charts developed by the CDC that correct for gender differences)
Stovitz, S	3–18	USA	2008	135	Prospective descriptive cross-sectional study using BMI and pain assessment. OR of pain for the knee and hip in obese children	Knee: OR = 1.13 per 10 kg increase in weight, 95% CI: 1.01 – 1.29. OR = 1.04 per unit increase in BMI, 95% CI: 1.01 – 1.08 Hip: OR = 1.29 per 10 kg increase in weight, 95% CI: 1.05 – 1.60. OR = 1.09 per unit increase in BMI, 95% CI: 1.03 – 1.16	BMI for age exceeding 95th percentile (based on growth charts developed by the CDC that correct for gender differences)
de Sa Pinto, AL	7–14	Brazil	2006	49	Prospective cross-sectional study using BMI, limb flexibility, posture examination, clinic questionnaire, tender points and fibromyalgia criteria. Frequency of genu valgum and genu recurvatum in obese children compared with normal-weight children	Genu valgum: 55.1% vs 2%; $P < 0.0001$ Genu recurvatum: 24.2% vs 2%; $P < 0.001$	BMI for age exceeding 95th percentile (as determined by the National Health and Nutrition Examination Survey)
Bell, LM	7–15	Australia	2011	283	Cohort study using BMI, structured interview, medical assessment, anthropometrics and fasting blood investigations, including oral glucose tolerance test	Chi-square $P = 0.010$ OR compared with controls For overweight children: 1.53 For obese: 4.09	Based on international age- and gender-specific BMI cutoffs
Taylor, ED	8–16	USA	2006	355	Retrospective medical chart review records using BMI, IWQOL-A and DXA scans	OR: 4.45; 95% CI: 1.6–13.2; $P = 0.0053$	BMI for age exceeding 95th percentile (as determined by the National Health and Nutrition Examination Survey)
Bell, LM	6–13	Australia	2007	177	Cohort study using BMI, structured interview, medical assessment, anthropometric and fasting blood investigations, including oral glucose tolerance test	For musculoskeletal pain: OR (with every increase of 1.0 in BMI z-score): 2.54 95% CI of OR: 1.41 – 4.59 Wald $P$ -value (for BMI z-score): 0.003	Children were classified as overweight or obese using the Cole <i>et al.</i> <sup>16</sup> age- and gender-specific overweight and obese cutoffs of BMI for children
Hainsworth, KR	8–18	USA	2009	319	Retrospective review of medical records using BMI, anthropometrics, clinical and diagnostic data, self report of pain and HRQOL scores	Differences in musculoskeletal/orthopaedic pain characteristics between the three weight groups was substantial but not significant with $P = 0.054$	BMI was measured using the US Centre for Disease Control and Prevention 2000 growth charts for sex and age
Krul, M	2–17	Netherlands	2009	2,459	Retrospective review of Dutch National Survey of Family Practice using Survey database and face-to-face interview	OR: 1.92; 95% CI: 1.15 – 3.20; $P \leq 0.05$	A standard developed for age-specific overweight and obesity BMI cutoff points in Dutch children was used to determine the presence of overweight and obesity in the study population
Wilson, AC	8–18	USA	2011	118	Retrospective review of medical chart using Clinic questionnaire, BMI and CALI-21 for activity limitation	A significantly higher rate of overweight and obesity was observed among youth with chronic pain compared with a normative sample.	CDC's online paediatric BMI calculator, which was used to obtain BMI, BMI percentile and BMI
Adams	2–11 (and 12–19)	USA	2012	913178	Cross-sectional study examined associations between weight class and diagnosis of fractures, sprains, dislocations and pain	Significant increase in pain of the lower extremities in extremely obese children between 2 and 5 years of age (OR = 1.60, 95% CI 1.16 – 2.20) compared with their normal weight counterparts and for children 6–11 years extremely obese (OR = 1.31, 95% CI 1.16 – 1.48), moderately obese (OR = 1.24, 95% CI 1.13 – 1.35) and overweight (OR = 1.17, 95% CI 1.07 – 1.28) compared with their normal weight counterparts	Definitions for overweight and obesity based on sex-specific BMI-for-age growth charts developed by CDC and WHO

Abbreviations: BMI, body mass index; CDC, Center for Disease Control; DXA, dual X-ray absorptiometry; HRQOL, health-related quality of life; IWQOL-A, impact of weight on quality-of-life adolescent questionnaire; PODCI, Paediatric Outcomes Data Collection Instrument.

resulting in more ankle, foot and knee problems than children who are within a normal-weight range for their age.<sup>26</sup> Obesity is associated with pain, joint dysfunction<sup>27</sup> and bone fractures.<sup>25</sup> The progression of these osteoarticular changes into adult life, if weight management is not achieved, could lead to the need for ongoing orthopaedic treatment.<sup>33</sup> Overweight and obese children reported musculoskeletal pain primarily due to changes within articulating joints such as knee and ankle, and as a result of fractures.<sup>25–27</sup> Kessler's and other studies regarding bone fractures report significantly higher rates of fractures in overweight and obese children, yet pain in these studies is not reported.<sup>36–39</sup>

From this review, it was found that children and their parents may report pain and activity differently. In the context of activity, children linked their pain with levels of activity, whereas parents associated activity with the child's weight.<sup>34</sup> Therefore, the way pain is self-reported may require further validation from the perspectives of both parent and child. The relationship between increase in BMI, weight and pain demonstrates a risk factor for damage to the musculoskeletal structure, and this damage is often expressed by the child as pain.<sup>25,26</sup> Evidence is emerging to

suggest that a reduction in physical functioning of obese and overweight children may occur and be evident through the child's expression of pain, further impacting on their self-esteem resulting in a poorer quality of life.<sup>25,28,30</sup> Changes to the musculoskeletal system in overweight and obese children have been shown to negatively influence motor performance, including muscle strength, balance and walking, through changes in plantar flexion during the swing phase of walking, resulting in a flatter foot.<sup>40–44</sup> Hip and knee flexion is also affected in obese children owing to an increase in concentric contraction of hip flexors,<sup>45</sup> creating higher energy transfer and loads across hip joints,<sup>46</sup> resulting in a change in gait to cope with the child's increased body mass. Therefore, the reporting of musculoskeletal pain by overweight children may reflect a significant marker of a reduction in osteoarticular health and changes to skeletal structure. In reviewing the literature associated with obese and overweight children, there appears to be links between bone health, pain, physical activity and quality of life, and these links may be important if the issue of musculoskeletal pain in this group of children is to be addressed.

**CONCLUSION**

This review sought to identify the extent of musculoskeletal pain in overweight and obese children as reported in literature. The emerging evidence suggests that being overweight or obese has a significant impact on the health and well-being of these young people and may contribute to ongoing health problems such as musculoskeletal pain and bone/joint dysfunction in later life. The cumulative effect of children being overweight or obese and experiencing musculoskeletal pain requires further investigation.

**CONFLICT OF INTEREST**

The authors declare no conflict of interest.

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