PEDIATRIC REVIEW
Musculoskeletal pain in overweight and obese children

SM Smith1,2, B Sumar1 and KA Dixon1

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 terms associated with children, obesity and musculoskeletal pain. Ten studies were included for thematic analysis when predetermined inclusion criteria were applied. 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. 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 sequelae 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 ~4 million children under the age of five being reported as overweight.1 The WHO defines overweight and obesity as abnormal or excessive fat accumulation that may impair health.2 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 obese3 and children from low socioeconomic areas being 70% more likely to be either overweight or obese.4 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 35.5 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.5 A number of reports suggest that overweight and obese children have subsequently developed short- and long-term health problems that continue into adult life.6,7 In particular, psychological co-morbidities associated with being overweight or obese during childhood and adolescence are well documented.8,9 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.9,10 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.11 Degenerative osteoarthritis and cartilage breakdown along with musculoskeletal pain have been reported as part of the disability spectrum related to obesity.12 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.12 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.13–15 Children affected by chronic musculoskeletal pain have been found to have increased levels of anxiety and depression, as well as lower levels of activity.16 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.17,18 Interestingly, Tanamas and co-workers19 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.

1Family and Community Health Research Group, School of Nursing and Midwifery, University of Western Sydney, Campbelltown, NSW, Australia and 2Centre for Pharmacology and Therapeutics, Imperial College, Chelsea and Westminster Campus, London, UK. Correspondence: Professor SM Smith, Family and Community Health Research Group, School of Nursing and Midwifery, University of Western Sydney, Locked Bag 1797, Penrith, NSW 2751, Australia.
E-mail: sheree.smith@uws.edu.au

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MATERIALS AND METHODS
This literature review was carried out using a systematic method 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 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 suggest that thematic analysis is a process for ‘identifying, analysing and reporting patterns (themes) within data’.

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.22–24 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.25 Similarly, a Dutch study identified that overweight and obese children self-reported ankle and foot problems 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.27 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](image-url)

| Specific search elements | Steps in search process | Term combination |
|--------------------------|-------------------------|-----------------|
| ‘Characteristic’         | 1                       | *Obesity/       |
|                          | 2                       | ‘obes’,‘abt’.    |
|                          | 3                       | *Obesity, Morbid/|
|                          | 4                       | ‘Overweight’,    |
|                          | 5                       | ‘overweight’,‘abt’.|
| 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’,‘abt’.    |
|                          | 10                      | *Chronic Pain/  |
| ‘Body region’            | 11                      | *Back Pain/     |
|                          | 12                      | *Low Back Pain/ |
|                          | 13                      | (‘knee’ adj3 ‘pain’),‘abt’. |
|                          | 14                      | (‘hip’ adj3 ‘pain’),‘abt’. |
|                          | 15                      | (‘foot’ adj3 ‘pain’),‘abt’. |
|                          | 16                      | (‘musculoskeletal’ adj3 ‘pain’),‘abt’. |
|                          | 17                      | ‘Pelvic pain/    |
|                          | 18                      | (‘pelvis’ adj3 ‘pain’),‘abt’. |
| Final search             | 19                      | 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 |

[1] final search was limited to English text human subjects, age range and undertaken between 1 January 2000 and 30 December 2012. [2] * before the MESH term means focused and not exploded. [3] abt limits search to abstract and title. [4] indicates searching for term within three words of each other regardless of order.
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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.25 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.26 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.34 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.23 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...
resulting in more ankle, foot and knee problems than children who are within a normal-weight range for their age.\textsuperscript{26} Obesity is associated with pain, joint dysfunction\textsuperscript{27} and bone fractures.\textsuperscript{23} The progression of these osteoarticular changes into adult life, if weight management is not achieved, could lead to the need for ongoing orthopaedic treatment.\textsuperscript{33} 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.\textsuperscript{25} 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.\textsuperscript{26-29}

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.\textsuperscript{34} 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.\textsuperscript{25,26} 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.\textsuperscript{25,26,34,39} 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.\textsuperscript{40-44} Hip and knee flexion is also affected in obese children,\textsuperscript{41} resulting in a poorer quality of life.\textsuperscript{25,28,30} Changes to the expression of pain, further impacting on their self-esteem resulting in the child's increased 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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