Original Article

Orthopedic Problems in Thai Obese Children

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Objective: Overweight has reached epidemic proportions globally. The authors conducted a cross-sectional study aimed at describing the prevalence and characteristics of orthopedic problems in otherwise healthy Thai obese children.

Materials and Methods: Obese children aged between 2 to 15 years with a high body mass index (BMI ≥95th percentile for age) were included in the study. Children with endocrine abnormalities were excluded. All eligible participants received physical and radiographic examinations to evaluate any deformity including dual-energy x-ray absorptiometry scans to measure bone mineral density (bone age).

Results: Ninety-five obese children, mean age 9.7±3.7 years, were included of whom 61% were male. The average BMI was 31.7 kg/m^2, and more than 50% of the children had a BMI above the 200th percentile. Orthopedic problems, i.e., pain, deformities, or injuries, were found in 60% of the children. The most common musculoskeletal problems were knee pain and knee deformities. The mean BMD Z-score was 2.36±1.2 and the mean bone age was 11.7±4.4 years.

Conclusion: Orthopedic problems are common in obese children, especially those with a BMI exceeding the 150th percentile for their age. They also tend to have a higher BMD and advanced skeletal age. These factors may restrict their mobility and tolerance for physical activity. Health care providers should be aware of the higher risk of orthopedic problems in obese children, and the need to initiate interventions or programs to help the children lose weight and prevent complications.

Keywords: Orthopedic problems, Childhood obesity

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Obesity has reached epidemic proportions globally. In Thailand, an increasing prevalence of obesity has been reported in both children and adults. Among children and adolescents aged from 3 to 18 years old, the prevalence of obesity is 7.6% and 9.0% respectively[1]. Overweight children have been reported to have more musculoskeletal problems than normal weight children in a study from the Netherlands[2].

Obesity is not simply a cosmetic problem: it affects both physical and psychological health. Obese children mostly Most obese children grow up to be obese adults[3,4], and adult obesity leads to many problems such as cardiovascular problems, metabolic problems, and musculoskeletal problems. Despite the fact that some orthopedic problems in childhood are the result of excess body weight, the prevalence of orthopedic complications of childhood obesity has not exactly known been precisely determined.

Taylor et al reviewed the medical charts of 227 overweight children and found 14% had musculoskeletal pains and about 13% had previous fractures[5]. The bone age of heavy children significantly exceed their chronological age, and they progress through puberty at an earlier age than normal children[6,7]. There have been some studies of bone mineral density in obese children, but the results are still controversial[8-10]. Goulding reported a case-controlled study of 100 obese pediatric patients with forearm fracture. Most of them were >85th percentile of BMI for their age and had a lower bone mineral content, area, and volumetric bone mineral density compared to control subjects[8].

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As mentioned in previous studies, there are many questions concerning orthopedic problems in obese children still to be answered. This is especially true of the population of Thai children, which differs from western children in many ways. The authors intended to describe the prevalence and characteristics of orthopedic problems in Thai obese children who were otherwise normal as well as to assess the BMD and skeletal ages of this population.

Materials and Methods

A cross-sectional study of Thai obese children was conducted at the Faculty of Medicine Ramathibodi Hospital during 2007 to 2008. Obese children (BMI $\geq$95th percentile for age and sex) aged 2 to 15 years who were enrolled at the obesity clinic, Department of Pediatrics, were recruited. Obese children with known endocrine abnormalities such as hypothyroidism, brain tumor, or posttraumatic brain injury were excluded. Each child and/or parent gave written informed consent for protocol participation. The study was approved by The Committee on Human Rights Related to Research Involving Human Subjects, Faculty of Medicine Ramathibodi Hospital.

Participants' baseline characteristics, including age, age at onset of obesity, gender, birth history, weight, height, BMI percentile for age and sex, food intake, drugs, infections, and metabolic diseases were collected. Their history of musculoskeletal complaints, such as injury and pain, and family history of obesity or musculoskeletal problems were also recorded. Each child underwent a brief orthopedic physical examination. The examination included a back examination and trunk balance, hip, knee, ankle, and foot examination for signs of ligamentous laxity which could indicate musculoskeletal abnormalities such as scoliosis, slipped capital femoral epiphysis, ankle and foot deformities. Radiographic images of their non-dominant hands for evaluation of skeletal age plus images of affected parts based on their history and the physical examination were made. Skeletal ages were assessed using the Greulich and Pyle atlas[11]. Bone mineral density was assessed by total-body dual energy x-ray absorptiometry [DEXA] using a Hologic (Bedford, MA, USA) Discovery fan-beam densitometer. Orthopedic problems were identified either from their history or physical examination. According to Helth CH and Staheli LT' study, the presence of genu valgum was defined an intermalleolar distance of more than 8 cm, while genu varum was defined as participants with intercondylar distance of more than 6 cm[12].

Statistical analyses were performed using Stata version 10.0 (StataCorp, College Station, TX, USA). The prevalence of musculoskeletal complaints, previous musculoskeletal injuries, and deformities was calculated. Continuous data were analyzed using mean and standard deviation [SD]. Categorical data were analyzed using proportion and percentage. Chi-square and unpaired t-test were used to compare categorical data and continuous data, respectively. The *p*-value <0.05 was considered as statistically significant.

The sample size of 89 was calculated using the prevalence of orthopedic problems in obese children from previous reports (13%)[5,13-15], alpha = 0.05, power of test = 0.8, and accepted difference of variation = 7%.

Results

Ninety-five obese children were recruited into the study. Each had a BMI above the 95th percentile for his/her age. Most of the participants were male (61.1%); the mean age was 9.7$\pm$3.7 years (range 2.2 to 14.8). Their mean age at the onset of obesity was 4.4$\pm$2.8 years (range 0 to 11). Mean weight was 66.2$\pm$30.0 kilograms (kg) with a range of 20 to 200; their mean height was 141.2$\pm$23.0 centimeters (cm) with a range of 90 to 179, and their mean BMI was 31.7$\pm$7.8 kg/m^2 with a range of 20.5 to 67.6. BMI percentiles are shown in Table 1. More than half the participants (54.7%) had a BMI more than the 200th percentile for their age.

Sixty orthopedic problems were found in 57 children (60% of all participants), and most of

Table 1. Demographic characteristics

Characteristics	n = 95
Gender, n (%)	
Male	58 (61)
Female	37 (39)
Age (mean years $\pm$ SD)	9.7$\pm$3.7
Age at onset of obesity (mean years $\pm$ SD)	4.4$\pm$2.8
Weight (mean kg $\pm$ SD)	66.2$\pm$30.0
Height (mean cm $\pm$ SD)	141.2$\pm$23.0
BMI (mean kg/m^2 $\pm$ SD)	31.7$\pm$7.8
BMI percentile (n (%))	
100th	2 (2.1)
125th	14 (14.8)
150th	17 (17.9)
175th	10 (10.5)
>200th	52 (54.7)

Data are mean $\pm$ SD unless otherwise indicated

participants had deformities (66.7%). The most common deformity was genu valgum (80%). The next most common problem was musculoskeletal pains (21.6%), and the most affected parts were the knee, foot, and ankle. Two children were found to have genu valgum with knee or ankle pain. One child had a previous ankle sprain and knee pain. There was no scoliosis, no slipped capital femoral epiphysis and no ankle or foot deformities in this cohort (Table 2).

The participating children were classified into two groups based on whether they had orthopedic problems or not. Comparative analyses were performed. No statistically significant difference was found among age, age at onset, weight, or height between the two groups. However, when the participants were classified into two groups according to their BMI, the children with a BMI in the 150th percentile or above were significantly more likely to have orthopedic problems than those with BMI less than the 150th percentile, (p-value = 0.04) (Table 3).

After receiving caregivers' permission, 35 children were sent for radiologic imaging of their non-dominant hand to evaluate their skeletal age, and 31 children were sent for BMD assessment. Comparative analysis showed that skeletal age and BMD Z-scores were not statistically significantly different between children with and without orthopedic problems.

Table 2. Characteristics of orthopedic problems

Orthopedic problems	n (%)
Musculoskeletal pain	13 (21.6)
Knee pain	7 (54)
Foot and ankle pain	6 (46)
Previous injury	7 (11.7)
Deformity	40 (66.7)
Genu valgus	32 (80)
Genu varus	8 (20)

Discussion

Orthopedic complications due to excess weight in adults include progression of degenerative osteoarthritis and articular cartilage breakdown[15]. A recent study has shown that obese children can develop many health conditions that were once thought to be found only in adults[16]. Some childhood orthopedic problems are the result of excess body weight. For example, it is well recognized that children with Blount disease tend to be heavier than their peers. The cause of genu varum in Blount disease had been thought to be the result of increased compressive forces on the physis leading to asymmetric growth inhibition[17,18]. At least half the adolescents with slipped capital femoral epiphysis are above the 95th percentile in weight for their age[19]. The pathophysiology is not completely known, but it seems to involve both mechanical and biological factors. The increased stress, which is mechanical, often results from excess weight[19-21]. Obese children were found to have a 1.7 times greater risk of forearm fracture compared to non-obese children. The hypothesis has been that an increased weight load is distributed all over obese children's bodies, especially to bones and joints[22]. Leet reviewed the cases of 104 femoral fractures in children between 6 and 14 years of age who had been treated operatively and where complications had been

Table 3. Incidence orthopedic problems

Variables	No orthopedic problems (n = 38)	With orthopedic problems (n = 57)	p-value
Gender (n)			
Male	23	35	0.93[a]
Age (mean year ± SD)	9.9±3.5	9.6±3.8	0.73[b]
Age at onset (mean year ± SD)	4.4±2.6	4.3±2.9	0.92[b]
Weight, kg	60.7±22.0	69.8±34.0	0.15[b]
Height, cm	141.9±21.2	140.8±24.4	0.83[b]
BMI percentile, n (%)			
<150th	10 (26.3)	6 (10.5)	0.04[a]
≥150th	28 (73.7)	51 (89.5)	

[a] p-value from Chi-square; [b] p-value from unpaired t-test

identified. In that study, obese children had an increased rate of postoperative complications compared with children who were not obese[6]. There is the possibility of more physeal injury in obese children than normal children. There is a possibility that obese children suffer more physeal injury than normal children due to increased force on the physis[23].

The present cross-sectional study found the prevalence of orthopedic problems in otherwise healthy children to be as high as 60%. The problems were comprised mostly of deformities, i.e., genu valgum and genu varum. The remaining problems were musculoskeletal pains and previous injuries. These findings are comparable with previous reports[5,16]. The authors found one child with Blount's disease who has never sought orthopedic consultation before. He was sent for further examination and is scheduled for regular follow-up.

Children who had a BMI above the 150th percentile were found to be an at-risk group, since they had significantly more orthopedic problems than those who had a lower BMI. Efforts to achieve weight reduction in obese children should be strongly encouraged, especially in children with a BMI more than the 150th percentile for their age.

Mean skeletal age was 11.7±4.4 years which is about 2 years above their chronological age, a finding comparable with previous reports[6,7]. However, the skeletal ages of children with and without orthopedic problems were not statistically different. The mean BMD Z-score was 2.36±1.2 which is higher than in most previous reports[8-10,24]. A possible reason for this finding might be that obese children tend to have an advanced skeletal age, so their BMD Z-score will be below that of normal children in the same age group.

The population of this study was obese children with no prior orthopedic problems who came to the Department of Pediatrics to attend a weight-reduction program. The population was comparable to obese children in our Thai society who are otherwise healthy so the findings are likely to be applicable to the general population in Bangkok. The limitations of this study were the lack of non-obese children for comparison and the small number of children available children for the skeletal age and BMD assessment. A further study should involve larger multi-center samples.

Conclusion

Children with a BMI exceeding the 150th percentile for their age are significantly more likely to have orthopedic problems. Obese children also tend to have a higher BMD and advanced skeletal age than normal children of the same age. Many of these problems can restrict their mobility and tolerance for physical activity. With early detection of these conditions, the children can receive proper management. Health care providers should be aware of the higher risk of orthopedic problems in obese children so they can initiate interventions or programs to help the children reduce their weight and prevent complications. Future studies should also investigate the biomechanical principles which underlie the increased prevalence of orthopedic problems in childhood obesity.

What is already known on this topic?

The prevalence of obesity is increasing in both children and adults globally. The obese children have been reported to have more musculoskeletal problems than normal weight children. Obesity is not simply a cosmetic problem. Rather, it affects both physical and psychological health.

What this study adds?

Orthopedic problems were common in obese children, especially in children with BMI exceeded 150th percentile for their age. They also tend to have higher BMD and advanced skeletal age. These may restrict their mobility and tolerance for physical activity. From

Table 4. Skeletal age and BMD of obese children

Variables	No orthopaedic problems (n = 21)	With orthopaedic problems (n = 45)	*p*-value*
Skeletal age (n = 35)	13.1±3.6 (n = 11)	11.1±4.6 (n = 24)	0.21
BMD Z-score (n = 31)	2.3±1.0 (n = 10)	2.4±1.3 (n = 21)	0.91

Data are mean ± SD
* *p*-value from unpaired t-test

this study orthopedic problems found in 60% of the cases, and the most common problems were knee pain and knee deformities.

This first study of obesity in Thai children found that 60% of obese children had orthopedic problems, most commonly knee pain and deformities. These children also tend to have higher BMD and advanced skeletal age. These factors may restrict their mobility and tolerance for physical activity. These findings indicate that the obesity problems of Thai children are not significantly different from those in other regions of the world.

Potential conflicts of interest

The authors declare no conflict of interest.

References

1. Jitnarin N, Kosulwat V, Rojroongwasinkul N, Boonpraderm A, Haddock CK, Poston WS. Prevalence of overweight and obesity in Thai population: Results of the National Thai Food Consumption Survey. Eat Weight Disord 2011;16:e242-9.
2. Krul M, van der Wouden JC, Schellevis FG, Suijlekom-Smit LW, Koes BW. Musculoskeletal problems in overweight and obese children. Ann Fam Med 2009;7:352-6.
3. Rimm IJ, Rimm AA. Association between juvenile onset obesity and severe adult obesity in 73, 532 women. Am J Public Health 1976;66:479-81.
4. Wang Y. Cross-national comparison of childhood obesity: the epidemic and the relationship between obesity and socioeconomic status. Int J Epidemiol 2001;30:1129-36.
5. Taylor ED, Theim KR, Mirch MC, Ghorbani S, Tanofsky-Kraff M, Adler-Wailes DC, et al. Orthopedic complications of overweight in children and adolescents. Pediatrics 2006;117:2167-74.
6. De Simone M, Farello G, Palumbo M, Gentile T, Ciuffreda M, Olioso P, et al. Growth charts, growth velocity and bone development in childhood obesity. Int J Obes Relat Metab Disord 1995;19:851-7.
7. Cameron N, Pettifor J, De Wet T, Norris S. The relationship of rapid weight gain in infancy to obesity and skeletal maturity in childhood. Obes Res 2003;11:457-60.
8. Goulding A, Taylor RW, Jones IE, McAuley KA, Manning PJ, Williams SM. Overweight and obese children have low bone mass and area for their weight. Int J Obes Relat Metab Disord 2000;24: 627-32.
9. Leonard MB, Shults J, Wilson BA, Tershakovec AM, Zemel BS. Obesity during childhood and adolescence augments bone mass and bone dimensions. Am J Clin Nutr 2004;80:514-23.
10. Nagasaki K, Kikuchi T, Hiura M, Uchiyama M. Obese Japanese children have low bone mineral density after puberty. J Bone Miner Metab 2004;22:376-81.
11. Gilsanz V, Ratib O. Hand bone age: A digital atlas of skeletal matority. Berlin: Springer-Verlag Berlin Heidelberg; 2005.
12. Heath CH, Staheli LT. Normal limits of knee angle in white children-genu varum and genu valgum. J Pediatr Orthop. 1993;13:259-62.
13. Wearing SC, Hennig EM, Byrne NM, Steele JR, Hills AP. The impact of childhood obesity on musculoskeletal form. Obes Rev 2006;7:209-18.
14. Wills M. Orthopedic complications of childhood obesity. Pediatr Phys Ther 2004;16:230-5.
15. Hooper MM. Tending to the musculoskeletal problems of obesity. Cleve Clin J Med 2006;73:839-45.
16. Daniels SR. The consequences of childhood overweight and obesity. Future Child 2006;16:47-67.
17. Davids JR, Huskamp M, Bagley AM. A dynamic biomechanical analysis of the etiology of adolescent tibia vara. J Pediatr Orthop 1996;16:461-8.
18. Dietz WH Jr, Gross WL, Kirkpatrick JA Jr. Blount disease (tibia vara): Another skeletal disorder associated with childhood obesity. J Pediatr 1982;101:735-7.
19. Aronsson DD, Loder RT, Breur GJ, Weinstein SL. Slipped capital femoral epiphysis: current concepts. J Am Acad Orthop Surg 2006;14:666-79.
20. Loder RT. The demographics of slipped capital femoral epiphysis. An international multicenter study. Clin Orthop Relat Res 1996;(322):8-27.
21. Loder RT, Richards BS, Shapiro PS, Reznick LR, Aronson DD. Acute slipped capital femoral epiphysis: the importance of physeal stability. J Bone Joint Surg Am 1993;75:1134-40.
22. Davidson PL, Goulding A, Chalmers DJ. Biomechanical analysis of arm fracture in obese boys. J Paediatr Child Health 2003;39:657-64.
23. Leet AI, Pichard CP, Ain MC. Surgical treatment of femoral fractures in obese children: does excessive body weight increase the rate of complications? J Bone Joint Surg Am 2005;87:2609-13.

24. Ellis KJ, Shypailo RJ, Wong WW, Abrams SA. Bone mineral mass in overweight and obese children: diminished or enhanced? Acta Diabetol 2003;40(Suppl 1):S274-7.