Clinical Study

Association between body mass index, body height, and the prevalence of spinal deformities

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Abstract

BACKGROUND CONTEXT: The most common spinal deformities among adolescents are adolescent idiopathic scoliosis (AIS; 2%–3% prevalence) and Scheuermann kyphosis (SK; 1%–8% prevalence). Both are believed to have a genetic influence in their etiology. The association between body mass index (BMI) and body stature and their possible association to spinal deformities is uncertain.

STUDY DESIGN: A cross-sectional prevalence study.

PURPOSE: To examine the prevalence of all adolescent spinal deformities according to the extent of their severity as well as their possible association to BMI and body height.

OUTCOME MEASURES: Subjects diagnosed as having spinal deformities were classified into one of three severity groups; "Mild," "Intermediate," or "Severe," according to their curve scoliosis or kyphosis measurement with a standing X-ray.

METHODS: The data for this study were derived from a medical database containing records of 17-year-old male and female patients before their recruitment into mandatory military service. Information on the disability codes associated with spinal deformities according to the Regulations of Medical Fitness Determination was retrieved. Logistic regression models were used to assess the association between the BMI and body height to various degrees of spinal deformities by severity.

RESULTS: The study cohort included 829,791 consecutive subjects, of whom 103,249 were diagnosed with spinal deformities (76% were mild in degree). The prevalence of spinal deformities was significantly greater among the underweight male and female patients (p<.001). Increased BMI had a protective effect for developing spinal deformities. The odds ratios for severe spinal deformities were greater compared with mild spinal deformities in the underweight groups. The risk for developing spinal deformities increased significantly with height for both genders (p<.001).

CONCLUSIONS: An association between height and the risk for spinal deformities by severity was found for all height groups. Below normal BMI is associated with severity of spinal deformities, whereas above-normal BMI apparently has a protective effect. Body height is also positively associated with the severity of spinal deformities. © 2014 Elsevier Inc. All rights reserved.

Keywords: Spinal deformities; Body mass index (BMI); Height; Obesity; Underweight; Overweight; Adolescents; Scoliosis; Scheuermann kyphosis

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EVIDENCE & METHODS

Context
BMI and height are thought to be associated with adolescent deformities. The authors performed a cross-sectional prevalence study to assess this relationship.

Contribution
Using 103,249 (of 829,791 total) subjects found to have deformities, the group found that increased height was associated with the risk of and severity of deformity. The same held for below normal BMI individuals.

Implications
The findings are in line with clinical observation. That is, tall, skinny, females are more likely to have deformities. Causation cannot be determined using this methodology. Thus, the impact of the findings on therapeutics remains an open question.

—*The Editors*

Introduction

Orthopedics is Latin for "straight child," emphasizing the significance society places on deformity as well as the functional affect it may have on the individual youngster. Spinal deformity is a commonly encountered problem in pediatric and orthopedic surgical practice. It may dramatically alter the physical appearance of the child and adolescent and have a significant psychological impact, particularly in the adolescent for whom self-image is so important. There are numerous causes of spinal deformity in the pediatric population, with idiopathic scoliosis and Scheuermann kyphosis (SK) accounting for most of them in the adolescent period. Adolescent idiopathic scoliosis (AIS) is a common and potentially severe musculoskeletal disorder. It is characterized by spinal deformity in the coronal, sagittal, and axial planes [1]. Approximately 80% of AIS curves greater than 20° occur in girls [2]. The etiology of AIS appears to be genetic [3], but the mechanisms by which the curves develop are unknown. The growth of the curve is related to the size of the curve, peak growth rate, age at onset, gender, and type of curve [2,4]. The adolescent form of scoliosis accounts for the majority of cases of the idiopathic type [5].

The second common spinal deformity, SK, is a rigid kyphosis of the thoracic or thoracolumbar spine occurring in adolescents [6]. The thoracic pattern is the more common and it is associated with a nonstructural hyperlordosis of the lumbar and cervical spine [7]. SK-reported incidence ranges from 1% to 8% of the general population [8–10]. The prevalence of SK is approximately equal in male and female patients [9,11,12]. The etiology of SK remains unknown. Several investigators have noted an apparent increased familial incidence of the condition [8,9,11]. There are few publications on the association between the body mass index (BMI), bone mass, or body stature and their possible relation to spinal deformities especially, idiopathic scoliosis. Qui et al. [13] found that significantly longer corrected height, lower body weight, and lower BMI were found in patients with AIS after the onset of puberty and suggested the presence of abnormal growth in patients with AIS during peripubertal development. Sadat-Ali et al. [14] assessed the prevalence of low bone mass among girls with AIS and their siblings who had normal spines and found that scoliosis caused osteopenia and osteoporosis among the affected girls whereas their siblings had normal bone mass. These studies showed a tendency of the patient with scoliosis to have a low BMI, a low bone mass, and greater height than the others [15,16]. Other studies failed to find any association between scoliosis and BMI and body height [17,18]. In a recent review, Burwell et al. discuss a theory on the development of scoliosis and its relation to the production of adiposity hormone leptin by the adipose tissue, and on the influence of low BMI as an important aspect of the pathogenesis of scoliosis in adolescent girls [19]. In this study, we examined the prevalence of all adolescent spinal deformities according to the extent of their severity as well as their possible association to BMI and body height.

Subjects and methods

The present cross-sectional, epidemiologic study received approval from the Israeli Defense Forces review board.

Medical database

Every 17-year-old Israeli citizen is required by law to report to a military recruiting center for a comprehensive medical evaluation for the purpose of medical classification. Individuals of certain minority populations are exempted. The medical evaluation includes the candidate completing a self-reported medical questionnaire and a medical questionnaire, which is completed the candidate's family physician. Measurements of height, weight, blood pressure, and visual acuity, are routinely carried out. The examinee undergoes a comprehensive medical history interview and a physical examination by physicians of the medical board and is referred to auxiliary tests and specialist consultations when indicated. Upon completing the medical evaluation, the examinee is assigned a medical profile and a disability classification by the medical board. The profile and disability classification are numerical codes that represent the individual's medical status and diagnoses. These codes are set according to the Regulations of Medical Fitness Determination that specifies which disability code is appropriate for a given medical condition. The medical data, medical profile, disability classification, and demographic data are stored in a computerized