Spine Deformity
www.spine-deformity.org

Spine Deformity 5 (2017) 374–380

A Case-Control Study of Body Composition, Prevalence, and Curve Severity of the Patients With Adolescent Idiopathic Scoliosis in the East Part of China

Yu Zheng, MD[a,b,c,d], Yini Dang, PhD, MD[e], Yan Yang, MA[d], Ning Sun, BSc[d], Tao Wang, BSc[d], Huabo Li, BSc[d], Lijie Zhang, BSc[d], Chengqi He, MD[b,c], M.S. Wong, PhD[a,*]

[a]*Interdisciplinary Division of Biomedical Engineering, The Hong Kong Polytechnic University, 11 Yuk Choi Road, Hung Hom, Kowloon, Hong Kong, 999077, China*
[b]*Center of Rehabilitation Medicine, West China Hospital, Sichuan University, 37 Guo Xue Xiang, Chengdu, 610041, China*
[c]*Institute for Disaster Management and Reconstruction, Sichuan University–The Hong Kong Polytechnic University, Huanghe Middle Road, Chengdu, 610041, China*
[d]*Department of Rehabilitation Medicine, Wuxi Rehabilitation Hospital, 100 Beitang Street, Wuxi, 214000, China*
[e]*The First Affiliated Hospital of Nanjing Medical University, Nanjing, China*

Received 29 October 2016; revised 9 February 2017; accepted 3 April 2017

Abstract

Objective: The purpose of the study is to investigate the characteristics of prevalence and curve severity in patients with adolescent idiopathic scoliosis (AIS) and the body composition alterations between the patients with AIS and healthy controls.

Methods: Information on the study sample was obtained from a screening database. The AIS cohort was paired with an age- and gender-matched healthy cohort. The stratification of BMI and curve severity was conducted according to the criteria developed by the US Centers for Disease Control and Prevention and the Scoliosis Research Society. The prevalence and curve severity of the patients with AIS were investigated. Multigroup comparison of body composition parameters was conducted according to BMI between the patients with AIS and healthy controls.

Results: A total of 1,202 patients with AIS and an age- and gender-matched cohort were recruited from local schools. The underweight cases had the highest prevalence of AIS and significantly higher Cobb angle compared with the other three BMI subgroups. Although the patients with AIS had lower body weight, body fat mass, percentage of body fat, and fat-free mass compared with healthy controls, converse results were observed in the underweight cases after stratification according to BMI.

Conclusion: Based on the sporadic body composition of the patients with AIS observed in the current study, it is predictable that the pathophysiological alterations may be different before and after the onset of scoliosis. Well-designed human or animal studies for underweight patients would be helpful to reveal the mechanisms of pathophysiological alterations and better predict the development of AIS.

Keywords: Adolescent idiopathic scoliosis; Body composition; Body mass index; Body weight; Underweight

Introduction

Adolescent idiopathic scoliosis (AIS) is a complex three-dimensional spinal deformity that affects patients throughout their peripubertal growth period. The etiology of AIS appears to be genetic [1]; however, the mechanisms by which the curves develop are still unknown. The meta-analysis by Zhang et al. reported a pooled prevalence of scoliosis of 1.02% in mainland China [2]. For effective preventive and therapeutic management, it is important to elucidate the etiopathogenesis of AIS.

This work was supported by the Wuxi Science and Technology Program (WSTP), China (grant number: ZD201408). The WSTP had no further role in study design; collection, analysis, and interpretation of data; writing of the report; or the decision to submit the paper for publication.

Author disclosures: none.

*Corresponding author. Interdisciplinary Division of Biomedical Engineering, The Hong Kong Polytechnic University, 11 Yuk Choi Road, Hung Hom, Kowloon, Hong Kong, 999077, China. Tel.: +852 27667680; fax: +852 27667680.

E-mail address: m.s.wong@polyu.edu.hk (M.S. Wong).

2212-134X/$ - see front matter
http://dx.doi.org/10.1016/j.jspd.2017.04.002

There has been a long-term debate as to whether there is a real connection between the debut of AIS and the body composition alterations. Numerous growth studies have attempted to answer this question with different samples [1,3-19]. Among them, several investigators confirmed the lower body weight, taller stature, larger arm span, lower body mass index (BMI), delayed menarche, and lower bone mass in the patients with AIS than the healthy controls. Sadat-Ali et al. compared girls with AIS and their healthy siblings and found that scoliosis caused osteopenia and osteoporosis among the affected girls, whereas their siblings had higher BMI and bone mineral density [17]. Nonetheless, some researchers failed to find any significant association. A study screened 3,631 children and found that height and weight in nonscoliotic children were not statistically different from their scoliotic counterparts [16]. In addition, Dangerfield et al. even reported an inverse result that girls with scoliosis were shorter than the healthy controls [18]. No general consensus has been reached as to these previously observed characteristic anthropometric alterations in patients with AIS.

Although body composition alterations in the patients with AIS are increasingly clarified, to our knowledge, only a few studies have investigated the difference in body composition between patients with AIS and their nonscoliotic counterparts [20,21]. Conflicting findings were reported with small sample size in these studies. Therefore, we aimed to investigate the differences in body composition alterations between patients with AIS and age- and gender-matched healthy controls based on a relatively large screening database, as well as the prevalence and curve severity of the patients with AIS according to BMI.

Methods

Design

The present observational, cross-sectional case control study received approval from the Chinese Ethics Committee for Registering Clinical Trials.

Study population

Every primary and secondary school student undergoing nine-year compulsory education in mainland China is required to receive a comprehensive medical evaluation annually granted by the National Health and Family Planning Commission of the People's Republic of China. For the purpose of early detection and management of AIS, a school screening of AIS was undergoing parallelly with the annual medical evaluation among students aged 10–16 years in Wuxi City, Jiangsu Province. All schools were enrolled, with no special consideration for geographic, economic, or ethical representation. Ethical approval was obtained, and informed written consent was also obtained from all the subjects or from their legal guardians before screening.

Physical examinations and Adam's forward bending test (FBT) combined with determination of angle of trunk inclination by scoliometer were performed during a school-based screening phase. Those who had angles of trunk inclination of 5° or above were referred for radiographic examination. Participants diagnosed as the patients with AIS (Cobb angle $\geqslant$10° confirmed with the whole spine x-ray film) in our hospital were enrolled in this study. An age- and gender-matched healthy control (angle of trunk inclination $<$5° confirmed with the scoliometer) was also paired from the screening database. Subjects in both cohorts with history of congenital deformities, neuromuscular diseases, skeletal dysplasia, endocrine diseases or cardiorespiratory dysfunctions were excluded from the study.

Measurements of anthropometric parameters

Anthropometric parameters including body height, body weight, BMI, percentage of body fat (PBF), body fat mass (BFM), and fat-free mass (FFM) were measured and calculated. Body height was recorded to the nearest 0.1 cm without shoes standing against a wall-mounted ruler. Body weight was measured to the nearest 0.1 kg in light clothes without shoes. BMI was calculated as body weight in kilograms divided by body height in meters squared. PBF, the percentage of BFM by body weight, was measured with a hand-to-hand bioelectrical impedance meter (Omron Body Fat Analyzer HBF-306; Omron, Japan) [22]. BFM is the total quantity of lipids that is extracted from fat and other cells, and the FFM is the weight of the remaining components once BFM has been excluded from body weight.

Measurements of Cobb angle

Based on the standing posterior-anterior whole spine x-ray film, the inclination of the end vertebrae, and indirectly the magnitude of the curve, is assessed by measuring the Cobb angle. The Cobb angle is formed by the inclination of the upper end plate of the upper end vertebra and the inclination of the lower end plate of the lower end vertebra. The final diagnosis of scoliosis, as defined by the Scoliosis Research Society [23], was based on Cobb angles of 10° or more measured by two independent observers (N. S. and T. W.). The intraobserver correlation coefficient in measuring the Cobb angle was 0.954 (95% CI: 0.932-0.976).

Data stratification

All the subjects enrolled in this study were classified according to the age-and-sex growth charts developed by the US Centers for Disease Control and Prevention: underweight (BMI $<$5th percentile), normal weight (BMI $\geqslant$5th and $<$85th percentile), overweight (BMI $\geqslant$85th and $<$95th percentile), and obesity (BMI $\geqslant$95th percentile) [24].