available at http://www.tzuchimedjnl.com/

Tzu Chi Medical Journal

ELSEVIER

Original Article

The Etiology of Short Stature in Children in Eastern Taiwan: A Retrospective Study

*Chien-Wen Yang[1,2], Yu-Hsun Chang[1], Chia-Hsiang Chu[1], Shao-Yin Chu[1,2,3]**

[1]*Department of Pediatrics, Buddhist Tzu Chi General Hospital, Hualien, Taiwan*
[2]*Department of Medicine, Tzu Chi University, Hualien, Taiwan*
[3]*Department of Medical Education, Buddhist Tzu Chi General Hospital, Hualien, Taiwan*

Article info

Article history:
Received: May 26, 2010
Revised: June 10, 2010
Accepted: June 30, 2010

Keywords:
Eastern Taiwan
Etiology
Short stature

Abstract

Objective: To study the etiology of short stature in children in eastern Taiwan.

Materials and Methods: This retrospective study included patients referred to Hualien Buddhist Tzu Chi General Hospital for evaluation of short stature from 2002 to 2008. Data were collected from medical records, and included body height and weight by percentile, maternal history, birth history, past medical history, relevant hematological and biochemical investigations, urinalysis, levels of growth and thyroid hormones, bone age, and genetic study.

Results: A total of 139 children were enrolled. Sixty (43.2%) were classified as having idiopathic short stature, 48 (34.5%) were attributed to underlying disease such as gastrointestinal disorder or chronic illness, 14 (10.1%) had been small for gestational age at birth and their growth had not caught up with that of their peers, 11 (7.9%) were diagnosed with familial short stature, and 6 (4.3%) were diagnosed with growth hormone deficiency.

Conclusion: Idiopathic short stature was the most common etiology of short stature in children in eastern Taiwan. The incidence of short stature attributed to underlying disease seems to be higher than in other areas of Taiwan. The percentage of small-for-gestational-age children without catch-up growth was also higher in eastern Taiwan than in other areas. (*Tzu Chi Med J* 2010;22(2):87–89)

*Corresponding author. Department of Pediatrics, Buddhist Tzu Chi General Hospital, 707, Section 3, Chung-Yang Road, Hualien, Taiwan.
E-mail address: chu_chu@tzuchi.com.tw

1. Introduction

Short stature is a common health care issue with diverse etiologies. It causes not only physical but also psychological problems in children (1). Identifying the underlying etiology is crucial for early prevention and treatment.

The population of eastern Taiwan has a relatively diverse ethnic background and many people are from the lower socioeconomic classes. Health care resources

are often located far from patients' homes. The etiology of short stature may be different from that in other parts of Taiwan. The aim of this study was to investigate the etiology of short stature in children in eastern Taiwan.

2. Materials and methods

Subjects who were diagnosed with short stature (ICD-9 code "784.3: lack of normal physiological development") in the outpatient clinic of Hualien Buddhist Tzu Chi General Hospital between January 2002 and April 2008 were included. Short stature is defined as a body height under the 3rd percentile according to the growth chart (2). Subjects were excluded if they had fewer than three outpatient follow-ups, had purely psychomotor delay, or had been small for gestational age (SGA) at birth but had caught up to their peers by the age of 2 years. Analytic data included age at diagnosis, maternal history, birth history, past medical history, sequential body height and weight growth at different ages, bone age, and laboratory data including complete blood count, biochemistry study, hormone tests, urinalysis, and karyotyping.

Etiology was categorized into five major groups: normal variants of growth; SGA without catch-up growth; hormone deficiency; underlying disease; and idiopathic short stature (ISS). Normal variants of growth were further categorized into familial short stature (FSS) and constitutional delay of growth and puberty (CDGP). FSS was defined as short stature on the height percentile which was within the normal range after correction for parents' height. CDGP was defined as short stature with normal growth velocity, but delayed bone age and puberty. SGA was defined as a birth weight less than the 3rd percentile (3). SGA without catch-up growth was defined as a birth weight less than the 3rd percentile with a body height less than the 3rd percentile at the age of 2 years. A detailed maternal history was reviewed in those with SGA without catch-up growth. Children whose growth velocity was less than 4 cm/year, who had age-specific low serum IgF-1, and who had 2 years delayed bone age after at least 6 months of follow-up received exercise tests to screen for growth hormone deficiency. They were admitted to hospital if growth hormone was less than 10 ng/mL on a growth hormone provocation test. ISS was defined as short stature in which the cause could not be determined from the available data. All data were analyzed using Microsoft Excel.

3. Results

A total of 139 children were enrolled. The ratio of girls to boys was 3:2 (82:57). Seventy-seven children (55.4%) were diagnosed before the age of 6 years. The five main categories of short stature are listed in Table 1. ISS was diagnosed in 60 (43.2%) cases and was the most common cause of short stature in eastern Taiwan.

Forty-eight (34.5%) children were found to have underlying disease (Table 2). Among them, 23 cases were associated with neuromuscular disorders, including epilepsy and cerebral palsy. Four children were diagnosed with malnutrition, three with iron deficiency anemia and one with zinc deficiency. Four children had chromosomal anomalies, including two with Down syndrome, one with fragile X syndrome, and one with microdeletion of chromosome 3p. Four children were

Table 1 — Etiology of short stature in 139 eastern Taiwanese children

	n (%)
Idiopathic	60 (43.2)
SGA without catch-up growth	14 (10.1)
Presence of underlying systemic disease	48 (34.5)
Normal variants of growth	11 (7.9)
FSS	5
CDGP	6
Growth hormone deficiency	6 (4.3)

SGA=small for gestational age; FSS=familial short stature; CDGP=constitutional delay of growth and puberty.

Table 2 — Underlying systemic diseases in eastern Taiwanese children with short stature

	n (%)
Neuromuscular disorders	23 (47.9)
Epilepsy	12
Cerebral palsy	9
Congenital muscle atrophy	1
Sturge-Weber syndrome	1
Gastrointestinal disorders	8 (16.7)
Micronutrient deficiency	4
Megacolon	2
Enterocolitis	1
Biliary atresia s/p Kasai procedure	1
Genetic diseases	8 (16.7)
Multiple congenital anomalies	4
Chromosome defect	4
Tumors	4 (8.3)
Neurofibromatosis	2
Neuroblastoma	1
Wilms' tumor s/p chemotherapy	1
Metabolic diseases	2 (4.2)
3-methylglutaconic aciduria	2
Hematologic disorders	1 (2.1)
Thalassemia	1
Miscellaneous	2 (4.2)
Congenital cystic adenomatoid malformation	1
Hypereosinophilia	1
Total	48 (100)

also diagnosed with multiple congenital anomalies without chromosomal abnormalities or known major systemic diseases. No cases of Turner syndrome or Prader-Willi syndrome were found in this study. One case of hypereosinophilia was detected; however, no drug reaction or parasite infection was noted.

Fourteen children (10.1%) were diagnosed with SGA without catch-up growth. Maternal prenatal smoking and alcohol consumption were found in nine (64.3%) and eight (57.1%) cases, respectively.

Among those with normal variants of growth, five (3.6%) children had FSS with a normal-corrected height percentile, normal annual growth velocity, normal laboratory studies and normal bone age study. Six (4.3%) children were diagnosed with CDGP with delayed bone age, and it was estimated that their final height would reach their genetic height. All of them are currently being followed-up.

Twenty-nine children underwent growth hormone provocation tests. Six (4.3%) were diagnosed as having growth hormone deficiency and none of them was found to have hypothalamic-pituitary lesions. All of them were referred from school nurses. No cases of hypothyroidism were found in this study.

4. Discussion

ISS was the most common cause of short stature in eastern Taiwan, while normal variants of growth such as FSS and CDGP were the main causes in western Taiwan [4] and Pakistan [5]. The different results imply that lifestyle, as well as genetic and environmental factors play more pivotal roles in eastern Taiwan.

There was a lower prevalence of growth hormone deficiency compared with western Taiwan [4] and Pakistan [5]. No pituitary lesions or underlying malignancies were found in this population, perhaps because of the small population base or undetected cases. Continuous investigations are indicated. In this study, 83.3% of patients with growth hormone deficiency were boys, which has not been previously reported. The significance needs further clarification.

The percentage of children with SGA with poor progression (10.1%) was much higher than in western Taiwan (1.4%) [4] and Pakistan (4.2%) [5]. The etiology may be related to prenatal factors such as exposure to smoking and maternal alcohol consumption [6,7]. Thirty-eight children (including 40% of our SGA cases) were lost to follow-up from the outpatient clinic, which implies that psychosocial and economic issues, and difficulty reaching medical resources, should be addressed in this area.

Our study found many underlying chronic diseases that resulted in short stature. The mechanisms involved in short stature may be related to underlying disease or be multifactorial without one specific cause. Malnutrition seems to be one of the most common causes reported. Deficiency of micronutrients, long-term gastrointestinal disturbance [8], cerebral palsy [9], side effects of chemotherapy [9], tissue hypoxia, and iron overload related to endocrine complications have been reported [10]. In our patients, 8.6% were found to have epilepsy, although the factors contributing to growth failure remain unclear. Comprehensive dietary care and intensive management of underlying disease are mandatory in patients with underlying disease.

Almost half of the children with short stature (44.6%) were discovered to have growth problems after attending primary school and were referred by school nurses. The six patients diagnosed with growth hormone deficiency were all referred by school nurses. This result indicates that we should not only continue to strengthen school nurses' abilities to survey health, but also implement policies to educate parents on their children's growth.

References

1. Zimet GD, Owens R, Dahms W, Cutler M, Litvene M, Cuttler L. Psychosocial outcome of children evaluated for short stature. *Arch Pediatr Adolesc Med* 1997;151:1017–23.
2. Chen W, Wu SF. Growth charts of Taiwanese youth: norms based on health-related physical fitness. *Mid Taiwan J Med* 2003;8:85–93.
3. Saenger P, Czernichow P, Hughes I, Reiter EO. Small for gestational age: short stature and beyond. *Endocr Rev* 2007;28:219–51.
4. Shu SG, Chen YD, Chi CS. Clinical evaluation of short children referred by school screening: an analysis of 655 children. *Acta Paediatr Taiwan* 2002;43:340–4.
5. Sultan M, Afzal M, Qureshi SM, et al. Etiology of short stature in children. *J Coll Physicians Surg Pak* 2008;18:493–7.
6. Leonardi-Bee J, Smyth A, Britton J, Coleman T. Environmental tobacco smoke and fetal health: systematic review and meta-analysis. *Arch Dis Child Fetal Neonatal Ed* 2008; 93:351–61.
7. O'Leary CM, Nassar N, Kurinczuk JJ, Bower C. The effect of maternal alcohol consumption on fetal growth and preterm birth. *BJOG* 2009;116:390–400.
8. Moshang T Jr. *Pediatric Endocrinology: The Requisites in Pediatrics*, 1st edition. St. Louis: Elsevier Mosby, 2005: 127–67.
9. Kuperminc MN, Stevenson RD. Growth and nutrition disorders in children with cerebral palsy. *Dev Disabil Res Rev* 2008;14:137–46.
10. Galanello R, Origa R. Beta-thalassemia. *Orphanet J Rare Dis* 2010;5:11.