

Are incidence and severity of clubfoot related to the season of birth?

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Background: This study was designed to determine whether the occurrence of clubfoot follows a seasonal pattern in neonates from eastern and south-eastern China and to speculate the potential etiology of clubfoot.

Methods: We reviewed 239 neonates with clubfeet during a period of 4 years as well as the monthly neonatal population of the Sixth National Population Census. Seasonal variations in terms of month of birth and severity were analyzed.

Results: The incidence of clubfoot in neonates from eastern and south-eastern China showed seasonal variations, and the incidence was higher in autumn with a reference to the average birth rate in this corresponding area. No significant difference was found in severity of clubfoot.

Conclusion: This seasonal pattern is of significant value to further understanding the etiology and pathogenesis of clubfoot in the corresponding area of China.

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Introduction

Congenital clubfoot is one of the most common lower-limb musculoskeletal abnormalities in neonates. However, the etiology of idiopathic

clubfoot is unknown but appears to be multifactorial, with genetic, environmental factors and regional heterogeneity.^[1-3] Seasonal variations may represent the predisposing genetic and environmental factors contributing to the incidence of idiopathic clubfoot.^[1,4,5] Such studies are mostly dependent on data obtained from Western countries to the present. But the data on the seasonal patterns of clubfoot in the Chinese population are poorly reported. The present study aimed to ascertain whether eastern and south-eastern neonates born with clubfeet follow seasonal patterns.

Methods

We reviewed 239 neonates with clubfeet registered in our institution. The following inclusion criteria were used: (1) diagnosis of idiopathic clubfoot; (2) date of birth varying from September 1, 2009 to August 31, 2013; (3) mothers of the neonates who lived in Eastern and South-eastern China when they were pregnant; (4) partus maturus neonates; (5) neonates of Han ethnic background. Collected data included sex, laterality, birth date, parity, maternal age, and presentation. The severity of deformity was rated by a single specialist using Pirani classification before the initiation of treatment. Four groups were established according to the four seasons: spring (March to May), summer (June to August), autumn (September to November) and winter (December to February). Eastern and South-eastern China consists of one city and five provinces: Shanghai, Zhejiang, Jiangsu, Anhui, Jiangxi and Fujian. Partus maturus was delivered at 37 to 42 weeks of gestation. We excluded the neonates who had previous treatment when we investigated monthly or seasonal variations in the severity of clubfoot. We referred the monthly neonatal populations of the mentioned city and provinces from the data of the Sixth National Population Census (November 2009 to October 2010) as the comparison data.^[6] Seasonal variations in birth month and laterality were analyzed by the Chi-square test; seasonal variations in the severity of clubfoot were analyzed by the Kruskal-Wallis test. *P* value <0.05 was considered statistically significant.

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Table 1. The number of neonates with clubfoot observed and expected at our institution during the period of 4 years

Study period	Observed	Expected
Sep 1, 2009-Aug 31, 2010	62	59.75
Sep 1, 2010-Aug 31, 2011	59	59.75
Sep 1, 2011-Aug 31, 2012	64	59.75
Sep 1, 2012-Aug 31, 2013	54	59.75
<i>P</i> value		0.8134

Table 2. Seasonal distribution of neonates with clubfoot classified by sex

Seasons	Total	Male	Female	Six areas*
Spring	65	45	20	702 958
Summer	55	44	11	673 679
Autumn	58	44	14	745 014
Winter	61	44	17	870 455
<i>P</i> value	0.8215	0.9994	0.4068	<0.01

*: Six areas include Shanghai, Zhejiang, Jiangsu, Anhui, Jiangxi and Fujian provinces. The data were collected from 2010 Population Census of the People's Republic of China.

Results

This study included 239 neonates with clubfeet, including 177 males and 62 females. The mean age at presentation was 27.5 days (range, three days to five months). In this series, 191 (80%) were first-borns at the maternal age younger than 30 years and 224 (94%) did not receive any treatment prior to referral to our hospital. Normal fetus positioning was found in 197 neonates (82%) and none of them had a positive family history of clubfoot. Bilateral clubfeet were found in 107 neonates, but unilateral clubfeet in 132 (right feet in 81 and left feet in 51). No statistically significant difference was seen in numbers of patients during the four years ($P=0.8134$) (Table 1). Table 2 shows neither seasonal variation ($P=0.8215$) nor sex-related seasonal variation ($P=0.9994$ and 0.4068) in this group of neonates. A significant difference ($P<0.01$) was observed in seasonal distribution of neonates from Eastern and South-eastern China (Table 2). With reference to the data from the Sixth National Population Census of China, we found that the peak prevalence of clubfoot appeared between September and October, and the lowest incidence rate was seen between November and December (Fig. A). Moreover, there was no monthly diversity in the severity of clubfoot ($P=0.8119$) (Fig. B).

Discussion

To our knowledge, this is the first report presenting the seasonal variation of clubfoot in Chinese neonates. In this study, the prevalence of clubfoot did not fluctuate during the period of 4 years in eastern and south-eastern China (Table 1). A monthly or seasonal variation in

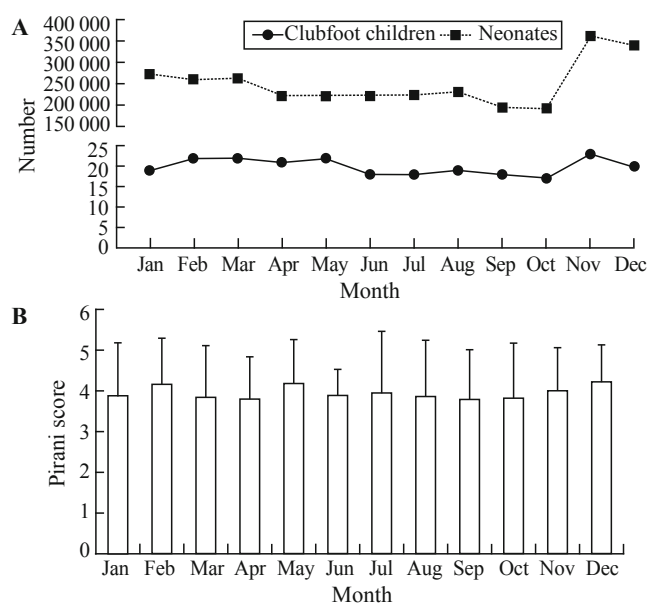


Fig. A: The graph showing the monthly distribution of neonates with clubfoot in the authors' institution during the 4-year period and the monthly distribution of neonates from the six areas during the period between November 2009 and October 2010; **B:** The graph showing the mean value of Pirani score with standard deviation per foot at the monthly interval.

incidence of clubfoot was reported previously.^[1,4,5,7] Pryor et al^[4] found that the birth rate peaked in winter in 77 neonates with clubfeet, whereas others^[5] found that July was the month of maternal conception for 330 babies with clubfoot who were treated in Washington, DC. Another two studies demonstrated that the peak incidence persisted from March to April and from January to March, respectively.^[1,7] However, seasonal variation was not found in some other studies.^[2,8-10] Results varied in different study groups because of different genetic background, environment, climate and geographical location. Recent studies have shown that both genetic and environmental factors are involved in the etiology of clubfoot.^[1-3,11-13] Han ethnic Chinese neonates with idiopathic clubfoot from eastern and south-eastern China, who have similar genetic background and similar residential environment and climate, might show identical patterns of seasonality in incidence.

No significant seasonal difference was found in the number of neonates with clubfoot. But there was a significant seasonal difference in the number of neonates from the six regions, which was higher in November and December and lower in September and October. The results of the present study showed regional patterns in neonates from Eastern and South-eastern China. This finding indicates that the neonates born in September or October may be exposed to some factors that may increase their susceptibility to clubfoot.

These factors may have a maximal effect in late winter and early spring, which roughly corresponds to the third month of gestation when the developing lower limbs are susceptible to teratogenesis. Consequently, our results could reveal a seasonal incidence rate in neonates with clubfoot, which was higher in fall. Moreover, we did not find any significant diversity in the monthly severity of clubfoot. The results of the present study revealed that the factors resulting in seasonal variation in the incidence of clubfoot might not affect the severity of clubfoot.

Clubfoot is a common disorder with unclear etiology, in which both genetic and environmental factors are probably involved.^[1-3,10-13] The patients included in the present study were Han ethnic neonates and their mothers resided in eastern and south-eastern China at pregnancy. All the patients were partus maturus neonates, most of the patients were normal positioning of the fetus and first-born. None of them had a positive family history. These findings suggested that the genetic backgrounds of our patients were similar and that some factors of seasonal diversity may be involved in the seasonal occurrence and the pathogenesis of clubfoot. It is also suggested that there may be a higher risk of exposure to exogenic factors such as pollution, noise, alcohol, tobacco and drugs in a more densely populated area, leading to a higher incidence of clubfoot.^[14-16] Some atmospheric noxious substances were found to show seasonal patterns with higher concentrations in winter, and lower concentrations in summer in Southern and South-eastern China owing to rainless climate in winter and rain scavenging in summer or monsoons.^[17,18] Our results revealed that a seasonal variation in the birth rate of neonates with clubfeet in eastern and south-eastern China, which is a more industrialized and densely populated area, may be due to the complex interaction between genetic and environmental factors. Nevertheless, the interaction between the two factors has not yet been proved.

One limitation of our study is that many neonates born with clubfeet were not registered because of the limited source of healthcare registry in China. Our institution is specialized in the field of clubfoot management using Ponseti method across China^[19] and thus a great number of patients come to seek treatment at our institution. Although the data were collected only from a single institution, the number of 239 neonates represented an appropriate sample size, which is larger than that from other similar studies.^[1,4,5,9] Moreover, it seems that the real incidence of idiopathic clubfoot in Han ethnic population might be much lower than that of other ethnic populations.^[12,20] It is supposed that our institution might have registered a predominant number of clubfoot patients in this region. Comparison of the

data of monthly neonatal populations of the six regions of China and the Sixth National Population Census showed that the findings of the present study could reveal seasonal variation in disease incidence.

There is a seasonal variation in birth rate of neonates with clubfeet from Eastern and South-eastern China. The seasonal variation might act as an indicator for genetic and environmental factors involved in the etiology of clubfoot in this part of China. Since this study was conducted in a single institution, further multi-center investigations are required to identify possible factors predisposing to clubfoot incidence in terms of seasonal variation.

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Ethical approval: The institution of authors approved the study protocol and the study was conducted in conformity with the ethical principles of international medical research institutions, and informed consent was obtained from the parents and guardians of the neonates.

Competing interest: There are no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc) that might pose a conflict of interest in connection with the submitted article.

Contributors: Zhao L designed the study. Zhao DH, Rao WW, Wu ZK and Du Q collected the data. Zhao DH, Liu JL and Wu ZK analyzed the data. Zhao DH wrote the manuscript. Zhao DH and Rao WW contributed equally to this study.

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