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The nutrient status of Chinese infants with pneumonia.

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Abstract

Recent studies have shown that zinc, iron, vitamin A and other nutrients are closely related to the body's resistance to infection. This study was aimed to investigate the nutrient status of Chinese infants with pneumonia and reveal the relationship between nutrients and the outcome of pneumonia. Total 120 infants with pneumonia and 60 healthy infants aged 6 to 36 months were enrolled in this study as diseased and control groups. Serum levels of zinc, calcium, magnesium, iron, vitamin A and vitamin D were measured, and the values were compared between the two groups. We found that the incidences of iron, zinc, and vitamin A deficiency were significantly higher in diseased group than in control group ($p<0.05$), while the incidences of calcium, magnesium and vitamin D deficiency had no significant differences ($p>0.05$). Serum levels of zinc, iron, and vitamin A were significantly lower in diseased group than in control group ($p<0.05$), while those of calcium, magnesium and vitamin D had no significant difference ($p>0.05$). In conclusion, Zinc, iron, and vitamin A deficiency were observed among Chinese children with pneumonia. Zinc, iron and vitamin A supplementation may be helpful for the prevention and treatment of infant pneumonia.

Keywords: Pneumonia; Trace elements; Vitamin; Infant; Chinese

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Introduction

Pneumonia is one of the leading diseases as a threat to the health and lives of children in China. The incidence and the mortality of pneumonia are significantly higher in childhood [1]. Infection factors are the most common causes of pneumonia and anti-infection treatment is the main approach for pneumonia therapy. Recent studies have shown that zinc, iron, vitamin A and other nutrients are closely related to the body's resistance to infection [2]. Currently, there are controversies regarding the role of nutrients in childhood pneumonia [3-5]. In this study we aimed to investigate the nutrient status of Chinese infants with pneumonia and help reveal the relationship between nutrients and the outcome of pneumonia.

Subjects and Methods

Total 120 outpatient and hospitalized infants were included in this study from October 1, 2010 to March 1, 2011, and diagnosed as pneumonia based on symptoms, signs, chest X-ray findings, sputum culture, throat swab, Mycoplasma pneumoniae serological tests. Among them, 65 were male and 55 females. They were aged 6 to 36 months (average 11.0 ± 3.8 months). There were 45 cases of bacterial pneumonia, 41 cases of viral pneumonia, 15 cases of mycoplasma pneumonia, and 19 cases of mixed infection. In addition, 60 healthy children of the same age who visited child health clinic were enrolled as controls. Among them, 32 were male and 28 female, mean age 10.6 ± 3.3 months. The study protocol was approved by Ethics Committee of Huaian No.1 People's Hospital and all parents of the enrolled subjects gave informed consent.

Fasting blood samples were collected from each subject for the separation of serum. The serum samples were tested for the contents of nutrients as follows: vitamin A was detected by Shimadzu LC-10AT HPLC; vitamin D was detected by ELISA using 25-hydroxy vitamin D test kit (IDS, UK); calcium, iron, magnesium and zinc were detected by Shimadzu AA-6300 atomic absorption spectrometer. The normal range of 25-dihydroxy vitamin D3 content was defined as 27.5-170 nmol/ml. Serum level of 25-hydroxy vitamin D3 at 25-27.5 nmol/l was defined as vitamin D insufficiency, and below 25 nmol/l was defined as vitamin D deficiency.

Statistical analysis

Data were expressed as mean±SD and analyzed using the SPSS version 12 statistical analysis package (SPSS Inc., Chicago, IL, USA). Examined data were assessed using the t-test, $\chi 2$, and ANOVA. P<0.05 was accepted as statistically significant.

Results

We compared the incidences of nutrient deficiency in diseased and healthy control groups and found that the incidences of iron, zinc, and vitamin A deficiency were significantly higher in diseased group than in control group (P<0.05). However, the differences in the incidences of calcium, magnesium, and vitamin D deficiency were not significant between the two groups (P> 0.05) (Table 1).

Next we compared serum nutrient contents in diseased and control groups. The results showed that serum zinc, iron, vitamin A levels were significantly lower in diseased group than in control group (P <0.05), while serum calcium, magnesium and vitamin D levels showed no significant differences in two groups (P> 0.05) (Table 2).

Because previous studies have shown that vitamin D deficiency was associated with severe acute lower respiratory infection in children under 5 years [6], we further selected 40 cases of asthmatic pneumonia from diseased group and compared serum vitamin D levels between them and control group. The resuls showed that serum vitamin D level was 54.46±30.16 nmol/L in children with asthmatic pneumonia, significantly lower than that in control group (67.70±34.39 nmol/L) (P<0.05).

Table 1. *The incidences of nutrient deficiency*

Groups	Zinc deficiency	Iron deficiency	Vitamin A deficiency	Calcium deficiency	Magnesium Deficiency	Vitamin D deficiency
Diseased group	37.09%	35.36%	46.59%	18.26%	8.07%	22.47%
Control group	20.08%	18.76%	25.08%	17.09%	6.01%	18.33%
χ^2	4.15	4.32	5.81	0.01	0.12	0.45
P	<0.05	<0.05	<0.05	>0.05	>0.05	>0.05

Table 2. *Comparison of serum nutrient levels in diseased and control groups*

Groups	Zinc (µmol/L)	Iron (µmol/L)	Vitamin A (µg/L)	Calcium (mmol/L)	Magnesium (mmol/L)	Vitamin D (nmol/L)
Diseased group	16.0±3.56	19.9±4.79	365.7±35.3	2.35±0.68	1.10±0.55	66.5±32.0
Control group	23.2±4.05	25.1±5.07	451.1±32.1	2.40±0.73	1.12±0.62	67.7±34.3
t	15.823	6.653	2.137	0.268	1.859	0.0312
P	<0.05	<0.05	<0.05	>0.05	>0.05	>0.05

Discussion

The normal function of human immune system is affected by many factors, including nutrition which plays an important role in the maintenance of immunity. To our knowledge, this is the first study that systematically analyzed the nutrient status in children with pneumonia, which is usually related to the failure of immune system to defend infection.

Our results showed that the incidence of vitamin A deficiency was significantly higher while serum vitamin A level was significantly lower in infants with pneumonia than in healthy control group. These results are consistent with previous findings that vitamin A is beneficial to boost the immune system [7]. Vitamin A is an indispensable factor in T cell growth, differentiation and activation [8]. In addition, vitamin A promotes the maturation of B-lymphocyte function and increases the ability to secrete antibodies. Vitamin A also stimulates the production of interleukin 1, 2, 4, to enhance immune cell function [9].

Furthermore, retinoic acid could protect lung epithelial cells against lung inflammation mediated by TNF-α [10]. In fact, previous data have proved that the incidence of vitamin A deficiency is significantly higher in children with respiratory tract infection than in normal children [11,12].

In this study we also found that the incidences of zinc and iron deficiency were significantly higher and serum zinc and iron levels were significantly lower in infants with pneumonia than in healthy children. As trace elementys, zinc and iron play an important role in maintaining the structure and function of central immune organs (thymus, bursa) and peripheral immune organs (lymph nodes, spleen, tonsils) [13]. Zinc deficiency leads to the inactivity of the enzymes invlolved in nucleic acid synthesis such as thymidine kinase. Consequently, DNA replication, RNA and protein synthesis get disrupted. In addition, zinc deficiency can cause a decline in thymic hormone activity, resulting in reduced immune function [13]. Indeed, zinc deficiency has been reported in HIV infected Ugandan children aged 1-5 years [14].

Iron is essential for the function of iron proteins that play a role in the innate immune response, such as hepcidin, lactoferrin, siderocalin, haptoglobin, hemopexin, Nramp1, ferroportin and the transferrin receptor [15]. Iron deficiency leads to reduced immunity and increases the incidence of infection. Collectively, these data suggest that zinc and iron deficiency in children may contribute to the development of pneumonia by increasing the chance of infection.

Interestingly, we found that serum vitamin D level was not significantly different between children with pneumonia and healthy children. However, vitamin D insufficiency is relatively frequent in children with asthma. In these children, lower vitamin D level is associated with increased allergy and asthma severity [16]. Therefore, we compared children with asthmatic pneumonia with healthy children and found that serum vitamin D level was significantly lower in children with asthmatic pneumonia than in control group. These results confirm that vitamin D deficiency is an important risk factor for asthmatic pneumonia in children.

In conclusion, this study shows lower levels of zinc, iron, and vitamin A among Chinese children with pneumonia. Zinc, iron and vitamin A supplementation may be helpful for the prevention and treatment of pneumonia in infants.

Competing interests

The authors declare that they have no competing interest.

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