Reports of Biochemistry & Molecular Biology
Vol.5, No.1, Oct 2016

Original article

www.RBMB.net

Trace Elements Status in Sera of Patients with Allergic Asthma

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Abstract

Background: Asthma is a multifactorial disease and its severity varies with the inflammatory grade. There are conflicting reports about the roles of trace elements in asthma. This study examined the effects of zinc (Zn), copper (Cu), and selenium (Se) concentrations in sera of patients with allergic asthma attending Ghaem Hospital, Mashhad, Iran.
Methods: Forty-nine patients, aged 10 to 50 years, with asthma in moderate or severe stages, and 24 healthy controls, were enrolled in this study. After demographic data collection and clinical evaluations, the subjects' serum concentrations of Zn, Cu, and Se were measured via atomic absorbency.
Results: Mean serum levels of Zn and Se in patients with allergic asthma were lower than in the healthy control group, but the Cu concentration in sera of patients with allergic asthma was slightly higher than healthy controls.
Conclusions: Low levels of trace elements, specifically Zn, may have a role in the pathogenesis of allergic asthma; replacement of these elements may be an effective treatment.

Keywords: Asthma, Hyper sensitivity, Trace elements

Introduction

Asthma is a common chronic disease with high morbidity and mortality rates that often lead to emergent visits and hospitalization (1). The reasons for the incidence and severity of this condition and its dramatic increase in prevalence over the last 20 years are not well understood, but could be due to genetic susceptibilities and/or environmental, economic, and nutritional factors (2, 3).

However, as allergy appears to be an important predictor of asthma, it is likely the factors that protect against allergy may be important in asthma prevention (4). One of a number of environmental factors that has been proposed as a reason for the escalation in asthma prevalence is a decreasing intake of dietary antioxidants, and some observational studies have shown significant associations between asthma and antioxidants, such as vitamins C and E (5, 6).

Recently, it has been hypothesized that essential elements may play important roles in asthma genesis since they take part in oxidative stress reactions as cofactors of antioxidant enzymes. Antioxidant and trace element deficiencies seem to be important factors in this regard (7).

Recent studies, according to models of experimental antigen challenge and clinical and preclinical findings, showed that asthma attacks correlate with immediate release of high levels of reactive oxygen species (ROS), including superoxide and hydrogen peroxide (H_2O_2), which as free radicals can affect asthma status and may intervene with the late asthmatic response. Recent experimental models and clinical studies of asthma indicate some mechanistic link between intermittent excessive oxidative processes and various inflammatory diseases, especially asthma (8).

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Received: Nov 1, 2015; Accepted: Jan 8, 2016

Pathophysiology of asthma, bronchial airway, and lung inflammation can result from a lack of, or failure to, activate antioxidants, or from a lack of their reactivity with enzymes. Serum superoxide dismutase (SOD) activity is dramatically lower in people with asthmatic lungs than in normal people. It has been hypothesized that CuZnSOD activity and asthma are related (9). Although the cause of the greater than 50% reduction of SOD activity in asthma is unclear, it is thought that alterations in MnSOD and CuZnSOD are involved (10, 11).

Because asthma has been demonstrated to involve increased oxidative stress, trace elements, including copper (Cu), selenium (Se), and zinc (Zn) have been hypothesized to play important roles in the pathogenesis of asthma. However, significant associations between their status and the prevalence or severity of asthma have not been consistently demonstrated in human studies. Despite numerous investigations of trace elements and their enzymes in asthma, the relationship is not well understood. This investigation highlights both the complex etiology of human asthma and the inherent problems with the investigated trace elements.

The aim of our work was to determine and compare the concentrations of the trace elements Cu, Se, and Zn in sera of patients with moderate and severe allergic asthma and healthy controls.

Materials and Methods

Study population

The study was conducted in 2012 at the Allergy Research Center, Ghaem Hospital, Mashhad, Iran. The enrolled population included 49 allergic asthma patients and 24 controls between 10 and 50 years of age. The study was approved by the Ethics Committee of Mashhad University of Medical Sciences, Mashhad, Iran, and all subjects signed informed consent forms. All the patients were examined by two allergists, underwent spirometry to check their asthma, and received skin prick tests for aero-allergens. They all fulfilled the criteria of persistent asthma based on the asthma guidelines. Asthma severity was evaluated on the basis of the Expert Panel Report 3 (EPR3) guidelines (12). Their asthma was confirmed according to EPR3 criteria for at least a six-month history of moderate to severe asthma. The individuals with metabolic diseases, malnutrition, or histories of consuming vitamins or mineral supplements were excluded from the study. Data reported in the checklist included age, gender, family history, and supplement consumption for both the healthy control and patient groups. Healthy individuals with histories atopy in their life, and patients with vitamin or mineral supplement consumption since the first asthma attacks were excluded. Because patients were referred from different clinics, we lacked accurate patient histories and based our information on patient statements.

Biochemical Analysis

Peripheral blood was obtained from the subjects and their sera were isolated. Serum Se, Cu, and Zn concentrations were determined by an atomic absorption spectrophotometer (Yang Lin, Korea).

Statistical Analysis

Data were analyzed with SPSS version 16 (New York, USA), and the means and standard deviations (Mean ± SD) were reported. The comparisons between the groups were performed using analysis of variance or Student's t-test and χ^2 test. The *P* value was considered significant below 0.05.

Results

Demography

The mean ages and standard deviations of the patients and controls were 35.6 ± 10 and 37.3 ± 11, respectively. The difference between the two groups' ages was not statistically significant. Forty-seven % of the patients were male and 53% were female, while 54% of the controls were male and 46% were female data about the population who were enrolled in this investigation reported in table 1.

Table1. Report of patients and healthy subject details of number and gender, who were enrolled in this investigation

		Patients	Healthy
Sex	Male	23 (47%)	11 (46%)
	Female	13 (54.2%)	26 (53.1%)
Total		49 (100.0%)	24 (100.0%)

Se assay

The serum Se concentration of patients with allergic asthma was lower than that of the healthy control group, but the difference was not significant (Table 2). The mean Se concentrations in male and female patients in comparison with healthy control group can be seen vividly in Fig 1by details; although its concentration in both genders was not statistically different. Also, no significant difference in Se serum concentration was found between patients with moderate and severe allergic asthma (121.5 ± 23.7 µg/L and 121.3 ± 17.3 µg/L, respectively).

Table 2. Se, Zn, and Cu concentrations in sera of allergic asthma patients and healthy control groups

Trace elements	Concentration in sera (mean ± SD) (µg/L)	
	Patients	Healthy
Se	121.5 ± 21	127 ± 19
Cu	998.4 ± 199.5	949.3 ± 223
Zn	831 ± 120	910 ± 116

Zn assay

The serum Zn concentration was significantly lower in patients than in the healthy control group (Table 2). Both genders in the patient group had lower Zn concentrations than those in the control group (Fig. 2). Serum Zn concentrations were not significantly different between patients with moderate and severe allergic asthma (1001.9 ± 166 µg/L and 993.7 ± 241 µg/L, respectively).

Cu assay

The Cu concentration in sera of patients with allergic asthma was higher than that of the healthy control group, but the difference was not significant (Table 2). No significant difference was seen between males in the two groups if genders considered distinctly, but the Cu concentration in female patients was significantly higher than that of females in the healthy control group (Fig. 3). On the other hand, the serum Cu concentrations in patients with moderate and severe asthma were 1002 ± 166 and 994 ± 241 µg/L, respectively. This difference was not significant.

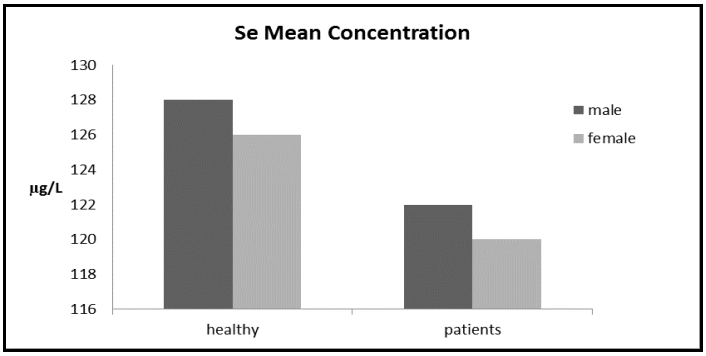

Fig. 1. Se concentrations in sera of patients with allergic asthma and healthy control groups, genders were considered distinctly. The Se concentration in male and females of healthy group was higher than patients both gender but not statistically was not significant. *P* value>.01

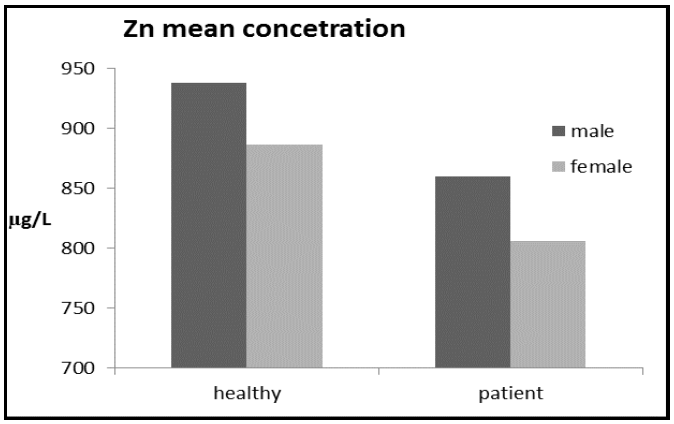

Fig. 2. Zn concentrations in sera of patients with allergic asthma and healthy control groups, both genders in two groups were distinctly calculated. The Zn concentration in male and females of healthy group was higher than patients in both gender and it was statistically significant. P value>.01

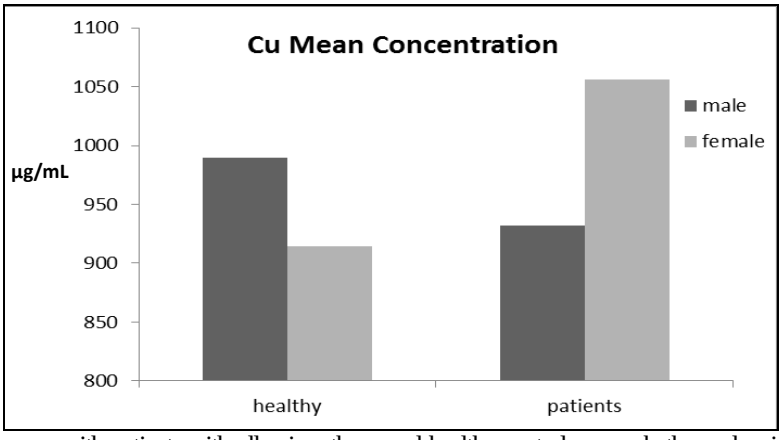

Fig. 3. Cu concentrations in sera with patients with allergic asthma and healthy control groups both genders in two group were distinctly calculated. The Cu concentration in females of patients group was higher than healthy group and it was statistically significant. *P* value>.01

Discussion

Asthma is a chronic disease with airway inflammation characterized by reversible airflow obstruction. One outcome of asthma is bronchial hyper-responsiveness (13). Because trace elements play key roles in inflammation, they may affect asthma status (14).

In our study, no significant differences were found for serum Se concentrations between healthy controls and patients with allergic asthma. This result agrees with previous reports that found no differences in serum Se concentrations between asthmatic patients and healthy individuals (15-17). The data also showed no difference in serum Se concentrations between moderate and severe asthmatics. These results indicate that Se has no effect on allergic asthma severity.

Zn concentrations were significantly lower in patients than in controls, although no correlation was found between Zn concentrations and disease severity. Since Zn concentrations were lower in patients with allergic asthma than in controls but no difference was seen between patients with moderate vs. severe asthma, we conclude that Zn deficiency may have a role in asthma onset but not progression (4, 18). Zn is an important trace element and its concentration is frequently used to evaluate inflammatory diseases (19). Furthermore, many studies have reported that that Zn deficiency can lead to a variety of complications, including growth retardation, delayed wound healing, chronic diarrhea, and increased susceptibility to infections (20). It can also disturb the equilibrium between types 1 and 2 T helper cells, which causes increased inflammation; the same mechanism detected in allergic airway hypersensitivity (21). A number of clinical studies have linked an increase in the incidence of asthma with low dietary Zn intake. Significant decreases in serum, plasma, and hair Zn levels have also been reported in some asthmatic individuals (22). Therefore, it is suggested that the deficiency of Zn may reduce antioxidant function and lead to increasing risk of bronchial asthma. Our data indicates that allergic asthma may be affected by low Zn levels and is consistent with data for non-allergic asthma and other inflammatory diseases (5).

Many previous studies have reported that the serum Cu concentrations in bronchial asthma patients tended to be higher than in healthy individuals (6-7). Cu/Zn-SOD is an antioxidant enzyme that contains Cu as an essential component. Our data showed that the Cu concentration in patients with allergic asthma was higher than that in the healthy control group, particularly in females. Some previous studies indicated that high Zn serum concentrations can lead to declines in both Cu/Zn-SoD and Cu concentrations, as Cu deficiency can reflect a high Zn concentration (23). So, the high serum Cu concentrations in patients in this investigation are further evidence of Cu Zn antagonism in the pathophysiology of asthma.

In conclusion, we recommend that serum analysis of trace elements, especially Zn, be considered in the workup of intractable allergic asthma, and the administration of zinc supplements

may be useful in the prevention and treatment of allergic asthma. Further studies conducted on intervention to change trace element level underlying structure function changes in asthma, and in particular in severe asthma, are needed to define the pathophysiology and biochemistry of asthma. If this paradigm holds, it will be important for the design of therapies.

Acknowledgment

This study was financially supported by the Research Deputy of Mashhad University of Medical Sciences Ethical Committee. The approval code was 86262. The authors thank laboratory of Immunology colleagues Azizolah Behjati, Kaveh Barati pour, Sedigheh Ajorkaran, and Zahra Raghimi for their collaboration. The authors declare no conflict of interest.

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