RESEARCH PAPER

Blood Lead Levels and Childhood Asthma

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Objectives: To measure blood lead levels in children (5-14 y) with bronchial asthma, and correlate with asthma severity.

Design: Cross-sectional analytical.

Setting: Pediatric Allergy and Immunology Clinic of a Children's hospital in Cairo, Egypt.

Participants: 200 children (127 males) with bronchial asthma and125 age- and sex-matched healthy controls (80 males).

Procedure: Blood lead levels were measured by atomic absorption spectrophotometer technique, and were subsequently correlated with asthma severity.

Results: No significant difference in mean (SD) blood lead levels was observed between children with asthma [13.3 (4.8) µg/dL] and control group [11.4 (3.9) µg/dL]. 190 children (58.5%) had elevated blood lead levels (>10 µg/dL), with no significant difference between patients (60%) and controls (56%). Patients with elevated blood lead levels had significantly higher frequency of eosinophilia (66.7%) and increased total immunoglobulin E (83.3%) compared to other patients with blood lead levels <10 ìg/dL (10% and 43.8%, respectively). Patients of asthma with elevated blood lead levels had higher grades of severity of asthma compared to those with blood lead levels <10 µg/dL.

Conclusions: Blood lead levels are not significantly associated with diagnosis of asthma but elevated blood lead levels seem to be associated with increased asthma severity and higher frequency of eosinophilia and elevated immunoglobulin E levels.

Keywords: *Bronchial asthma, Eosinophilia, Lead poisoning, Risk factors*.

Lead poisoning and asthma are common pediatric health problems. Both diseases have environmental mechanisms and some risk factors for both diseases are similar. Lead paints are a primary source for lead poisoning [1], and there is evidence that exposure to household allergens increases asthma morbidity [2]. Household dust is an important source for both lead and allergens [3]. Lead exposure alters immune system components and is associated with increased production of immunoglobulin E (IgE) [4]; it also depresses the activity of several enzyme systems that influence cellular reducing capacity and consequently may increase asthma risk [5].

We hypothesized that exposure to lead is one of the environmental risk factors for bronchial asthma among children living in urban overcrowded areas. This study was designed to measure the blood lead level (BLL) among a sample of children with asthma living in an urban slum area, and to correlate it with asthma severity.

METHODS

This observational, cross-sectional study was conducted at the Pediatric Allergy and Immunology Clinic, Ain Shams University, Children's Hospital, Cairo, Egypt, during the period May 2011 to October 2012. This clinic serves infants and children in Abbassia (lower-middle-class urban district in Cairo). The study was approved by the Ethical Committee of the Pediatrics Department, Faculty of Medicine, Ain Shams University. An informed consent was obtained from the parents or caregivers of each child before enrolment in the study.

The patient group included 200 children (127 males) aged 5-14 years, with bronchial asthma diagnosed clinicaly according to GINA (2010) criteria (clinical symptoms of episodic wheezing, chest tightness and dyspnea that improved at least partially after bronchodilator therapy [6]. Asthma severity was classified according to the National Asthma Education and Prevention Program, 2007 [7].

One hundred and twenty-five apparently healthy children males) without personal or family history of asthma or other atopic conditions (atopic dermatitis, allergic rhinitis or allergic conjunctivitis) were included as controls. They were recruited from the outpatient clinic among those attending for preoperative assessment for elective surgeries such as tonsillectomy and adenoidectomy. A part of the blood sample collected for pre-operative assessment of controls was used for the study. Written informed consent was obtained from

parents or guardians who accepted to participate in the study. We excluded patients and controls with other respiratory diseases.

Socio-demographic information included age, gender, parents' education, parents' occupation and parental smoking. Parents' education was graded as non-educated (illiterate), under-moderate (primary or preparatory education), moderate (secondary education) and high (university graduation or postgraduate). Environmental and behavioral factors included parental smoking, eating canned food, drinking canned juice, putting colored toys in the mouth, using colored pencils, use of toothpaste, and use of newspapers in food preparation wrapping, preserving, or as table mats. Chest examination was performed to assess degree of clinical severity and to exclude acute respiratory infection. In all subjects, 3 mL of venous blood was collected. The blood count was performed using the Coulter counter (Coulter micro DIFF 18, CA, USA). The differential leukocyte counts were estimated manually from the blood film and expressed in absolute count values. Eosinophilia was considered when the absolute eosinophil counts exceeded the normal reference values for age [8]. Serum total immunoglobulin E (IgE) was measured by quantitative enzyme immunoassay (Biocheck, Inc 323 Vintage Park Dr. Foster City, CA 94404) based on solid phase ELISA. Total IgE was considered high when it exceeded the upper limit of the normal range for age (60 IU /mL for children younger than 6 years, 90 IU /mL for 6-8 years and 200 IU /mL for children older than 8 years) [9]. Blood lead level (BLL) was measured by atomic absorption spectrophotometer technique [10]. According to the Centers for Disease Control and Prevention, elevated BLL was considered when it was >10 µg/dL [1].

TABLE I COMPARISONS BETWEEN CHILDREN WITH ASTHMA AND CONTROL GROUP REGARDING DIFFERENT VARIABLES

Variable	*Asthma (n=200)*	*Controls (n=125)*	*P*
Age (in years)	7.4 (3.5)	7.4 (2.3)	0.460
BLL (ug/dL)	13.3 (4.8)	11.4 (3.9)	0.191
#Gender: Male	127 (63.5)	80 (64)	0.675
#Parental Smoking	93 (46.5)	38 (30.4)	0.233
*#High BLL	120 (60)	70 (56)	0.582

*BLL: blood lead level.*High BLL was considered above 10 µg/dL Values in mean (SD) or #No. (%).*

TABLE II ASTHMA SEVERITY PARAMETERS AND BLOOD LEAD LEVELS IN STUDY SUBJECTS [NO. (%)].

Variable	*BLL >10µg/dL (n = 120)*	*BLL<10µg/dL (n = 80)*	*P*
Severity of asthma			
Mild intermittent	24 (40)	36 (60)	0.021
Mild persistent	54 (60)	36 (40)	
Moderate persistent	28 (82.4)	6 (17.6)	
Severe persistent	14 (87.5)	2 (12.5)	
Eosinophilia	80 (66.7)	8 (10)	<0.001
High total IgE	100 (83.3)	35 (43.8)	<0.001

Statistical Analyses: The data were coded and analyzed with the Statistical Package for Social Sciences (version 20; SPSS Inc, Chicago, III). Student t test was used for parametric quantitative variables, and chi-square test was used to compare frequency of qualitative variables among the different groups. Backward likelihood ratio technique for binary logistic regression model was used to find out independent predictors of elevated BLL. The covariates included in the regression model were parental smoking, eating canned food, drinking canned juice, putting colored toys in the mouth, using colored pencils, use of toothpaste and use of newspapers for handling food. For all analyses, the level of significance was set at $P< 0.05$.

RESULTS

One hundred and ninety children (58.5%) had elevated BLL (BLL ≥10 ug/dL), with no significant difference between patients (60%) and control group (56%) (***Table* I**). Patients with elevated BLL had significant increase in the severity of asthma, higher frequency of eosinophilia, and higher total IgE compared to other patients with BLL below 10 µg/dL (***Table* II**).

Regarding sociodemographic risk factors for elevated BLL among all studied children, low mother's education and low father's education were significantly associated with elevated BLL. Gender, mother's occupation and father's occupation were not associated with elevated BLL (***Table* III**).

Parental smoking, putting colored toys in the mouth, using colored pencils, eating canned food, use of newspapers for handling food and use of toothpaste were associated with elevated BLL (***Table* III**).

DISCUSSION

In this study, we found that elevated BLL among patients with asthma was associated with higher frequency of eosinophilia and increased total IgE, and with a significant increase in the severity of asthma compared to the patients with asthma with BLL <10µg/dL.

Previous studies have suggested that lead exposure alters immune system components and is associated with

WHAT IS ALREADY KNOWN?

- Lead poisoning and asthma are affected by the environment and substandard housing conditions.

WHAT THIS STUDY ADDS?

- Elevated BLL (≥10 µg/dL) is significantly associated with increased severity of childhood asthma.

many steps in the pathophysiology of increased bronchial hyper-responsiveness [11-14]. The relatively higher frequency of elevated BLL in our study compared to the previous studies done in Cairo, Egypt [15,16] can be explained by recruitment of children from high risk areas for lead contamination in our study.

In our study, we did not find a significant difference between patients and control group regarding the mean BLL. Previous researchers have also reported that elevated BLL and chronic exposure to lead was not associated with the risk of developing asthma [17,18]. On the other hand, association between exposure to lead and bronchial asthma was demonstrated by some studies [4,19,20]. The young age of included children and high frequency of elevated BLL among studied population may explain the inconsistency between our results and results of these studies.

TABLE III SOCIO-DEMOGRAPHIC AND OTHER RISK FACTORS FOR ELEVATED BLL AMONG ALL STUDIED CHILDREN

Risk factors	*BLL≥10µg/dL N = 190*	*BLL<10µg/dL N = 135*	*P*
Mother's education			
Non educated (42)	37(88.1)	5 (11.9)	< 0.001
High (85)	35 (41.2)	50 (58.8)	
Father's education			
Non educated (40)	33 (82.5)	7 (17.5)	
High (85)	30(35.3)	55 (64.7)	
Parental smoking (175)	120 (68.6%)	55 (31.4%)	0.032
Putting colored toys in mouth (230)	175 (70.1%)	55 (23.9%)	<0.001
Using colored pencils (287)	182 (63.5%)	105(36.5%)	<0.001
Eating canned food (277)	182 (65.7)	95 (34.3)	<0.001
Use of newspapers			
During food preparation (195)	150 (76.9)	45 (23.1)	<0.001
In wrapping & preserving food (140)	110 (78.6)	30 (21.4)	<0.001

Our study has some limitations. As a cross sectional study, the BLL is primarily an indicator of recent exposure. For environmental risk factors, the study relied on reporting by parents; the specific products and environments were not directly tested for presence of lead.

In conclusion, although elevated BLL had no significant correlation with asthma diagnosis, it was significantly associated with increased asthma severity.

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