SHORT COMMUNICATION

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Association between blood levels of lead, blood pressure and risk of diabetes and heart disease in workers

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Abstract Background: Previous studies have supported the association between high levels of blood lead levels (BLL) and elevated blood pressure. In addition, significant correlations between BLL and a variety of risk factors for blood pressure and diabetes mellitus have been well-established. Objective: To examine the relationship between BLL, blood pressure and diabetes as well as other selected social and biochemical factors, among workers in the United Arab Emirates (UAE). Methods: This comparative study included 110 industrial workers (exposed to lead in the workplace) and 110 non-industrial workers (not exposed); all were recruited in the city of Al-Ain, Abu Dhabi, UAE and the groups were evenly matched for age, gender and nationality. Results: The industrial workers had a significantly higher mean of BLL (median 81 and geometric mean (GM) 62 µg/dl) than did non-industrial workers (median 11 and GM 13 µg/dl). In the present study, the lead-exposed group also had significantly higher blood lead levels, body-mass index (BMI), systolic and diastolic blood pressures, fasting blood glucose and plasma levels of total cholesterol, lactate dehydrogenase and uric acid than did the non-exposed group. Furthermore a significant correlation between BLL and systolic blood pressure was observed. Conclusion: The study supports the hypothesis of a positive association between lead exposure, high blood pressure and risk of diabetes and heart disease.

Key words: Blood lead · Exposed · Unexposed · Hypertension · Diabetes · Heart disease · UAE

Introduction

The United Arab Emirates (UAE), like many other developing countries, has witnessed a rapid development in many aspects of life during the past two decades (Bener et al. 1996). In the UAE, pollution from lead is a relatively new phenomenon and has been associated primarily with the growth of industry and the expanding use of motor-vehicles for transport (Bener et al. 1999). Currently, therefore, environmental and occupational pollution from lead is an important concern in the UAE as well as in neighboring Arabian Gulf Countries.

Results of previous studies have supported the association between blood lead and blood pressure (Cramer and Dahlberg 1966; Beever et al. 1976; Pocock et al. 1984; Menditto et al. 1994; Pikle et al. 1985; Apostoli 1998). In addition, significant correlations between blood lead and a variety of risk factors for cardiovascular disease (CVD) such as hypertension (Wu et al. 1996; Schwartz 1988; Weiss et al. 1986), and diabetes mellitus (DM) have been well-established (Harlan et al. 1985; Hayashi et al. 1999); Schwartz 1995; DeFronzo 1997; Bener et al. 2000).

The aim of the present study was to examine the relationship between blood lead, blood pressure and diabetes taking into account selected social and bio-

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chemical factors among industrial and non-industrial workers in the UAE.

Materials and methods

Study design

This cross-sectional study included 110 industrial workers (exposed to lead in the workplace) and 110 non-industrial workers (control or not-exposed) who were evenly matched for age, gender and nationality. The workers were recruited from the Preventive Medicine Department, Ministry of Health, for a periodic routine medical check-up or health examination in Al-Ain, UAE, and the study was conducted between January and June 1999. The inclusion criterion was a minimum of 3 years of employment in the same job. Using a questionnaire and an interview in a clinical setting, we gathered information on socio-demographic status, employment history, physical activity, and smoking habits.

Exposed group

This group consisted of 110 male industrial workers working in heavy industry, taxi drivers, petrol station filling and garage workers, chemical, printing, and building operatives, and workers in the metal industry or other industrial activities.

Non-exposed or control group

This group included 110 male workers working in manual jobs, such as shopkeepers, tailors, skilled or unskilled professional workers, or those in other similar jobs not exposed to lead. A slight exposure is sometimes possible because of hobbies but in these cases exposure to lead was considered negligible.

Clinical and biochemical data

A public health nurse measured the blood pressure in the right arm of study participants while the subject was in a sitting position. Three measurements were taken at 5-min intervals after the subjects had rested for 20 min. A standard mercury sphygmomanometer with a random zero device was used for all measurements. The pressures at the first and fifth Korotkoff sounds were recorded as systolic and diastolic blood pressures, respectively. The average of the three readings was used in data analysis.

After the subjects had fasted overnight, venous blood samples were collected for determination of uric acid, triglycerides, total cholesterol and HDL-cholesterol, anti-coagulated with EDTA and centrifuged for plasma preparation. Serum samples for insulin were obtained by centrifuging clotted blood and were stored at -20 °C until assayed. Serum insulin levels were determined by a solid-phase 125I radio-immunooassay kit (Diagnostic Products, USA). This assay indicated a fasting 2 SD insulin range of 0–180 pmol/l for healthy subjects. Serum glucose was determined by the glucose dehydrogenase method (Dimension clinical chemistry system, Dade International, USA). Total cholesterol and triglycerides were measured by enzymatic techniques on a Technicon Analyzer (Technicon Instruments). Measurement of HDL-cholesterol was performed by the same technique following heparin manganese precipitation of VLDL- and LDL-cholesterol. The level of LDL-cholesterol was calculated by the Friedewald et al. (1972) formula. Uric acid levels were determined with a commercial kit (Dimension clinical chemistry system, Dade International, USA).

Analysis of blood lead concentrations

For lead measurement, 2 ml of venous blood from industrial and non-industrial employees were drawn into a 5 ml polypropylene tube with sodium heparin as anti-coagulant. The whole-blood samples were thoroughly mixed at room temperature and subsequently stored at 4–8 °C before analysis. Blood lead determinations were performed at the Faculty of Science and Central Laboratories Unit, UAE University with a Philips PU 9100X (Byunikan) atomic absorption spectrophotometer (AAS) equipped with graphite furnace and Zeeman background correction system. The analytical method used followed that described by Wu et al. (1996). All specimens were analyzed three times and the average was taken when the relative standard deviation was less than 5%. The results for individual blood lead concentrations were based on the average of all measurements and are given as μg/dl whole-blood. Throughout the period of analysis, the validity of the results obtained by this procedure was documented by a quality control program (Parsons 1992).

Statistical differences between workers exposed and not exposed to lead in the workplace were estimated for two continuous variables by the t-test and the non-parametric Mann-Whitney test. For comparison of group means ANOVA was used, and for categorical variables the chi-square test was employed. Correlations were evaluated with Spearman’s rank test. The level P < 0.05 was considered to be the cut-off value for significance.

Results

Table 1 compares blood lead (BLL), socio-demographic characteristics, smoking habits and physical activity at work for lead-exposed and non-exposed workers. Industrial workers had a significantly higher mean of BLL level (median 80.9 and geometric mean (GM) 62.0 μg/dl) than non-industrial workers (median 11.0 and GM 13.3 μg/dl).

The physical and blood-chemistry characteristics of exposed and non-exposed workers are compared in Table 2. Exposed workers had higher body-mass index (BMI), systolic blood pressure, fasting glucose, total cholesterol, lactate dehydrogenase, triglycerides and uric acid than did the non-exposed group. Also, significant correlations between BLL and systolic blood pressure \( (r = 0.286, P < 0.01) \), total cholesterol \( (r = 0.239, P < 0.01) \), triglycerides \( (r = 0.368, P < 0.01) \), and fasting glucose \( (r = 0.396, P < 0.01) \) were observed.

Discussions

Lead exposure is an environmental threat to both industrial and non-industrial workers. In this study, the industrial and non-industrial workers studied are demographically similar with regard to age as well as nationality and marital status. It should be noted that most of the industrial workers were not aware of lead exposure in the workplace. In the present study, BLL for industrial workers (median 80.9 and GM 62.0 μg/dl) is higher than has been reported from studies in China (Liou et al. 1994), Taiwan (Wu et al. 1996), South Africa (Ehrlich et al. 1998), Italy (Mutti and Smargiassi 1998), and the United States (Bleecker et al. 1997). Additionally, the levels tend in the present study to exceed the WHO (1987) acceptable maximum level (48 μg/dl) for occupational lead exposure, whereas, BLL for non-industrial workers (median 11.0 and GM 13.3