Original Article

Association between Plasma Metal Levels and Diabetes Risk: a Case-control Study in China*

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Abstract

Objective Many metals, some of which have been classified as environmental endocrine disruptors, are used extensively in everyday consumer products and are ubiquitous in our living environment. In the present study, we aimed to explore the associations between the prevalence risk of type 2 diabetes and plasma levels of 20 trace elements as well as those of heavy metals in a Han Chinese population.

Methods We conducted a case-control study to investigate the associations between plasma concentrations of 20 metals and diabetes in Jiangsu province. A total of 122 newly diagnosed cases of type 2 diabetes and 429 matched controls were recruited from community physical examinations in Suzhou City of Jiangsu Province. Plasma metal levels were measured by inductively-coupled plasma mass spectrometry.

Results After adjusting for confounders, plasma vanadium, chromium, manganese, copper, zinc, arsenic, selenium, strontium, palladium, cadmium, cesium, and barium were associated with diabetes risk ($P < 0.05$). The adjusted *OR* increased with increasing concentration of vanadium, manganese, copper, zinc, and cesium.

Conclusion Many metals, including manganese, copper, zinc, arsenic, selenium, and cadmium in plasma, are associated with the morbidity of diabetes. Monitoring of environmental metal levels and further studies are urgently needed.

Key words: Metals; Diabetes; Chromium; Arsenic; Cadmium

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INTRODUCTION

One of the well-known independent risk factors for type 2 diabetes is fasting plasma glucose (FPG)[1], which may also increase the risk of cardiovascular disease (CVD)[2-4]. In recent years, epidemiological evidence has supported the idea that toxic heavy metals, including cobalt, arsenic, selenium, cadmium, iron, and copper, are associated with the prevalence of CVD[5-8]. In fact, some metals can persist in the living and working environment for several years, and some heavy metals (such as nickel, cadmium, arsenic, and argentum) even have biological half-lives of more than several years[9-11], which makes them a public health concern. Nevertheless, evidence for the association of heavy metals with diabetes or FPG is still limited or due to controversies.

Son et al.[12] found environmental exposure to cadmium in abandoned mine residents to be associated with diabetes. Barregard et al.[13] also found a significant interaction between high concentrations of blood cadmium (B-Cd) and diabetes mellitus (DM), providing support for the hypothesis that adults with DM have a higher risk of renal glomerular damage from cadmium exposure than those without DM. Shapiro et al.[14] observed dose-response relationships between four metals (lead, cadmium, mercury, and arsenic) and the incidence of gestational diabetes mellitus (GDM), only plasma arsenic levels displayed a significant association with GDM, but no statistically significant associations were observed between cadmium and GDM. A significant association was observed between cerebrovascular disease (CCVD) and urinary cobalt in a previous study in the USA[5], but in a study investigating the risk of diabetes and prediabetes among occupational workers, higher levels of urinary cobalt was associated with an increased risk of diabetes in male subjects only. Moreover, their research also uncovered significant associations between nickel, copper, and diabetes. Many of the above-mentioned chemicals are used extensively in everyday consumer products and are ubiquitous in our living environment. However, there are limited epidemiologic data regarding the risk of metabolic dysfunction associated with metal element exposure and a variety of metal levels in the blood of the Han Chinese population. Consequently, more studies are needed to confirm the observed associations and explore new findings.

Based on the above background information, we aimed to explore the associations of type 2 diabetes risk with the plasma levels of 20 trace elements as well as heavy metals in the present study, including vanadium, manganese, iron, chromium, cobalt, copper, nickel, zinc, arsenic, selenium, rubidium, strontium, ruthenium, rhodium, palladium, argentum, cadmium, cesium, barium, and lanthanum, among 551 Han Chinese adults recruited from a community physical examination clinic in Suzhou, Jiangsu Province, China.

MATERIALS AND METHODS

Study Participations

The subjects in our study were examined and recruited between April 2014 and July 2016. The source population consisted of community residents in Suzhou City. We selected both cases and controls from the same City for the reason of more similar living environment and dietary habits comparing to different cities, which may be confounders for type 2 diabetes.

The diagnostic criteria for new cases of diabetes were based on blood glucose levels, defined as random plasma glucose concentrations ≥ 11.1 mmol/L plus symptoms of diabetes, 2-hour post-load oral glucose tolerance test (OGTT) ≥ 11.1 mmol/L, or fasting plasma glucose (FPG) ≥ 7.0 mmol/L. In addition, an HbA1c ≥ 6.5% has been accepted as a diagnostic criterion for DM. Adults who were selected as newly diagnosed cases should not have been previously diagnosed with type 2 diabetes by a physician and should not be current or past users of any oral hypoglycemic drugs or insulin. However, the definitions of newly diagnosed diabetes were determined after professional medical discussions with learned and experienced endocrinologists from the physical examination center.

Each subject donated 5-mL venous blood samples for subsequent blood testing. FPG was assayed with an automated biochemical analyzer (Randox Laboratories Ltd., UK) using the enzymatic colorimetric method. Clinical laboratory technicians working in Nanjing Prevention and Treatment Center for Occupational Diseases carried out the experiment according to standard operation procedures.

Questionnaire

Subject information was collected *via* questionnaire administered by trained interviewers