Original Article

Metal Exposure and Risk of Diabetes and Prediabetes among Chinese Occupational Workers*

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Abstract

Objective To study the association between metal exposure and risk of diabetes and prediabetes among Chinese workers exposed to metals.

Methods We used data obtained from the baseline survey of the Jinchang Cohort Study of workers in Jinchang Industry, the largest nickel production company in China. A total of 42,122 workers ≥20 years of age were included in the study. A standardized, structured questionnaire was used to collect epidemiological information. Physical examinations and laboratory tests were conducted to evaluate the health status of the participants and to measure various biomarkers including blood sugar, lipids, and urinary metal concentrations. Logistic regression was used to study the association between occupational groups categorized according to the measured metal levels (office workers, low-level; mining/production workers, mid-level; and smelting/refining workers, high-level) and risk of diabetes and prediabetes.

Results The overall prevalence of diabetes and prediabetes was 7.5% and 16.8%, respectively. The adjusted odds ratios for diabetes among mining/production workers and smelting/refining workers compared to office workers were 1.5 (95% CI: 1.3, 1.7) and 3.8 (95% CI: 3.4, 4.3), respectively. No association was observed between these occupational groups and prediabetes in this study.

Conclusion Occupations associated with higher levels of metal exposure were associated with an increased risk of diabetes in this cohort. More studies are needed to confirm this observed association.

Key words: Metals; Occupational exposure; Diabetes; Prediabetes; Risk factors

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INTRODUCTION

Diabetes mellitus is a major public health and socioeconomic challenge that affects nearly all countries[1]. Every year, 3.2 million people worldwide die from complications associated with diabetes[2]. Diabetes is a metabolic disorder characterized by deficient insulin secretion or insulin receptor insensitivity that results in fasting hyperglycemia[3]. The prevalence of diabetes is likely to rise with changing lifestyles characterized by reduced physical activity and increased obesity[1,4-5]. Besides traditional lifestyle-related risk factors, environmental exposures such as heavy metals may contribute to the development of diabetes[6-7]. Thus, there is considerable interest in understanding the role of metal exposure in the development of diabetes[8].

The general population is primarily exposed to metals through the air, water, and food ingestion. Occupational exposure to metals occurs predominantly in mining, refining, alloy production, electroplating, and welding[9]. Data from animal and human studies have suggested that exposure to metals may be associated with an increased risk of diabetes. Specifically, several animal studies have reported that nickel exposure can induce hyperglycemia[10-11]. Some human studies have further demonstrated that other metals, and nickel in particular, may play a role in the development of diabetes[12-13]. Liu et al. observed that nickel exposure was associated with the prevalence of diabetes in a study of 2155 Chinese adults[7]. Lai et al. reported an association between arsenic and diabetes in a cross-sectional study of 891 subjects in Taiwan[14]. However, most of the previous population-based studies included diabetes patients that were based on self-reports, and the sample size or number of individuals with diabetes was small[8]. There have been limited large-scale population-based studies on metal exposure and risk of diabetes[7].

In order to provide additional insight into the role of occupational metal exposure on a variety of health outcomes, we initiated a large prospective cohort study of about 45,000 metal exposed workers in Jinchang city, Gansu province, China (Jinchang Cohort Study) in 2011. This study collects comprehensive epidemiological and biological data in order to understand the environmental toxicity of metal exposure and the associations between metal exposure and risk of cancer and other diseases. The current analysis used data obtained from the baseline Jinchang Cohort Study survey to explore the associations between occupational groups that were categorized according to their measured urinary metal levels and risk of diabetes and prediabetes.

METHODS

Study Population

The Jinchang Industry, the largest nickel production company in China, is a large mining group of about 45,000 workers engaged in mining, concentrating, metallurgy, and deep processing. The primary focus of the company is the smelting and processing of nickel, copper, and cobalt as well as the chemical processing of materials. The company has become the third-largest nickel and second-largest cobalt manufacturing enterprise in the world, and the third-largest copper and largest platinum group metal manufacturing enterprise in China. The rationale, design, and methods of the Jinchang cohort have previously been described in detail[15-16]. Since 2011, all workers in the company have been eligible for a medical exam every two years, which includes in-person interviews, comprehensive physical exams, laboratory-based tests, and biosample collection. Only those who participated in the medical examinations were eligible to enter the Jinchang Cohort Study. We established the Jinchang Cohort Study with a cross-sectional baseline survey from June 2011 to December 2013.

Of 46,295 workers, 44,947 (97.1%) underwent medical examinations and completed the baseline survey. Of these subjects, 42,122 (93.7%) were included in the current study; 2825 (6.3%) were excluded because they did not complete the full medical examination (including the in-person interview, physical exams, laboratory tests, and donation of a blood sample). Thus, a total of 42,122 workers with a mean age of 46±13 years (61.7% men, 38.3% women) were included in this study.

Data Collection

Several types of data were collected for analysis, including questionnaire data obtained from in-person interviews, clinical data from physical and biochemical examinations, and biosample collection. In-person interviews were conducted at the hospital by trained interviewers, who completed a standardized and structured questionnaire that