30 درصد تخفیف نوروزی ویژه کارگاه‌ها و فیلم‌های آموزشی

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پش
Respiratory Symptoms and Pulmonary Function Tests among Galvanized Workers Exposed To Zinc Oxide

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ABSTRACT

Background: Galvanization is the process of coating steel or cast iron pieces with a thin layer of zinc allowing protection against corrosion. One of the important hazards in this industry is exposure to zinc compounds specially zinc oxide fumes and dusts. In this study, we evaluated chronic effects of zinc oxide on the respiratory tract of galvanizers.

Methods: Overall, 188 workers were selected from Arak galvanization plant in 2012, 71 galvanizers as exposed group and 117 workers from other departments of plants as control group. Information was collected using American Thoracic Society (ATS) standard questionnaire, physical examination and demographic data sheet. Pulmonary function tests were measured for all subjects. Exposure assessment was done with NIOSH 7030 method.

Results: The Personal Breathing Zone (PBZ) air sampling results for zinc ranged from 6.61 to 8.25 mg/m³ above the permissible levels (Time weighted average; TWA: 2 mg/m³). The prevalence of the respiratory symptoms such as dyspnea, throat and nose irritation in the galvanizers who exposed to zinc oxide fumes and dusts. The prevalence of obstructive respiratory disease was significantly (P=0.034) higher in the exposed group.

Conclusions: High workplace zinc levels are associated with an increase in respiratory morbidity in galvanizers. Therefore administrators should evaluate these workers with periodic medical examinations and implement respiratory protection program in the working areas.

Introduction

Galvanization is the process of coating iron and steel pieces with a thin layer of zinc that causes complete protection from corrosion13. Two techniques of galvanization were done including hot dip galvanization (warm method) by passing the steel through a molten bath of zinc at the temperature of around 460 degrees Celsius. Another technique is electro galvanizing which deposits the layer of zinc from an aqueous electrolyte by electroplating. The subject of this study is warm galvanization, which has two phases. The first phase is pretreatment including the degreasing, acid pickling and fluxing. The second one is treatment in which the materials are submerged into galvanizing kettles containing molten zinc. Fume exposure is the most important hazard in this industry which contains zinc chloride, ammonium and zinc oxide (ZnO), other hazards are heavy metal fumes especially zinc and hydrochloric acid vapors.5,6

ZnO is a common constituent of particulate air pollution. Environmental exposure to zinc compounds is the result of industries such as galvanization and exhaustion of vehicles tires and other sources. Acidental inhalational exposure to concentrated ZnO (fume and dust) especially in welding foundry processes and galvanizing induces metal fume fever (MFF)7. Despite the trivial effects of MFF on respiratory function, current evidences indicate that in a long time it can causes chronic airway obstruction, for example prevalence of chronic airway obstruction in welders with repeated episodes of MFF is higher7. Zinc is a sensitizing agent and several cases of occupational asthma from exposure to galvanizing fumes were reported2,7-12. In addition, a case of urticaria and angioedema from exposure to ZnO fumes with MFF as reaction was reported13. The other case is hypersensitivity pneumonitis from zinc fumes exposure, which pulmonary function reduction persists for long terms13. High ambient air particulate matter (PM 2.5) zinc levels are associated with number of asthma exacerbations and hospital admissions12,13.

Potential health risks to workers exposed to ZnO are significant6. Previous studies have focused mostly on the acute effect of ZnO such as MFF on respiratory systems. Few studies have assessed the possible link between chronic lung function changes and ZnO exposures. These studies, however, were limited by lack of exposure assessment and an unavailable control group.
In the present study, we evaluated the occurrence of respiratory symptoms and chronic effect on pulmonary function in workers exposed to fumes containing zinc.

Methods

This study is retrospective cohort. The study was carried out in 2012, which was conducted in 71 male galvanizers exposed to ZnO (exposed group) and 117 male workers from other units of Arak galvanization plant (control group) which is located in the center of Iran. The length of servicing of all subjects was at least two years. All subjects were evaluated for respiratory symptoms and pulmonary function tests. Information was collected by using ATS standard questionnaire, physical examination and spirometric parameters including forced vital capacity (FVC), forced expiratory volume in one second (FEV1), FEV1/FVC, peak expiratory flow rate (PEFR), forced expiratory flow at 25–75% of FVC (FEF25-75) were measured. Subjects were excluded from the study if they had a history of respiratory diseases such as asthma, bronchitis, emphysema, bronchiectasis, lung cancer…or any other chronic condition in the pre-employment assessment.

The study was approved by the ethics committee of the Tehran University of Medical Sciences. Participants gave written informed consent before the study. Demographic information, history of working years, smoking habits and some questions about respiratory symptoms such as cough, sputum, dyspnea and chronic bronchitis (productive cough for two consequent years at least for three months) and throat, nose and eye burning were recorded in the questionnaire. Information about pulmonary function tests was taken according ATS criteria.

Physical examination and spirometry apparatus (Spirolab 2), between 8-12 a.m. before starting work. A minimum of three respiratory maneuvers were taken and the best of them was taken according ATS criteria.

Concentration of dusts and fumes of ZnO and hydrochloric acid vapors, were measured in two different days, one month prior to the study, using NIOSH 70-30 method and with stationary and personal air sampling pumps (SKC; 2L/min) fitted with a Casella apex.

We estimated the effect size as 5 based on previous studies. Data were analyzed by SPSS 11.5 (Chicago, IL, USA). Quantitative and qualitative variables were measured. Chi square Test was used for determination of association between two qualitative variables, while independent sample t-test was used for evaluation difference between quantitative variables both in exposed and non-exposed groups. \( P \) value < 0.050 has been considered as a significant association.

Results

The concentration of ZnO in personal breathing zone (PBZ) ranged from 5.61 to 8.25 mg/m³, which all were above the permissible level (5 mg/m³). The ambient samples of ZnO yielded concentration of 3.03 to 4.46. The concentration of hydrochloric acid in PBZ sampling was below the permissible level (TLV=5 PPM).

According to Table 1, the exposed group to ZnO was younger than control group and the mean age of exposed group was 30.6 years, while for control group was 30.15, which was not significant. The mean length of service was 4.4 years in exposed group and 6.09 in control group \( (P=0.021) \). Smoking did not have any significant difference between two groups.

The information of clinical findings has been shown in Table 2. Accordingly, dyspnea and nose, throat and eye burning were significantly more frequent in exposed group than control group. The prevalence of sputum production tended to be higher in the galvanizer than in the control group.

The information about pulmonary function tests has been shown in Table 3. Among measured spirometric parameters (FEV1%, FVC%, FEV1/FVC, PEF% and FEF25, 75%) only FEV1% was statistically lower in exposed group than in control group.

Discussion

In this study, the workplace exposure assessment indicates that the ZnO concentration in PBZ samples was higher than permissible level in galvanizers. These are similar to Pasker et al. study, which evaluated the effect of ZnO fumes on respiratory system in a galvanization plant. On the other hand, in a study carried out on health hazards evaluation in a galvanization plant, ZnO fumes concentration
The galvanizers who were exposed to ZnO fumes had more respiratory complaints. In addition, we found a significant effect on pulmonary function, which may affect the respiratory health and they are at risk of decrease of pulmonary function. It is of interest that we found statistically significant airflow obstruction (decreased FEV1/FVC ratio) with ZnO, even in workers with short-term exposures. It seems that a strong effort should be made to evaluate workers with periodic medical examinations, better ventilation should be attained, and workers should wear respiratory protective devices.

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Conflict of interest statement

None declared.

References


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