Iranian J Publ Health, Vol. 42, No.4, Apr 2013, pp.397-401

Original Article

Asthma Symptoms and Specific IgE Levels among Toluene Diisocyanate (TDI) Exposed Workers in Tehran, Iran

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(Received 25 Sep 2012; accepted 12 Feb 2013)

Abstract

Background: Toluene diisocyanate (TDI) is an imperative chemical substance used in the production of polyurethane foams, elastomers, paints and coatings that cause a variety of health problems in workers who are exposed in work places. This study aimed to determine the asthma symptoms and serum specific IgE levels in TDI exposed workers and comparing the results with healthy control group.

Methods: All the plants that use TDI in the manufacturing of paint and glue in the west of Tehran Province entered to the study and all the workers (550) completed modified initial questionnaire of the NIOSH, the questions were consisted of asthma symptoms. For each symptomatic exposed worker one healthy, sex and age matched control selected. Total IgE and Specific TDI IgE tests were done for each case and control groups.

Results: Among 550 TDI exposed workers, 26(4.7%) had asthma symptoms. Nine (34.6%) of symptomatic workers who were exposed to TDI were active cigarette consumer versus 3(11.5%) unexposed workers, *P*=0.049(CI= 0.953-17.29) OR=4.059. Nine (34.6%) workers had positive family history of atopy versus 1(3.8%) unexposed workers, *P*=0.0138 (CI= 1.45-305.41) OR=13.24. TDI specific IgE was found in 2 TDI exposed workers and 1 unexposed worker (*P*=0.5). Mean of total IgE was 339.05 in exposed workers (*P*=0.201).

Conclusion: This study provides clinical and paraclinical data of workers exposed to TDI and points to a relation between atopy and smoking habit with asthma symptoms that offer preventing recommendations for TDI exposed workers and their heath administrators.

Keywords: Toluene diisocyanate (TDI), Asthma symptoms, IgE, Iran

Introduction

Toluene diisocyanate (TDI) is an imperative chemical substance used in the production of polyurethane foams, elastomers, paints and coatings and cause a variety of health problems in workers who are exposed in work places (1). Health effects that induced by TDI consist of asthma, chronic obstructive lung disease, hypersensitivity pneumonitis, alveolitis, conjunctivitis, and rhinitis (2). The ability of TDI and the other diisocyanates to cause respiratory hypersensitivity is well known (3).

Occupational asthma (OA) is a respiratory disorder express by bronchial hyper reactivity caused by agents present in the air in the workplace; it causes obstruction or sensitivity of the airways and is partly or completely reversible, instinctively or by treatment (4).

With increasing rate of asthma morbidity and mortality rate in many developed countries over the past 10-20 years (5,6), the incidence of OA is rising, because of increased exposure to work related toxic agents. Although it is a quite frequent disorder, the roles of smoking and atopy in its pathogenesis are not totally known (7,8).

Although many clinical and epidemiological studies have been carried out to evaluate the effects of exposure to TDI in workplaces on human health, many questions remain unanswered. It is the first time in Iran that TDI effects on exposed workers are assessed. This study aimed to determine the asthma symptoms and serum specific IgE levels in TDI exposed workers and comparing the results with healthy control group.

Materials and Methods

TDI exposed workers

All the plants that use TDI in the manufacturing of paint and glue in the west of Tehran Province entered to the study and all the workers (550) completed modified initial questionnaire of the NIOSH. The questions were consist of asthma symptoms such as wheezing, cough, chest tightness, shortening of breath, cigarette consumption, number of daily cigarette consumption, family history of allergy and work duration.

Total IgE and Specific TDI IgE tests were done for 26 workers who had asthma symptoms by RAST method with R-biopharm, Darmsiasi, Germany.

TDI unexposed workers

For each symptomatic exposed worker one worker selected as control if met these inclusion criteria: 1- sex and age matched 2- non asthmatic 3- did not exposed to TDI in work places. Questions about cigarette consumption, number of daily cigarette consumption, and family history of allergy were asked from selected control group. Total IgE and Specific TDI IgE test were carried out for control group such as symptomatic exposed workers.

Analysis

Data were analyzed by SPSS version 18 to calculate chi square test and OR (Odds Ratio) and 95% CIs (Confidence Interval). Paired samples test was used to compare total IgE means in exposed and unexposed groups. $P<0.05$ was supposed as significant level.

Results

All of the workers were male and the mean age of symptomatic workers was 36.38 ±8.49 yr. Among 550 TDI exposed workers 26 (4.7%) workers had asthma symptoms.

Among symptomatic workers ten workers (38%) stated that they ever had asthma but 9(34.6%) had physician asthma diagnosis. Fourteen (53%) workers had history of use of asthma medication. Details of asthma symptoms including the frequency of wheezing, breath shortness, cough, and chest tightness are presented in Table 1. Other allergic signs were observed concomitantly with asthma symptoms: 17(65.4%) allergic rhinitis, 14(53.8%) eye allergic and 15(57.7%) skin allergic cases were observed.

Table 1: Frequency of asthma symptoms in paint and glue factories in west of Tehran province

Symptom	Positive n (%)	Negative n (%)
Wheezing	22(84.6)	4(15.4)
Chest tightness	15(57.7)	11(42.3)
Cough	14(53.8)	12(46.2)
Breath shortness	23(88.5)	3(11.5)

Nine (34.6%) of workers who were exposed to TDI were active cigarette consumer versus 3(11.5%) unexposed workers, OR=4.059 (CI= 0.953-17.29) $P=0.049$ (Table 1). Six (23.1%) of exposed workers consumed daily more than 5

cigarettes in comparison with 2(7.7%) unexposed workers OR=0.278 (CI=0.050-1.531) *P*=0.124.
Nine (34.6%) of paint and glue plants' workers had positive family history of atopy versus 1(3.8%) unexposed workers, OR=13.24 (CI= 1.45-305.41) *P*=0.0138 (Table 2). TDI specific IgE was found in 2 TDI exposed workers and 1 unexposed worker (*P*=0.5).

Table 2: Frequency of cigarette consumption in symptomatic TDI exposed and unexposed workers

Cigarette consumer	Yes n (%)	No n (%)	Total n (%)
TDI exposed workers	9 (34.6)	17 (65.4)	26 (100)
TDI unexposed workers	3 (11.5)	23 (88.5)	26 (100)

OR=4.059 (CI= 0.953-17.29) *P*=0.049

Mean of total IgE was 339.05 IU/ml in exposed workers in compare of 52.19 IU/ml in unexposed workers (*P*=0.201). All the workers with positive specific IgE (2 workers) were exposed to TDI more than 10 years. Range of work duration in plants that consumed TDI was 1-27 years with mean of 10.58±6.

Discussion

Isocyanates cause a variety of respiratory disorders such as occupational asthma (OA) with prevalence of 5% to 10% in exposed workers (9). Other uncommon diseases like allergic alveolitis, and systemic symptoms also occur (10).
In our study, we found 26 (4.7%) of TDI exposed workers had asthma symptoms that appears less than the other reported rates (11-14). This difference may be related to the plants structure in west of Tehran Province, in the environmental observation of factories we found that the major parts of production have been carry out in the open places of plants such as yards. The work in the open places leads to decrease the TDI exposure and consequent low symptoms among workers.
The pathophysiology of occupational asthma usually includes an IgE-dependent mechanism. OA that was induced by IgE-dependent agents is similar to clinical and pathologic features of allergic asthma that is not related to work (15,16). Specific IgE antibodies to TDI have been reported in a range of 0% to 40% (17,18).
In this study we found specific IgE in 2 symptomatic exposed workers and one unexposed worker that did not show statistically significant relation between specific IgE and clinical symptoms of asthma, also we did not have any significant association of total IgE in two groups. We should consider that although the presence of IgE antibodies is highly diagnostic but it has no sensitivity in detecting isocyanates induced OA. It can be explained by the presence of more than one immunologic mechanism of respiratory sensitization in isosyanate induced asthma including IgE antibody-independent mechanisms (19,20).
In comparison of our clinical findings Littorin et al. in 2007 reported bronchitis 10%, cough 28%, cough with mucus 34% and wheezing 27% in TDI exposed workers (21).
Our study showed that use of cigarette increases the risk of asthma symptoms 4 folds in TDI exposed workers, OR=4.059 (CI= 0.953-17.29) *P*=0.049, however we could not find any association between daily cigarette consumption and asthma symptoms. In agreement of our findings Ucgum et al. showed that cigarette consumption is significantly higher in OA patients due to TDI (*P*=0.012) (14) whereas siracusa et al. found no relation between TDI induced OA and smoking (22), these contradictory results can explained by the "healthy smokers effect" healthy workers have more chance to get a job and continue it because they suffer less and their employer like to keep them rather than their unwell colleagues (23).
We showed family history of atopy elevates the risk of asthma symptoms in TDI exposed workers

versus unexposed workers OR=13.24 (CI= 1.45-305.41) *P*=0.0138. Mapp et al. stated genetic factors can influence disease susceptibility because TDI induced asthma symptoms only in a small part of exposed workers can be detectable (24) and many researches were carried out to detect the influencing gens (25-29).

Table 3: Frequency of family history of allergy in symptomatic TDI exposed and unexposed workers

Family history of allergy	Yes n (%)	No n (%)	Total n (%)
TDI exposed workers	9 (34.6)	17 (65.4)	26 (100)
TDI unexposed workers	1 (3.8)	25 (96.2)	26 (100)

OR=13.24 (CI= 1.45-305.41) *P*=0.0138

Conclusion

This study provides clinical and paraclinical data of workers who are exposed to TDI and points to a relation between atopy and smoking habit with asthma symptoms that offer preventing recommendations for TDI exposed workers and their heath administrators however further studies in this field is recommended.

Ethical considerations

Ethical issues (Including plagiarism, Informed Consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc) have been completely observed by the authors.

Acknowledgement

This research project was supported by a grant from Immunology, Asthma and Allergy Research Institute, Tehran University of Medical Sciences. The authors declare that there is no conflict of interest.

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