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Health–risk assessment of workers exposed to flour dust: A cross–sectional study of random samples of bakeries workers

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ABSTRACT

The objectives of this study were to measure exposure to dust in the small bakery shops, to define the determinants of occupational asthma, and to propose control measures for this. The study included bakery workers of one hundred bakeries (the cases; *n*=200, the controls; *n*=20). Their individual information was obtained by a simple questionnaire based on "Ear–Nose–Throat" (ENT) work–related symptoms such as coughing, wheezing, chest tightness and irritations. Subjects were considered as "possible occupational asthma cases". Medical visit was carried out to complete clinical and lung function investigations for these subjects. The mean flour dust concentration in the current study was 28 mg/m^3. Fifty six of bakery workers had work related symptoms significantly higher than those in controls. The spirometric results illustrated that the workers with experience of less than five years are not affected as there was no significant difference between exposed cases and controls in mean forced expiratory volume in one second (FEV1) or forced vital capacity (FVC) percent determined. But workers with experience of five years or more showed significantly lower mean FEV1 and FVC percent predicted when compared with controls. The results of lung function test for subjects demonstrated that the flour dust pollution adversely affects on main lung function parameters, such as FVC and FEV1. This study confirms that the risk of pulmonary disease among flour dust exposed workers is higher than the unexposed control subjects.

Keywords: *Occupational asthma, bakeries workers, FVC/FEV1, pollution, worker*

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1. Introduction

There are two kinds of occupational asthma (OA): (i) the reactive airways dysfunction Syndrome (RADS), which may be induced by acute inhalation of irritant substances; and (ii) the immunological type whose latency period after exposure is variable. A non–immunologic form of OA is RADS (Rosenman et al., 1997; Ameille et al., 2003) and described by other researchers as a persistent asthma syndrome following exposure to high levels of irritants, normally as a result of an accident occurring in the workplace or of a situation with polluted workplaces (Brooks et al., 1985; Boot et al., 2004; Migliaretti et al., 2005).

Scientific studies have been conducted in a variety of occupations and demonstrated that the most important risk for developing asthma is the level and duration of exposure to agents capable of causing occupational asthma (Brisman et al., 2000). Numerous studies illustrated the existence of a dose–response relationship between exposure intensity and the prevalence of immunological sensitization to various occupational agents (Nieuwenhuijsen et al., 1999; Cullinan et al., 2001; Mirmohammadi et al., 2013).

In a recent study (Demchuk et al., 2007), genetic factors that predispose asthma have been broken down into three broad categories: immune and inflammatory (12 genes), atopic (3 genes) and metabolic (one gene). Occupational rhinitis is also associated with OA and rhinitis symptoms precede those of the asthma in 58% of the cases where high–molecular–weight (HMW) agents are implicated and in 25% of cases involving low–molecular–weight substances (LMW) (Malo et al., 1997).

Baker's asthma is one of the first occupational diseases described in the literature. At the present time, baker's asthma belongs to the most frequent occupational disorders in many countries (Baur et al., 1988; Houba et al., 1998).

In a retrospective study, researchers found a higher asthma incidence during active years as a hairdresser (3.9 per 1 000 person–years) compared with the referents–women randomly selected from the general population (Albin et al., 2002). According to these statistics, the calculated risk for bakers to cause an occupational obstructive airway disease is more than 50 times higher than that of the average value noted for other professions. Lately researchers found evidence for a considerable number of unreported cases (Mirmohammadi et al., 2010). In Iran, significant numbers of people are working in small industries as is seen from country's official data. The jobs in group of working population of Mazandaran province show that out >13 000 people employed in the province, 3 250 are working in bakery and pastry shops.

The objectives of the study were to determine the risk assessment of flour dust exposure for workers of bakeries and incidence of occupational asthma among indoor workers in these places. Two important reasons for the need of the current study are: (i) the better understanding of flour dust pollution exposure at workplaces, (ii) the recognition of occupational asthma.

The study can help in finding practical ways to prevent of dust exposure in the bakeries' workplaces. There are two limitations that need to be acknowledged and addressed regarding the present study. The first limitation has concerned to individual knowledge of subjects in the current research project. The second limitation has to do with the extent to which the findings can be generalized beyond the cases studied. The number of cases is too limited for broad generalizations. However, gathering the information, sampling and study on small workplaces in developing countries is difficult and to our knowledge this is the first study using small shops workers for flour dust exposure assessment in Iran.

2. Materials and Methods

2.1. Study design

The current study was designed as a cross–sectional study among workers from small industrial and traditional bakeries. The subjects for participation in the current study were the workers involved in the selling of bread and its baking process. In Iran, data on the magnitude of flour dust health risks are lacking due to the absence of occupational disease registries. Present occupational health study is being set up to evaluate exposure to flour particulate matters, health effects and exposure–response relationships. This study mainly focuses on end users of flour or workers among bakeries shops. These shops were divided into two categories, i.e., traditional and industrial shops. Within these industries, exposure to a range of particulate matters with variable physical and chemical properties was noticed. All the subjects studied were in 25–45 years age group and white Caucasians, who lived near the area of study.

In the current study there were three types of bakeries: (T) traditional (using preliminary instrument for bakery), (I) industrial (using sophisticated instrument and tools) and (M) mixed design of baking devices. The limitation of this study is that some of the bakery shops or factories are beyond of the selected district while some exposed workers have different individual conditions.

2.2. Indoor air sampling

A universal personal sampling pump (SKC PCXR8, Bradford, UK) was used for indoor air sampling with the flow range of 1 000 to 5 000 mL/min and the sampling method was personal long–term. The samples were collected in the workers' breathing zone using IOM sampling heads with polytetrafluoroethylene filters (PTFE Membrane, SKC) of 2.0–µm pore sizes at a calibrated flow rate of 2 L/min. Field blanks were included for each sampling visit. For each gravimetric analysis, the filters were weighed twice in a preconditioned room (kept at a constant temperature and humidity) before and after sampling were undertaken and the personal dust exposure [8 h TWA (mg/m^3)] calculated. The weighed filter provides a mass of particles (in µg). The average flour particles concentration obtained by the digital balance with microgram accuracy (BIOS Sartorius, CPA224S, Germany).

2.3. Spirometery

Spirometric testing was carried out by an experienced occupational physician according to guidelines of the American Thoracic Society (American Thoracic Society, 1987; Baur, 1999). The first test was maximum forced exhalation was performed (a minimum of 6 sec) in the sitting position. To obtain accuracy, the test was repeated three times with forced expiratory volume in one second (FEV1) and forced vital capacity (FVC) tests. A Jaeger Master Screen Pneumo spirometer (North Rhine–Westphalia, Germany) was used to measure the workers lung expiratory volumes (FEV1 and FVC). The calibration of the spirometer was done with a 3–L volumetric syringe for the each day of test. A weighting scale/body electronic scale (RS–6006B, Guangdong, China) was used for workers weighting. A HM200P – Portable Stadiometer (Quick Medical, USA) was used to measure workers standing height. For all workers FEV1, FVC, FEV1/FVC ratio, TLC, RV, and RV/TLC ratio were measured. All the spirometry subjects were instructed for spirometery testing and they were asked not to take any medicine 24 hr prior to the tests.

2.4 Statistical method

The sample size required to produce an estimate of the total number of subjects (or of potentially exposed employees) within specified limits, with 95% confidence, was calculated using the formula which suggested by Rosner (2011):

$$n = \frac{N Z^2_{1-\frac{\alpha}{2}} p(1-p)}{d^2(N-1) + Z^2_{1-\frac{\alpha}{2}} P(1-p)} \quad (1)$$

where, n is the required sample size, N is the total number of workstations for sampling or subjects, $Z_{1-\alpha/2}$ is known as the critical value for the area of $\alpha/2$, and the total was to be estimated within plus or minus d, P and p are the population proportions. With a few pretests for air sampling in the work places the standard deviation (the measure of the spread of data around the mean) determined for determination of sample size (n) by the above formula.

The main objectives of sample size determination were: (1) to show evidence of an increased incidence during the first five years of working experience, and (2) to assess some health risk factors [including age, "Ear–Nose–Throat" (ENT) work–related symptoms, coughing, wheezing, chest tightness and irritations] by medical visit and clinical spirometry and lung function investigations, including fractional exhaled nitric oxide (FENO) and carbon monoxide (CO) measurements based on mean FEV1 or FVC.

Estimated sample size for the retrospective cohort study should have the power to show a difference in occupational asthma incidence between bakeries. A sample of 200 workers (and 20 controls) with no specific occupational exposure was used to demonstrate a significant difference of occupational asthma incidence after about five years of activity between bakers.

Multiple linear regression analysis technique was used (as the numbers of independent variables were more than one) to state the statistical relationship between the variables and to identify any meaningful relationship between those variables.

Pulmonary function tests were carried out using a portable electronic spirometer. All workers were tested for pulmonary function at the same time of the day (10:00–14:00 hr). The maneuver was explained to each subject. All subjects performed the maneuver in the standing position and the best of three readings was recorded. The results were compared using one–way ANOVA and the paired t–test by SPSS as statistical software.

3. Results

One hundred small bakeries were selected randomly for the study with workers (n=200), and healthy non smoking control subjects matched for age, sex, height, and area of residence (n=20). Within the bakeries, local exhaust ventilation (LEV) was