

# Pre-employment screening among trainee bakers

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## Abstract

**Objectives**—To assess the prevalence of atopy in a vocational school so as to evaluate the feasibility of pre-employment screening.

**Methods**—The prevalence of atopy by family diathesis, prick tests, immunoglobulin E (IgE) concentrations, and personal history of allergic respiratory diseases was investigated in 144 trainee bakers and 81 students on a graphic artists course (mean age 15.4 years). Skin sensitisation to wheat, rye, and barley flours, to  $\alpha$  amylase, and to storage mites was also evaluated.

**Results**—Personal allergic symptoms were reported by 13.2% of the bakers and 14.7% of the graphic artists and there was a significant association between symptoms and atopy by prick tests (odds ratio (OR) 17.2; 95% confidence interval (95% CI) 5.27–56.4) and by family history (OR 3.11; 95% CI 1.02–9.53). When bakers were grouped according to the presence of allergic symptoms and results of immunological tests, 6.9% had asthma, 6.3% had rhinoconjunctivitis, and a high percentage (28.5%) were without symptoms but scored positive on prick tests or family symptoms. Skin sensitisation to storage mites had similar prevalences (16%) in the two groups of trainees and occurred nearly always in atopic people. Positive skin tests to wheat flour (3.5%), rye (0.7%), and  $\alpha$  amylase (0.7%) were specific to bakers.

**Conclusions**—Pre-employment screening is a useful source of medical information and allows for counselling. The presence of asthma, or of another allergic disease in a severe form, is suggested as a criterion for excluding students of a vocational school from training as bakers. Student bakers without allergic symptoms but atopic by other criteria should be informed about their risks of developing occupational asthma, and periodic check ups must be recommended. Screening studies in vocational school provide a better understanding of specificity of skin sensitisation to occupational allergens.

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**Keywords:** atopy; bakers; vocational school

Baker's asthma is one of the most important occupational respiratory diseases and repre-

sents a substantial economic burden for the community.<sup>1-3</sup> Although reduction of environmental exposure to the causative substances is certainly the most effective means of prevention, the identification of personal predisposing factors could be very helpful in preventing the disease and reducing the costs of treatment and vocational retraining. Several cross sectional studies indicate that atopic people exposed to high molecular weight substances may be at increased risk of the development of occupational asthma; in the detergent enzyme industry, for example, the exclusion of atopic people from work has been shown to be effective.<sup>4-6</sup> The policy of excluding atopic people from work involving exposure to high molecular weight allergens is still a matter for debate.<sup>7-10</sup>

The aim of our study was to assess the prevalence of atopy and sensitisation to occupational allergens in a vocational school so as to evaluate the feasibility of pre-employment screening.

## Materials and methods

In northern Italy, we are at present prospectively evaluating a cohort of students at a vocational school for bakers. The aim is to identify the role of certain personal risk factors in the development of occupational allergy. The study is still in progress, but we analyse here the results of the check ups for atopy and the prevalence of sensitisations to wheat flour and  $\alpha$  amylase.

We studied 144 trainee bakers (81 attending the first year and 63 the second) and 81 students on a course for graphic artists. The students were tested two months after the beginning of the school by a trained physician who filled in a specific questionnaire with data on smoking and familiar allergic diathesis. Personal history of respiratory disease included acute and chronic bronchitis and inflammatory diseases of the upper airways. Personal allergic symptoms evaluated included rhinitis, conjunctivitis, asthma, and urticaria. Other questions concerned exposure to wheat flour outside the school, such as temporary work in bakeries, pizzerias, or pastry shops. The students were also questioned about the presence of attacks of rhinitis, coughing, wheezing, and dyspnoea when working with flours.

Skin prick tests were performed with a standard battery of common allergens (Lofarma-Milano). Positive control was histamine dihydrogen chloride and negative control was 1% glycerinate solution. All tests were read at 15 minutes and a wheal of 3 mm

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or more was measured as positive. The skin panel included five pollens (Graminae, Parietaria, Betulaceae, Compositae), house dust mites, and cat and dog dander. The following six storage mites were also tested: *Acarus sirus*, *Glycyphagus domesticus*, *Tyrophagus putrescentiae*, *Lepidoglyphus destructor*, *Goheria fusca*, and *Euroglyphus maynei*. Skin sensitisation to storage mites was analysed separately because their role as occupational allergens in bakeries is still controversial.<sup>11 12</sup> The occupational allergens tested were wheat, rye, and barley flours (Lofarma-Milano), and  $\alpha$  amylase from *Aspergillus oryzae* at a concentration of 1 mg/ml. Concentrations of immunoglobulin E (IgE) (Sferikit IgEtot, Lofarma-Milano) were tested in the blood of 192 of the 225 students. Specific IgE concentrations were measured in serum samples<sup>13</sup> from the five students with symptoms when exposed to wheat flour.

Atopy was evaluated by four different criteria: (a) family history of allergy including asthma and allergic rhinitis in parents or siblings; (b) personal atopy based on the results of skin prick tests (subjects were classified as atopic if they had at least one positive response to skin test with pollens, house dust mites, or cat or dog danders); (c) personal atopy based on total serum IgE concentrations higher than 180 U/ml; (d) clinical allergy based on personal history of asthma, allergic rhinitis, or atopic dermatitis.

Data analysis was performed with BMDP/Dynamic software (release 7.0). Continuous data were summarised as means (SD). The difference between means was tested by Student's *t* test. The  $\chi^2$  statistic was applied to data tabulated in  $2 \times 2$  contingency tables. The association between the response and the predictor variables was assessed by multivariate logistic regression

Table 1 Characteristics of the populations studied

	Bakers (n = 144)	Graphic artists (n = 81)
Mean (SD) age (y)	15.4 (1.6)	15.5 (1.4)
Male (%)	55.6	45.7
Smokers (%)	27.1	24.7
Non-allergic respiratory symptoms (%)	43	41.7
Atopy (%) by:		
Family	18.8	12.3
Prick tests	29.2	35.8
IgE > 180 U/ml	20.8	20.8
Allergic symptoms	13.2	14.7
Bakers in family (%)	13.2	7.4
Work as bakers (%)	28.5*	2.5

P < 0.05.

Table 2 Results of skin prick tests (%)

	Bakers (n = 144)	Graphic artists (n = 81)
House dust mites	20.1	22.2
Storage mites	16.7	16.0
Pollens	18.8	23.5
Cat and dog dander	12.5	3.7
Flours:		
Wheat	3.5	—
Barley	4.9	7.4
Rye	0.7	—
$\alpha$ Amylase	0.7	—

analysis. Logistic regression coefficients (SEM) were used to obtain the prevalence odds ratios (ORs) and 95% confidence intervals (95% CIs) adjusted for several potential confounders. The predictor variables entered the logistic model as categorical covariates, except for age, which was used as a continuous covariate. Stepwise selection of predictor variables was based on the likelihood ratio  $\chi^2$  test. The goodness of fit of the logistic model was assessed by the Hosmer-Lemeshow  $\chi^2$  statistic.

## Results

The mean (SD) age of the entire group was 15.4 (1.5) years, of whom 52% were males and 25.8% smokers. Thirty one students (13.8%) complained of allergic symptoms: 16 had asthma, 13 rhinitis, and two urticaria. Bakers and graphic artists were comparable with respect to sex, age, number of smokers, occurrence of non-allergic respiratory diseases, and atopic categories (table 1).

Among the bakers, 13.2% had family members working in the baking sector, whereas among graphic artists the figure was 7.4% (P > 0.1); 28.5% of bakers and 2.5% of graphic artists had already worked in specific occupations (P < 0.0001).

Altogether, 83 students had a history of exposure to wheat flour due to work or to school seniority (second year of school). The prevalence of allergic symptoms was 13% in this group and 14% among the 142 students never exposed (P > 0.5). Students exposed and not exposed to wheat flour were also similar when comparing atopy by other criteria (P > 0.5).

Overall, 31.7% of the students were atopic by prick tests. Rates of skin sensitisation ranged from 3.7% for animal danders to 23.5% for pollens; no significant differences were found between bakers and graphic artists (table 2). Skin sensitisation to at least one storage mite was similar in the two groups (16%); it was nearly always present in atopic students (92%) as was sensitivity to house dust mites (89.2%).

Table 3 Association between allergic symptoms and several predictors in 192 subjects (OR and 95% CI were obtained by multivariate logistic modelling)

Predictors	n	OR (95% CI)
Atopy by prick:		
Negative	126	1.0 (—)
Positive	66	17.2 (5.27–56.4)
Family:		
Negative	155	1.0 (—)
Positive	37	3.11 (1.07–9.53)
IgE:		
< 180 U/m	152	1.0 (—)
> 180 U/m	40	1.87 (0.69–5.10)
Smoking:		
No	140	1.0 (—)
Yes	52	0.55 (0.18–1.68)
Sex:		
Men	102	1.0 (—)
Women	90	1.08 (0.41–2.86)

Goodness of fit  $\chi^2 = 14.25$ ; df = 22; P = 0.882.

Table 4 Risk categories according to allergic symptoms, prick test, and family atopy (%)

	Group 1 Symptoms (+) Prick tests (+)	Group 2 Symptoms (+) Prick tests (-)	Group 3 Symptoms (-) Prick tests/family (+)	Group 4 Symptoms (-) Prick tests/family (-)
Bakers (n = 144)	12.5 (6.2)*	0.7 (0.7)*	28.5	58.3
Graphic artists (n = 81)	11.1 (6.2)*	3.7 (1.2)*	34.6	50.6

\*Asthma.

Positive skin test reactions to wheat (five cases), rye flours (one case), and *a* amylase (one case) were reported only among bakers; skin reactions to barley, on the other hand, were similar in the two groups.

The associations between allergic symptoms and several predictors (sex, smoking, atopy by prick tests, IgE concentrations, and family atopy) were evaluated by logistic regression analysis in bakers and graphic artists both separately and combining the groups. Allergic symptoms were always significantly associated with atopy by prick tests and family atopy. Table 3 shows the data of the entire group and indicates for atopy by prick tests an OR of 17.2 (95% CI: 5.27–56.4) and for family atopy an OR of 3.11 (95% CI: 1.02–9.53). There were similar findings when bakers and graphic artists were analysed separately.

On the basis of these results, the students were divided into four groups, according to presence or absence of allergic symptoms and family atopy, and results of skin prick tests (table 4). Group 1 comprised bakers and graphic artists with allergic respiratory symptoms and atopy by prick tests. Group 2 comprised students with allergic symptoms but who were non-atopic by prick tests. Group 3 comprised students without symptoms, but scoring positively on prick tests or on family atopy. Group 4 comprised students without personal or family allergic symptoms and with prick tests negative to common allergens.

The results show that 58.3% of bakers and 50.6% of graphic artists fulfilled none of the criteria used to evaluate atopy; 28.5% and 34.6% respectively were atopic by prick tests or family history, but were without symptoms. Allergic symptoms were reported by 13.2% of bakers and 14.7% of graphic artists; nearly all of these were also atopic by prick tests. Asthma was reported by about 6% of the students in each group.

Five bakers (4.1%) complained of respiratory symptoms when working with flours: four had rhinitis and one had rhinitis and conjunctivitis (table 5). All but one were males, all complained of allergic symptoms, and all were

atopic by prick tests. Four had had exposure to flours outside school; all but one was prick test or radioallergosorbent test (RAST) positive to wheat flour. There was one baker who was skin positive to both wheat and *a* amylase; he complained of symptoms when using wheat flours, had a personal history of allergy, and was atopic by prick test.

## Discussion

The most widely used methods for medical screening and surveillance of occupational asthma are itemised questionnaires, spirometry, and immunological tests. Where atopy is considered to be a risk factor, immunological tests are useful for prescreening new workers and several studies have sought to assess the importance of atopy as a marker of susceptibility to disease, usually by skin prick tests, and also family or personal history. In the case of occupational exposure to high molecular weight substances, many authors have noted a close association between allergic respiratory symptoms and atopy by prick tests.<sup>2,5,14-16</sup> Only a few prospective studies have evaluated the role of atopy in the development of occupational allergic diseases; however, they mainly assessed allergy induced by exposure to animals and the results are not consistent.<sup>9,10,17,18</sup> Although most workers who develop asthma to animal allergens are clearly atopic, there is still great debate on the wisdom and practicality of excluding atopic people from work at risk, because of the large number of atopic people who would be unsuitable to work and because this kind of screening programme may divert attention from improving the environment.<sup>7,10</sup>

In our study, the prevalence of atopy by prick tests and by IgE concentrations was comparable with that in other groups of the same age<sup>19-21</sup> and was similar among bakers and graphic artists. Atopy (defined as a positive response to at least one of the four criteria) was present in 50% of the students, but only 13.8% complained of allergic symptoms. The presence of allergic symptoms was significantly associated with atopy by skin prick tests and to a lesser extent, with family atopy, but not with IgE concentrations, sex, or smoking. In accordance with other findings,<sup>22</sup> IgE concentrations were not reliable as a screening tool for allergic disease; for this reason, this study used allergic symptoms and the results of prick tests as the main criteria for assessing risk. The population was then divided into four groups that could be considered as categories of risk for the development of occupational allergic diseases.

Table 5 Characteristics of the five students with symptoms when working with wheat flour

Case	Sex	Atopy				Wheat		Work Outside school
		Family	Prick	IgE (U/ml)	Personal	Prick	RAST	
1	M	-	+	423	+	+	-	+
2	M	+	+	115	+	+	-	-
3	M	-	+	174	+	+	+	+
4	M	-	+	212	+	-	+	+
5	F	+	+	51	+	-	-	+

Among the bakers, 58.3% of the subjects were in the non-atopic group 4; 28.5% were placed in group 3—namely, subjects atopic by prick test or family history but without allergic symptoms. They may be considered at risk as atopic people, but in view of their high numbers and absence of symptoms, we should be wary about defining these subjects as unsuitable for their chosen occupation. At present, there are insufficient data to predict the fate of the non-symptomatic atopic people with long term exposure to this specific job. In any case, the subjects should be informed about their risks of developing occupational asthma and periodic medical check ups must be recommended.

Subjects in groups 1 and 2 were those who complained of allergic disease and were mostly atopic by prick tests. The prevalence is similar for bakers and graphic artists; there were 19 bakers (13.2%) in groups 1 and 2 and 10 (6.9%) of them complained of asthma. These subjects may be considered at major risk,<sup>10 14</sup> and some of them may be defined as unsuitable to work as bakers; clearly, the negative indication is greater for people with more serious disease (asthma). We have no data to assess the predictive value of atopy as a marker of symptoms caused by exposure to wheat flour, but it is a matter of concern that short exposure to flours (varying from weeks to months) was sufficient to induce mild work related symptoms in five (3.4%) student bakers, who all complained of allergic symptoms and were atopic by prick tests.

If the presence of allergic symptoms (and of asthma in particular) was used to exclude subjects from bakery work, 10 of the student bakers in our sample would be unsuitable for work that involves exposure to flours or other high molecular weight allergens. For those nine with rhinoconjunctivitis or urticaria (6.3%), exclusion should be based on careful evaluation of the severity of symptoms.

Some authors advise against the screening out of atopic workers from certain occupations, because of its low predictive value for occupational allergic diseases and in view of the difficulties in finding other work and the adverse implications of unemployment. Undoubtedly, finding other work and unemployment are grave problems for older workers, but if pre-employment screening were done in young people before they begin their career, the problems arising would be much easier to solve. The social cost of such screening, done when a prospective student applies to a vocational school, is certainly more acceptable, because at this stage the student can easily change his or her choice of career.

Our screening study in a vocational school also provided us with a better understanding of results of epidemiological studies in exposed adults. Among adult bakers we found that skin sensitisation to wheat flour, but not other flours, was specific to bakers.<sup>23</sup> Our study among trainee bakers confirms this earlier finding, although our prevalence data are lower than those found in groups of bakers'

apprentices.<sup>9 24 25</sup> Sensitisation to *a* amylase was also specific to bakers.

The prevalence of skin sensitisation to storage mites among the students was similar to that found in adult bakers<sup>23</sup>; it was quite common among both bakers and graphic artists and mostly affected polysensitised students. These results indicate that storage mites are widespread in the environment and suggest that skin response to these allergens is a further indicator of atopy rather than a response to an occupational exposure specific to bakers.

Bread and pastry making is often a family based activity where it is more difficult to control environmental and health conditions than in an industrial setting. In our study, 13.2% of the trainee bakers chose this career because the family was already active in the field, and 28.5% already had occupational exposure, usually helping relatives. The vocational school can thus provide an excellent opportunity to give information and counselling on risks linked to occupation. The students must be made aware of the importance of personal prevention, and the need for periodical check ups in some cases, but they must realise that medical examinations are no replacement for environmental prevention.

In our opinion, therefore, exclusion of asthmatic teenagers from work as bakers is a rational option. Also, because the diagnosis of the disease is based principally on the clinical history, the teenagers at risk could easily be identified by the family doctor during the medical examination required for admission to the school. In the meantime, more long term follow up studies are needed for a clearer understanding of the fate of atopic people who are exposed to wheat flour.

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