CONFIRMATION OF SELF-ADMINISTERED QUESTIONNAIRES AS A VALID INDICATOR OF ATOPY IN COTTON TEXTILE WORKERS USING A QUANTITATIVE SKIN TEST

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Abstract

In a previous report, the association of atopic status as determined by questionnaire and the acute overshift change in FEV_1 and annual change in baseline FEV_1 and FVC was evaluated in cotton textile workers. There was a trend of a greater annual decline in FEV_1 in workers identified as atopic, however, this trend was not significant. The lack of significance may have been related to misclassification of atopic status by the questionnaire. To determine if workers were misclassified as atopic, a cohort of 92 workers from the 1991 study was reevaluated using the original questionnaire. In addition, 71 of these workers were skin tested for allergies using a battery of six common inhalant antigens. The reproducibility of the questionnaire was evaluated by comparing the 1991 responses to those obtained in 1994. Thirty-three percent of the 1994 population were classified as atopic on the basis of personal and family history of atopy or asthma. Comparison of the questionnaires indicated that 18% of the population reporting atopic status differently in 1994 versus 1991. Skin testing identified 22/71 workers as atopic. Relative to the skin test, the 1994 questionnaire was found to have a sensitivity of 68% and a specificity of 82%. Analysis of pulmonary function data showed that atopics as described by skin test have more frequent declines in overshift change in FEV_1 than non-atopics, however, the differences were small and, at the low dust levels in these mills, atopic status is not a strong predictor of responsiveness to cotton dust.

Introduction

Exposure to cotton dust is known to cause both acute and chronic respiratory illness. The clinical response is characterized by the disease called byssinosis. The hallmark of byssinosis is the Monday phenomenon; a cyclic disorder characterized by chest tightness, dyspnea, or cough experienced on the first day of the week.[1] However, not all individuals exposed to cotton dust develop byssinosis. The response to cotton dust is highly variable. Variability may be related either to specific substances in the dust or to differences in the workers response to the dust. A portion of variability among workers may be attributable to preexisting conditions. One condition that has been suggested is atopic status. Atopy is a hereditary allergic predisposition to environmental allergens. The atopic status of an individual may be determined by skin testing to a battery of common allergens. Atopics respond to exposure to the allergen by the persistent production of IgE antibody.[2] In the general population the prevalence of atopy is about 33%.[2] In 1991 Jennison and Jacobs used a self-administered questionnaire to determine the atopic status of cotton textile workers.[3] Based on the questionnaire response, the population of workers was stratified by atopy and the association of atopic status on overshift and annual changes in pulmonary function. In workers identified as atopic, there was a trend of a greater annual decline in FEV_1 than in non-atopics, however, this trend was not significant. The lack of significance may be related to misclassification of atopic status by the questionnaire. Although questionnaires provide valuable information regarding atopy, they may not be sensitive or specific. A more objective test of atopic status is needed. This study sought to validate the self-administered questionnaire used to determine atopic status in the 1991 study with a skin test to a battery of common inhalant allergens.

Materials and Methods

Study Population

The structure of this study is patterned by the 1991 Jennison and Jacobs study which included a study population of 131 cotton textile workers. Ninety two subjects completed a questionnaire regarding personal and family history of atopy that was identical to the one used in the 1991 study. Included were questions about seasonal allergies, hayfever, asthma, eczema, and other allergies. Subjects reporting the previous conditions were asked if their condition had been confirmed by a physician. Atopics were defined as responding positively to symptoms of seasonal allergy or hayfever. The remaining 39 individuals were excluded because they were no longer employed at the company or chose not to participate.

Skin Test

Skin testing was performed using Multi-Test applicators (Lincoln Diagnostics, Inc.; Decatur, IL) and a battery of common allergens. The battery of test allergens (Greer Laboratories, Inc., Lenoir, N.C.) included the following: cat dander, *Alternaria tenuis*, ragweed mixture, southern grass mixture, dust/house mite mixture and hickory/pecan mixture. Histamine (1:1000 wt/vol) and glycerine-saline (50% concentration) were used as positive and negative controls respectively. Workers were categorized as atopic and non-atopic on the basis of the skin test results. Persons with positive skin test were divided into two groups: those with a single positive skin test and those with two or more positive skin test.

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Spirometry

Annual pulmonary function test (PFT) data from 1985-1994 were collected for all subjects. All PFTs were performed in the same manner as in the 1991 study.[2] The tests were performed by technicians who had completed a National Institute of Occupational Safety and Health (NIOSH) approved course in pulmonary function testing.

Data Analysis

A 2 x 2 contingency table and the kappa statistic were used to measure the strength of agreement between 1991 and 1994 questionnaire responses and between the 1994 questionnaire and skin test. The frequency of decline in overshift change in FEV_1 and FVC in atopics compared to non-atopics was evaluated using a repeated measures model analysis. Regression slopes were calculated for annual changes in FEV_1 and FVC baseline values. A linear mixed model, controlling for all variables, was used to test the difference in slopes between atopics and non-atopics. All tests for significance were two-tailed ($p<0.05$).

Results and Discussion

Study Population

The study population included 92 of 131 workers from the 1991 study. Demographic data, baseline spirometry, and atopic status of the workers are given in Table 1. Thirty workers (32%) indicated that they had seasonal allergies or hayfever by questionnaire and were considered to be atopics for the purpose of this study. Of these, 18 (20%) reported that this diagnosis had been confirmed by a physician. Differences in baseline lung function measured in 1994 were not statistically significant between atopics and non-atopics although atopics had slightly better baseline function. Fourteen (16%) workers in the atopic population (including physician and non-physician confirmed atopics) and 27 (29%) workers in the non atopic population were current smokers.

Comparison of 1991 and 1994 Questionnaire

The comparison of the questionnaire response of subjects participating both in 1991 and 1994 is shown in Figure 1. Sixteen of 92 workers classified themselves differently in 1994 than in 1991. The kappa statistic, which is a measure of agreement between the two methods, was 0.64. This suggest at most fair agreement between the questionnaires. Misclassification of atopic status due to differences in the questionnaire responses may be attributable to a lack of knowledge about true atopic status, a change in atopic status between 1991 and 1994, problems associated with the questionnaire structure, the impression that answers may impact job security, or other related factors.

Skin Test

Skin testing was completed in 71 of the participants. Forty nine workers had no positive skin reactions, 8 had one positive reaction, and 14 had two or more positive reactions. A total of 22 workers had one or more positive reactions, resulting in an overall prevalence of atopy of 31%. This finding is consistent with the prevalence of atopy in the general population, which is roughly 33%.[1] Demographic data of the skin test population is given in Table 1.

The population was also sorted by the number of positive skin tests: 0, 1, >1 (Table 2). Baseline FEV_1 and FVC measurements appeared to be related to the number of positive skin tests. Those workers with greater than one positive reaction have slightly higher baseline values than workers with one positive reaction and workers with no positive reactions.

Comparison of 1994 Questionnaire and Skin Test

Figure 2 illustrates atopic status of the skin test population as determined by 1994 questionnaire and skin test results. Relative to the skin test, the 1994 questionnaire had a sensitivity of 68% and a specificity of 82%. These data indicate that the questionnaire is not an adequate predictor of atopic status as determined by an objective measure such as skin testing.

Pulmonary Function

Analysis of pulmonary function (Figures 3 and 4) indicated that on average, atopics, as defined by two or more positive skin test, had more frequent declines in overshift change in FEV_1 and FVC than non-atopics or persons with only a single positive skin test. Although these differences were not statistically significant, these data would suggest that atopics, as defined by more than one positive skin test, may be at increased risk of responding to cotton dust with an acute overshift decline in FEV^1 and FVC. However, it is difficult to support this conclusion because the dust levels were low in the mills from which these workers were selected. Furthermore, the pulmonary response to cotton dust is considered an obstructive response which is characterized by acute changes in FEV_1 rather than FVC and since both FEV_1 and FVC changes occurred, these data more likely reflect a generalized increase in responsiveness of atopic individuals.

Annual changes in baseline FEV_1 and FVC from 1985-1994, as percent of predicted, are given in Figures 5 and 6. For both atopic groups and for the non-atopics there was a gradual increase in the percent of predicted in FEV_1 over the study period. A similar trend of increasing percent of predicted FVC was observed for the atopic groups. However, for non-atopics the FVC was constant over the study period. These differences were not significant. The increasing trends may reflect a combination of a learning effect and the normal lung physiology with respect to age.[4] The level baseline for FVC for the non-atopics and baseline values less than 100% of predicted for the non-atopics and subjects with a single positive skin test may reflect the differences in smoking status between the groups (Tables 1and 2). Furthermore, the fact that this study did not observe longitudinal declines in pulmonary function

suggest that the subjects in the study have not been adversely affected by exposure to the levels of cotton dust in these mills.

Conclusions

1. The 1991 response to a self-administered questionnaire to determine atopic status was not reproducible when readministered in 1994.

2. The self-administered questionnaire used in this study lacked sensitivity and specificity when compared to an objective measure of atopic status (skin test).

3. Atopics had more frequent declines in overshift changes in FEV_1 and FVC than non-atopics, however, the differences were not significant and suggest that atopic status is not a strong predictor of responsiveness to cotton dust.

4. There were no longitudinal declines in pulmonary function which suggests that the workers in this study are not experiencing adverse effects as a result of cotton dust exposure.

References

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Table 1. Demographic Data of 1994 Questionnaire Population and Skin Test Population.

	1994 Questionnaire			1994 Skin Test		
	Total	Atopic[a]	Non-atopic	Total	Atopic[b]	Non-atopic
Subjects	92	18	74	71	22	49
Male	77	14	64	58	20	38
Female	15	4	11	13	2	11
Mean Age	39.33 (12.6)	41.3 (13.1)	38.16 (12.7)	39.25 (10.9)	37.25 (8.6)	39.84 (11.5)
Smoking Status						
Current	41	8	33	34	11	23
Never	40	6	34	32	10	22
Ex-smoker	11	5	6	5	1	4
Mean % Pred. FEV_1	96.73 (12.5)	100.00 (12.6)	95.55 (12.4)	96.70 (13.1)	97.85 (12.6)	94.6 (13.6)
Mean % Pred. FVC	98.4 (10.4)	99.5 (8.6)	97.85 (11.4)	97.70 (12.0)	99.0 (12.9)	96.0 (11.2)

[a]physician-confirmed atopy.
[b]atopy is defined as ≥ 1 positive number.

Table 2. Baseline Data Sorted by Number of Positive Skin Tests.

Positive Skin Test	0	1	>1
Number	49	8	14
Age[a]	30.2 (8.9)	28.6 (7.9)	26.4 (6.0)
Male:Female	38:11	8:0	12:2
Black:White	6:43	3:5	6:8
Current-Ex:Never	26:23	5:3	7:7
% Pred. FEV_1[a]	94.6 (13.6)	96.5 (12.2)	99.2 (15.0)
% Pred. FVC[a]	96.0 (11.2)	96.0 (12.2)	102.0 (13.6)

[a]Mean (SD)

		1994 Questionnaire			
		No Hayfever Allergy	Hayfever/ Allergy	Confirmed Hayfever/ Allergy	Total
1991 Questionnaire	No Hafever/ Allergy	55	2	3	60
	Hayfever/ Allergy	5	8	2	15
	Confirmed Hayfever/ Allergy	2	2	13	17
	Total	62	12	18	92

Figure 1. Comparison of Atopic Status as Determined by 1991 Questionnaire and 1994 Questionnaire.

		Skin Test			
		0 + Reaction	1 + Reac tion	>1 + Reac-tion	Total
1994 Questionnaire	No Hayfever/ Allergy	40	3	4	47
	Hayfever/ Allergy	2	2	5	9
	Confirmed Hayfever/ Allergy	7	3	5	15
	Total	49	8	14	71

Figure 2. Comparison of Atopic Status as Determined by 1994 Questionnaire and by Skin Test.

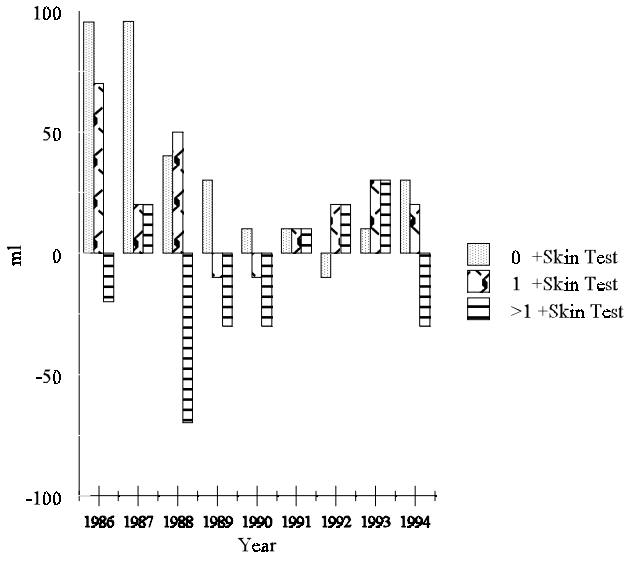

Figure 3. Acute Changes in FEV_1.

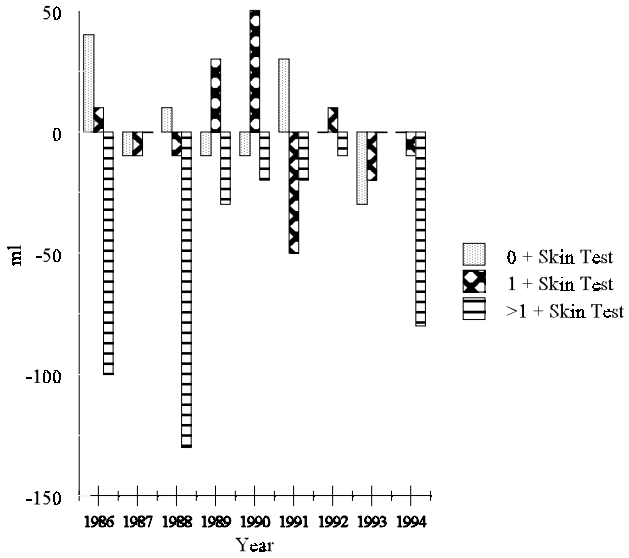

Figure 4. Acute Change in FVC

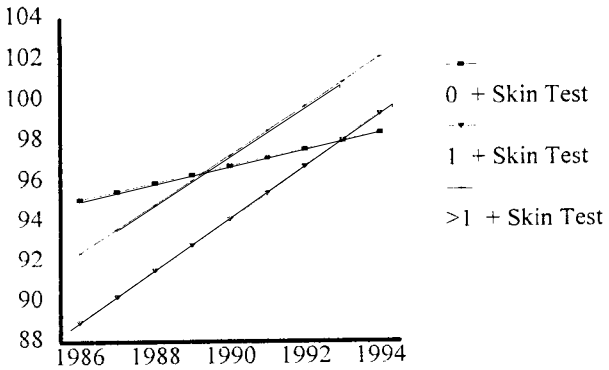

Figure 5: Annual Change in % of Predicted FEV1

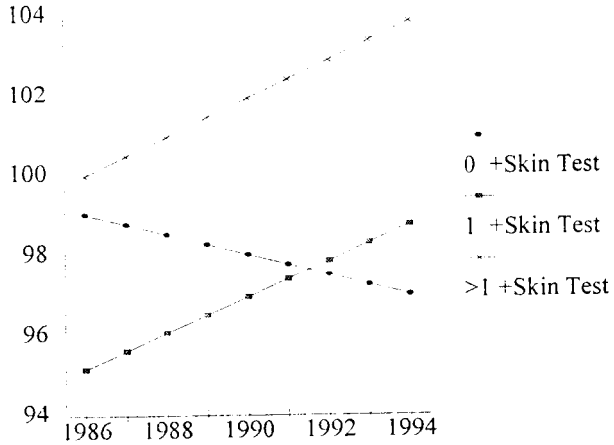

Figure 6. Annual Change in % of Predicted FVC