

A Comparison between Venables Standardized Respiratory Questionnaire and Pre-Shift Spirometry in Screening of Occupational Asthma in a Steel Industry

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Abstract

Background: Occupational asthma (OA) is the most common occupational lung disease in developed countries. One of the causative agents is metal fume that may be encountered in steel industries. Screening for the OA is mainly performed by questionnaire but in our country spirometry is used more commonly.

Objective: To compare the diagnostic value of the Venables standardized respiratory questionnaire and pre-shift spirometry as screening tools for OA.

Method: In a cross-sectional study, we investigated 450 workers of a steel industry by the Venables standardized questionnaire. We also performed a pre-shift spirometry as the screening spirometry and a post-shift spirometry. A person with 10% drop in post-shift FEV₁ compared with the pre-shift value was considered as asthmatic (our gold-standard). The results of the questionnaire and the pre-shift spirometry were then examined against the gold-standard test results. For each test, sensitivity, specificity, positive and negative predictive values were calculated.

Results: The overall prevalence of OA among our studied workers was 3.9% (95% CI: 1.9%–5.9%). The highest rate was seen in those working in catering (25%) and welding (10%) units. Pre-shift spirometry and the questionnaire had low sensitivity (42.9% and 28.6%, respectively) and positive predictive values (16.7% and 3.6%, respectively); moderate specificity (92.4% and 71.6%, respectively) and high negative predictive values (97.9% and 96.5%, respectively).

Conclusion: Taking into account the ease of use of the questionnaire, it seems that it is more feasible to use questionnaire as the primary screening tool for the diagnosis of OA.

Keywords: Occupational asthma; Steel industry; Venables questionnaire; Spirometry; Prevalence

Introduction

Over the last two decades, occupational lung diseases such as asthma and pneumoconiosis have

become major contributors to mortality and disability, particularly in developing countries.¹ Occupational asthma (OA) will continue to be the most important occupational lung disease during the 21st cen-

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TAKE-HOME MESSAGE

- Major contributors to mortality and disability, particularly in developing countries, are asthma and pneumoconiosis.
- Occupational asthma is the most common occupational lung disease in developed countries.
- Early diagnosis and early avoidance of future exposure to its cause are improved the outcome of disease.
- Questionnaire can be used as primary screening tool for the diagnosis of occupational asthma, though pre-shift spirometry had higher sensitivity and specificity.
- Negative results obtained by the questionnaire should be considered non-asthmatic, while those with a positive test result should be assessed by more sophisticated tests to be labeled as asthmatics.

ture.²

OA is believed to be responsible for up to 15% of all new cases of asthma in the US. Evaluation of patients with asthma, therefore, requires a careful and thorough work history to identify or exclude potential causes or triggers for asthma.³ Occupational exposures now account for 20% of adult-onset asthma. Overall, the incidence has not declined, but recognition of the problem and taking appropriate actions have resulted in dramatic reductions in some causes of OA.⁴

OA is characterized by airway obstruction and hyper-responsiveness due to work exposures. It is categorized into work-induced (asthma caused initially by work exposures) and work-aggravated (pre-existing asthma aggravated by work

exposures) asthma. Accurate diagnosis of each category is important since different managements are required.²

OA is the most common occupational lung disease in developed countries. There are considerable inter-population differences in the estimated incidence of OA that is in part due to differences in local industries and employment situations.⁵ The prevalence of OA is 13%–15% in industrialized countries and developing nations with rapid industrialization. The rate in less industrialized developing countries, however, is lower (6%).¹

There are some exposures which are accepted as causative agents of OA and include animal and vegetable proteins, isocyanates, colophony, latex, metal working fluids, glutaraldehyde, chrome, and cobalt.⁶

Occupational factors are estimated to account for 9%–15% of cases of asthma in adults of working age.⁷ Those workers with increased risk of developing asthma include bakers, food processors, chemical workers, plastic and textile workers, metal workers, and welders.^{7,8} There have been some outbreaks of OA due to use of cobalt in valve manufacture and chrome in stainless steel foundry.⁸

The risk of sensitization and OA is increased by higher exposure to many workplace agents.⁷ Health surveillance can detect OA at early stages of the disease and outcome is improved in workers who are included in a health surveillance program.⁷

Prognosis of OA is improved by early identification and early avoidance of future exposure to its cause.⁷ The likelihood of improvement or resolution of symptoms is greater in workers who have relatively normal lung function at the time of diagnosis and have shorter duration of symptoms prior to making the diagnosis.⁷ Early diagnosis of OA is extremely important, since this is a potentially curable

disease. The likelihood of improvement or resolution of symptoms, or of preventing deterioration is greater in workers who have no further exposure to the causative agent, relatively normal lung function at the time of diagnosis, and shorter duration of symptoms both prior to diagnosis and prior to avoidance of exposure.⁹

Some evidence considers questionnaire as the best method for screening of OA, although there is not consensus about this.⁵ The diagnosis is complicated and controversial; it will not be reached without a high index of suspicion and without asking questions about the temporal relationship of symptoms with work.¹⁰

The following items may help us diagnose OA: a) changes in work just prior to the onset or worsening of symptoms; b) unusual exposure within 24 hours prior to the onset or worsening of symptoms; c) symptoms are less severe on vacation or holidays; and d) there are also symptoms of allergic rhinitis and allergic conjunctivitis at work.¹¹ The main items to be asked from workers are wheezing and nasal and ocular itching.¹²

In Iran, screening of OA is usually done by spirometry. We conducted this study to compare the sensitivity and specificity of the Venables standardized respiratory questionnaire with pre-shift spirometry in screening of OA in a steel industry.

Patients and Methods

In this cross-sectional study conducted in a steel plant in Yazd, Central Iran, All the workers (n=450) were assessed for OA. After completing a questionnaire containing demographic data, smoking history, current and previous job(s) and duration of employment, personal and family history of asthma and allergy, and symptoms of upper airway irritation, participants were asked to complete the Venables standardized respiratory questionnaire. The ques-

tionnaire consists of nine questions about respiratory symptoms during the last year. The questions include cough, chest tightness and wheeze during climbing stairs or running; difficulty in breathing and wheeze which breaks sleep; difficulty in breathing and wheeze which appears in the morning; and wheeze in a smoky or very dusty place. If an individual had three or more positive responses to the above questions, the test was considered positive. Some questions about change in symptoms during a work day, work week, and weekends were also asked.

Then, each of the participants underwent spirometry—before and after work shift. The spirometry was performed (Spirolab II, MIR, Italy) in the plant in standard condition (sitting position, in the morning, at BTPS—standard body temperature and pressure) by a trained operator with supervision of an occupational medicine specialist. The highest of three technically acceptable recordings was taken as the final result.¹³ After baseline test, the participants went to their work places.¹³ Before performing the test, all factors intervening or contraindicating spirometry were questioned (*i.e.*, uncontrolled hypertension, recent surgery on thorax, abdomen and eye, recent myocardial ischemia or unstable angina, active hemoptysis, recent pulmonary infections, smoking or heavy meal during the last hour). Those participants with obstructive pattern in pre-shift spirometry were considered as suspicious for asthma in screening spirometry.

At the end of shift, post-shift spirometry was performed with the same device, same operator and in the same condition. Based on the amount of decline in post-shift spirometry (at least 10% decrease in FEV₁ compared with the pre-shift value), the study cases were then divided into two groups of “asthmatics” and “nonasthmatics.”⁶ The average difference in main spirometric indices (*i.e.*, FVC, FEV₁, FEV₁/

Table 1: Prevalence of asthma stratified by workplace. Only those places with five or more workers were included.

Workplace	Number of workers	Number of patients with asthma (%; 95% CI)
Melt	70	1 (1; 0–4)
Roller	113	3 (2.7; 0–5.7)
Lathes	90	3 (3; 0–7)
Welding	20	2 (10; 0–24)
Scrap	22	1 (5; 0–14)
Construction	30	2 (7; 0–16)
Catering	8	2 (25; 0–61)
Wire works	8	0 (0)
Total	361	14 (3.9; 1.9–5.9)

FVC) and volumes of isoflow ($FEF_{25\%-75\%}$) were measured and compared between the two groups. In this study, a 10% decline in FEV_1 in post-shift compared to pre-shift spirometry was considered the gold standard criterion for the diagnosis of OA. Statistical analysis was performed by SPSS® ver. 14.5. A p value <0.05 was considered statistically significant.

This study was approved by the Ethics Committee of Shahid Sadoughi University of Medical Sciences, Yazd, Iran. All participants gave written informed consents to enter this study.

Results

Nearly 10% of participants could not complete the questionnaire accurately or perform the spirometric maneuvers acceptably, or did not come back for the post-shift spirometry, and thus were excluded from the study. All the studied continuous variables were normally distributed. The studied workers had a mean±SD age of 32±7.4 (range: 18–64) years. The mean±SD duration of employment in the current and previous job was 4.6±4.5 (range: 1–24) and 4.6±4.8 (range: 0–24) years, respectively.

Table 2: Mean±SD spirometry values measured before and after shift.

Parameter	Before shift	After shift	p value
FEV_1 (L)	3.54±0.61	3.51±0.61	0.002
$FEV_1\%$	86.75±11.97	85.87±11.62	0.002
FVC (L)	4.24±0.72	4.18±0.72	<0.001
FVC%	86.99±11.34	85.68±11.17	<0.001
FEV_1/FVC	83.06±6.57	84.01±6.08	0.015
$FEF_{25\%-75\%}$	3.86±1.08	3.85±1.03	0.77
$FEF_{25\%-75\%}$	82.4±22.96	82.19±21.41	0.76

Two-hundred and one (44.7%) of the 450 studied workers had a previous job (52.0% with exposure to asthmogens). Table 1 shows the prevalence of asthma in different work-places. The prevalence of asthma was significantly different among various workplaces ($p = 0.038$). Seven percent of those with asthma and 21% of workers without asthma were smokers ($p = 0.21$; OR = 0.29; 95% CI: 0.038–2.27).

The mean±SD pre- and post-shift spirometry values are shown in Table 2. The mean±SD age was 37±11 and 32±7.4 years for asthmatics and non-asthmatics, respectively ($p = 0.02$). The mean±SD current job duration of employment was 7.5±5.2 years for asthmatics and 4.5±4.5 for non-asthmatics ($p = 0.015$). The overall prevalence of OA among our studied workers was 3.9% (95% CI: 1.9%–5.9%). The highest rate was seen in those working in the kitchen (25%) and welding (10%) units (Table 1).

Tables 3 and 4 show the results obtained from pre-shift spirometry and questionnaire against the gold-standard test defined earlier.

Discussion

OA includes airway obstruction and hyper-responsiveness due to work exposures. Different authors reported different prevalence rates of OA. The overall prevalence of OA among our studied workers was 3.9% (95% CI: 1.9%–5.9%) which is consistent with findings of El-Zein.¹⁴ The highest rate was seen in those working in catering (25%) and welding (10%) units (Table 1). Those working in the catering unit had a higher mean age; many of them were old workers who were transferred to the kitchen after 3-4 years of work elsewhere. This observation can partly be explained by existence of high level of asthmogens in the kitchen.

There is no definite recommendation

Table 3: Comparison of pre-shift spirometry and the gold-standard test

		10% decrease in post-shift FEV ₁ compared with the pre-shift value		Total
		Yes	No	
Obstructive pattern in pre-shift spirometry	Yes	6 (17%)	30 (93%)	36
	No	8 (2.3%)	367 (97.7%)	375
Total		14 (3.4%)	397 (96.6%)	411

Sensitivity = 42.9%; 95% CI = 17.7%–71.1%
 Specificity = 92.4%; 95% CI = 89.4%–94.8%
 Positive predictive value = 16.7%; 95% CI = 6.4%–32.8%
 Negative predictive value = 97.9%; 95% CI = 95.8%–99.1%

on using a specific test as the screening test of choice for OA. However, “questionnaire” has been introduced as one of the best screening methods in some references⁵—it is mentioned that spirometry does not add any benefits.

In this study, we compared the diagnostic value of the Venables standardized respiratory questionnaire and pre-shift spirometry as screening tools for OA against our gold-standard test—10% decrease in post-shift FEV₁ compared with the pre-shift value. Pre-shift spirometry

Table 4: Comparison of questionnaire and the gold-standard test

		10% decrease in post-shift FEV ₁ compared with the pre-shift value		Total
		Yes	No	
Asthma as diagnosed by questionnaire	Yes	4 (3.6%)	108 (96.4%)	112
	No	10 (3.5%)	272 (96.5%)	282
Total		14 (3.6%)	380 (96.4%)	394

Sensitivity = 28.6%; 95% CI = 8.4%–58.1%
 Specificity = 71.6%; 95% CI = 66.7%–76.0%
 Positive predictive value = 3.6%; 95% CI = 1.0%–8.9%
 Negative predictive value = 96.5%; 95% CI = 93.6%–98.3%

had higher sensitivity, specificity, positive predictive value (PPV) and negative predictive value (NPV) than the questionnaire (Tables 3 and 4).

Some studies emphasized that a questionnaire that can identify symptoms of wheeze and/or shortness of breath which improve on days away from work or on holiday have a high sensitivity, but relatively low specificity for the diagnosis of OA.⁷ Our results were in contrast to these findings—we obtained a low sensitivity of 28.6% and a moderate specificity of 71.6% for the questionnaire (Table 4). It was shown that the Venables standardized respiratory questionnaire has a sensitivity and specificity of 65%–91% and 85%–96% for the diagnosis of OA.^{15,16}

In this study, people with 10% decline in post-shift FEV₁ compared with pre-shift value, were considered “asthmatic.”⁶ Nonetheless, this is not a definite test for the diagnosis of asthma. It is better to employ more reliable methods such as non-specific or specific challenge tests for making the final diagnosis. This is one of the limitations of our study as we used the former definition as the gold-standard test for the diagnosis of asthma.

Considering all the diagnostic indices of the two screening tools examined (Tables 3 and 4), and taking into account the ease of use of the questionnaire, it seems that it is more feasible to use questionnaire as the primary screening tool for the diagnosis of OA. Considering the very high NPV of the questionnaire, those with negative results in the screening should be considered non-asthmatic, while those with a positive test result should be assessed by more sophisticated tests to be labeled as asthmatics.

Conflicts of Interest: None declared.

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