Work-related respiratory symptoms and pulmonary function tests in Iranian printers

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ABSTRACT

الأهداف: تقييم اختبار دور الرئة وتكرار الأعراض الشخصية لأعراض الجهاز التنفسي والأعراض الأرجيه المتعلقة بالعمل بين الأفراد العاملين رسامين.

الطريقة: أجريت هذه الدراسة خلال الفترة من يونيو حتى أكتوبر 2007 مدينة مشهد – إيران. تمت دراسة تكرار أعراض الجهاز التنفسي والأرجيه المتعلقة بالعمل في عينة من 73 رسام (المجموعة الأولى) و 73 شواهد مقابلة (المجموعة الثانية) مستخدمين استبيان للعام الماضي. تم قياس اختبار العمل الرئوي(PFT) في المجموعة الأولى والمجموعة الثانية.

النتائج: اشتكى 30 فرد 41% من المجموعة الأولى بأعراض الجهاز التنفسي المتعلقة بالعمل. كانت أكثر الأعراض عسر التنفس 30% و السعال 27%، كما اشتكى 16.5% في المجموعة الأولى من أزيز خلال العمل. كانت جميع الأعراض التنفسية لدى المجموعة الأولى أعلى من المجموعة الثانية p=0.04 حتى p=0.002. كانت الأعراض الأرجيه (الارتكاريا) مهمة بشكل أعلى في المجموعة الأولى عن المجموعة الثانية p=0.048 حتى p=0.009. إضافة إلى ذلك، كانت أعراض الجهاز التنفسي والأرجيه أعلى خلال العمل مقارنة بالأوقات الأخرى، التي كانت ملحوظة للسعال، وعسر التنفس، وسيلان الأنف و القيمة الإحصائية لجميع الحالات p<0.049, p<0.21. كانت قيم (PFT) منخفضة جميعاً في المجموعة الأولى مقارنة مع المجموعة الثانيةp=0.006 حتى p<0.0001.

خاتمة: أن العمل المطبعي متعلق بتكرار الأعراض الأرضية وأعراض الجهاز التنفسي المتعلقة بالعمل بشكل عالي. كانت قيم (PFT) منخفضة بشكل ملحوظ لدى الأفراد في المجموعة الأولى.

Objectives: To assess lung function tests and self-reported frequency of work related respiratory and allergic symptoms among subjects working as printers.

Methods: This study was carried out from June to October 2007 in Mashhad city, Iran. The frequency of work-related respiratory and allergy symptoms was studied in a sample of 73 printers (group I), and 73 matched controls (group II) using a questionnaire in the past year. Pulmonary function tests (PFT) were also measured in group I and group II.

Results: A total of 30 (41%) subjects from group I reported work-related respiratory symptoms. Breathlessness (30%) and cough (27%) was the most common symptoms, and 16.5% in group I reported wheezing during work. All respiratory symptoms in group I were significantly greater than those in group II (p=0.04 to p=0.002). Allergic symptoms (except urticaria) were also significantly greater in group I than those in group II (p=0.048 to p=0.009). In addition, respiratory and allergic symptoms were greater during work compared with the rest period, which was significant for cough, breathlessness, and runny nose (p<0.21 to p<0.049 for all cases). All PFT values were also significantly lower in group I compared to group II (p=0.006 to p<0.0001).

Conclusion: Printing work is associated with a high frequency of work related respiratory and allergic symptoms particularly during work period. The PFT values were also significantly reduced among subjects in group I.

Saudi Med J 2009; Vol. 30 (9): 1170-1175

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Received 12th May 2009. Accepted 11th August 2009.

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Occupational diseases are a major concern, and many studies have been made to figure out high risk occupations. Observatoire National des Asthmes Professionnels (ONAP) involved a network of occupational and chest physicians to report the incidence of occupational asthma in France. The findings of ONAP reported the highest risk of occupational asthma in bakers and pastry makers (683/million).[1] Exposure to various allergen and irritating chemicals may cause occupational respiratory symptoms, bronchoconstriction, cutaneous and rhino-conjunctival reactions. Printing industry is an occupation in which workers are exposed to ink, paper dust, and fumes from printing machines, which exposure to all of these noxious elements could influence health status. Time spent in the printing room and exposure to ink and benzopyrene correlates positively with lung cancer.[2] These workers are at high risk of developing chronic pharyngitis, chronic liver diseases, mechanical injuries, nasopharyngeal carcinoma, and benign skin tumor.[3] Printers who are exposed to 70 mg/dl of lead can get severe poisoning and respiratory disorders.[4] Increased respiratory and allergic symptoms, and decreased PFT values in spray printers exposed to paints containing hexamethylene di-isocyanates in South Africa, and sick building syndrome symptoms in Swedish population exposed to paper dust were reported.[5,6] Exposure to water-based inks can lead to self-reported asthma, lower airway symptoms, bronchial hyperresponsiveness (BHR), and reductions of lung function.[7] It has been also shown that triglycidyl isocyanurate (TGIC) can cause occupational asthma.[8] Lower respiratory symptoms in printers exposed to water-based paint as compared to other paints, and induction of skin and respiratory allergic disease caused by water-based paints due to polyfunctional aziridine (PFA) are shown.[9,10] Long-term exposure to paint solvent can also lead to nocturnal respiratory disorders.[11] In addition, increased pulmonary alveolar proteinosis (PAP) in a painter with elevated pulmonary concentrations of titanium has been reported.[12] Few studies have suggested that some common environment exposures in the work place of printers, such as exposure to carbonless copy paper,[13] and fumes from printer machines affects health adversely.[14] Increased respiratory symptoms and asthma was reported among people with other occupation, including bakers and pastry chefs.[15-17] In addition, increased respiratory symptoms and asthma was also reported in car spray painters,[18,19] which is mostly due to isocyanates exposure. Di-isocyanates are a group of low molecular weight aromatic and aliphatic compounds. They are widely used in the manufacture of flexible and rigid foams, fibers, coatings, such as paints, and varnishes, and elastomers. The aims of this study were to assess lung function tests, and self-reported frequency of work related respiratory and allergic symptoms among printers compared to unexposed controls.

Disclosure. This study was financially supported by the Research Council of Mashhad University of Medical Sciences, Mashhad, Iran.

Methods. A cross-sectional study was designed in the city of Mashhad on the North East of Iran from June to October 2007, to assess respiratory and allergic symptoms and lung function tests in a cohort of male printers (group I), who were exposed to chemicals due to the nature of the job, and a control group of unexposed males (group II). The study included 73 printers (mean ± SD: 32.55 ± 8.17 years) and 73 matched controls (mean ± SD: 32.50 ± 8.13 years) (**Table 1**). Group I worked in different printing houses, and group II were selected from the same residential district (all subjects resided in Mashhad city). All printing houses in the Mashhad city were identified, and the printers of half of them (randomly selected) were studied. All subjects in group I were working with printing ink and papers, and were constantly exposed to printing machine fumes. Subjects in group II were people with other jobs, which were selected from the adjacent area of each printing house. The participants were selected through non-probability (purposive) sampling method. All participants answered the designed questionnaire through a face-to-face interview. The study was approved by the ethical committee of our institution and informed consent was obtained from each subject. The study was carried out during summer and autumn of 2007. A Persian questionnaire*(Appendix) derived from pre-existing studies[20-22] was used to assess the respiratory and allergic symptoms. The questionnaire included questions on exposure pattern, respiratory symptoms, rhino-conjunctivitis, dermal reactions, smoking habits, and working hours each week. Symptoms experienced daily by the studied subject within the last week was considered as positive response. The participants answered questions regarding all employment years as a printer. They also stated if they for some reason quitted working as a printer for periods of more than a year. The questionnaire also contained questions on glove use, mask or ventilation during work, and whether it reduces the intensity of work-related symptoms. Pulmonary function tests (PFT) in group I

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and group II were measured using a spirometer with a pneumotachograph sensor (Model ST90, Fukuda, Sangyo Co., Ltd. Japan). Prior to pulmonary function testing, the required maneuver was demonstrated by the operator, and subjects were encouraged and supervised throughout the test performance. Pulmonary function testing was performed using the acceptability standards outlined by the American Thoracic Society (ATS) with subjects in standing position and wearing nose clips.[23] All tests were carried out between 1000 and 1700 hours. The PFT were performed 3 times in each subject with an acceptable technique. The highest level for forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), peak expiratory flow (PEF), maximal expiratory flow at 75%, 50%, and 25% of the FVC (MEF_{75}, MEF_{50}, and MEF_{25}, respectively) were taken independently.[24]

The data of PFT values and age were expressed as mean ± SD, and the data of respiratory and allergic symptoms as percentage of each group having the corresponding symptom. Differences in the data of symptoms between group I and group II were tested by Chi-square analysis on a 2x2 contingency tables. Differences in the data of symptoms between group I and group II, and also between rest and work period were also tested by calculating relative risk, and the 95% confidence intervals. The data of PFT values between group I and group II was tested using unpaired t test. A 2-sided *p*-value of 0.05 was the criterion for statistical significance. All analyses were performed with Statistical Package for Social Sciences software version 11.5 (SPSS Inc., Chicago, IL., USA).

Table 1 - Characteristic of printers and control group (all male).

Variables	Printers n=73	Control n=73
Age, mean ± SD	32.55 ± 8.17 years	32.50 ± 8.13 years
PCVD	None	None
PRD	None	None
Smoking	7	6
Working time, hours	4 - 12	-
Working duration, mean ± SD	11 ± 2.2 years	-

SD - standard deviation, PCVD - previous cardiovascular disease, PRS - previous respiratory disease

Results. A total of 30 (41%) subjects from group I reported work-related respiratory symptoms. Breathlessness (30%) and cough (27%) was the most common symptom, and 16.5% in group I reported wheezing at work. All respiratory symptoms in group I were significantly greater than those in group II (p=0.04 to p=0.002) (**Table 2**). Allergic symptoms (except urticaria) were also significantly greater in group I than those in group II (p=0.048 to p=0.009) (**Table 2**). All respiratory symptoms were greater during work compared with the rest period, which was significant for cough and breathlessness (p<0.021 and p<0.047, respectively). In addition, allergic symptom was also greater during work compared with the rest period, which was only significant for runny nose (p=0.049) (**Table 3**). All PFT values were significantly lower in group I than in group II (p=0.006 to p<0.001, **Table 4**).

Discussion. The results of the present study showed a significantly greater respiratory symptom, and lower PFT values in group I compared to group II, which indicates the effect of chemical exposure on

Table 2 - Comparison of respiratory and allergic symptoms between printers and control subjects.

Symptoms	Printers n (%)	Control n (%)	RR	CI	*P*-value
Respiratory					
Cough	20 (27.4)	7 (9.6)	0.350	0.159-0.777	0.003
Sputum	14 (19.2)	6 (8.2)	0.429	0.174-1.054	0.04
Breathlessness	22 (30.1)	8 (10.9)	0.364	0.173-0.763	0.002
Wheezing	12 (16.4)	5 (6.9)	0.417	0.155-1.123	0.04
Allergic					
Sneezing	10 (13.7)	4 (5.5)	0.400	0.131-1.218	0.048
Runny nose	13 (17.8)	4 (5.5)	0.310	0.105-0.900	0.009
Itchy eye	7 (9.6)	2 (2.7)	0.286	0.061-1.330	0.047
Urticaria	5 (6.8)	3 (4.1)	0.600	0.149-2.420	NS

n=73 for each group, RR - relative risk, 95% confidence interval (CI), NS - non significant differences

Table 3 - Comparison of respiratory and allergic symptoms in printers between rest and work period (N=73).

Symptoms	Rest period n (%)	Work period n (%)	RR	CI	*P*-value
Respiratory					
Cough	10 (13.7)	20 (27.4)	0.500	0.252 - 0.993	0.021
Sputum	9 (12.3)	14 (19.1)	0.643	0.297 - 1.391	NS
Breathlessness	11 (15.0)	22 (30.1)	0.500	0.262 - 0.955	0.047
Wheezing	7 (9.6)	12 (16.4)	0.583	0.243 - 1.398	NS
Allergic					
Sneezing	7 (9.6)	10 (13.7)	0.700	0.282 - 1.739	NS
Runny nose	6 (8.2)	13 (17.8)	0.462	0.186 - 1.148	0.049
Itchy eye	3 (4.1)	7 (9.6)	0.429	0.115 - 1.594	NS
Urticaria	4 (5.5)	5 (6.8)	0.800	0.224 - 2.861	NS

RR - relative risk, 95% confidence interval (CI), NS - non significant differences

Table 4 - Comparison of pulmonary functional tests (PFT) between control subjects and printers.

PFT values	Printers	CI	Control	CI	*P*-value
FVC	62.36 ± 19.32	57.85 - 66.90	96.27 ± 16.82	92.35 - 100.20	<0.001
FEV_1	68.15 ± 18.66	63.80 - 72.51	98.84 ± 19.05	94.40 - 103.29	<0.001
MMEF	84.45 ± 23.98	78.86 - 90.05	94.43 ± 23.70	88.91 - 99.97	0.006
PEF	56.68 ± 21.21	53.74 - 63.64	96.96 ± 18.29	92.70 - 101.24	<0.001
MEF_{75}	57.57 ± 25.69	51.58 - 63.57	103.49 ± 21.96	98.37 - 108.62	<0.001
MEF_{50}	83.44 ± 27.09	77.12 - 89.76	97.30 ± 27.32	90.94 - 103.68	0.0012
MEF_{25}	89.96 ± 14.04	86.68 - 93.23	100.04 ± 21.68	94.98 - 105.10	0.0005

Values were presented as mean ± SD (for each group n=73), FVC - forced vital capacity, FEV_1 - forced expiratory volume in one second, MMEF - maximal mid-expiratory flow, PEF - peak expiratory flow, MEF_{75}, MEF_{50}, and MEF_{25} - maximal expiratory flow at 75%, 50%, and 25% of the FVC, respectively. CI - 95% confidence interval

respiratory status of these workers. The results also demonstrates a significant greater frequency of some allergic symptoms among group I, indicating that irritant chemicals related to printing can induce allergy in people with this job. In addition, the respiratory and allergic symptoms were significantly higher while group I were at work, compared with while they were not working. This finding confirms that chemical exposure of work environment induces respiratory and allergic symptoms.

Previous studies also showed increased respiratory and allergic symptoms and lower PFT values among printers that supports the results of our study. Time spent in the printing room and exposure to ink and benzopyrene, used in printing material correlates positively with lung cancer.[2-5] A survey of automotive spray-painting establishments was undertaken in a study by Randolph et al[5] to evaluate the respiratory health status of spray-painters exposed to paints containing HDIs showed increased respiratory and allergic symptoms in printers, and indicate the risk of exposure to HDIs in the spray-painting industry, and highlights the need for more stringent industrial hygiene controls.[6] The TGIC, an epoxy compound, is often used as a hardener in paints. Several cases of allergic eczema and occupational asthma from occupational exposure to TGIC have been reported. Therefore, TGIC is capable of causing skin and respiratory allergy.[8] Water-based paints contain organic solvents and many additives, such as biocides, surfactants, pigments, binders, amines, and monomers. The chemical complexity may introduce new potential health hazards to printers, in particular irritative and allergic disorders. The study of Wieslander et al[9] indicates that the introduction of water-based paints and inks have improved the work environment for printers. Water-based paints cause less discomfort and airway irritation than the earlier solvent-based inks and paints.[9] However, PFA hardener is increasingly used in water-based inks and paints, as a replacement for organic solvents. The PFA is a strong

sensitizer, and the use of gloves and protective clothing appears to be insufficient to prevent occupational allergic diseases. In fact, lower respiratory symptoms in printers exposed to water-based inks compared to other inks, and induction of skin and respiratory allergic disease caused by water-based inks due to PFA are shown.[10] Therefore, the elimination of PFA from production processes is desirable. In addition, the associations between occupational exposure to water-based inks and the prevalence of self-reported asthma, other lower airway symptoms, BHR, and lung function was studied in printers, and a decrease in FEV1 and FVC during the workday was observed in young printers. The increased BHR compared to the controls and a decreased FEV1 was also observed in these printers.

The number of years working as a printer was related to a decrease in FEV_1, who also reported lower airway symptoms in relation to the degree of work with water-based inks.[7] The reduction in FEV_1 and increase respiratory symptoms seen in the study of Wieslander et al[7] is also in agreement to our study. Long-term occupational solvent exposure might also contribute to sleep-disordered breathing.[11] A professional worker who developed PAP with severe respiratory failure was reported, which indicates that titanium should be recognized as a potential cause of PAP in humans.[12] The ONAP also stated that the highest risks of occupational asthma were found in bakers and pastry makers, car painters, printers, and wood workers,[1] which were in line with the results of our study. Exposure to water-based paints can lead to self-reported asthma, lower airway symptoms, BHR, and reductions of lung function.

The important finding of the present study is the greater reduction in PFT values related to larger airways such as FEV_1, PEF, and MEF_{75}. These findings indicate the effect of irritants related to printing mainly affect large rather than small airways. These finding may be in contrast to the finding of the study of Wieslander et al[9] showing lower respiratory symptoms in printers exposed to water-based paints. The reason of this discrepancy is perhaps the differences in the type of ink that painters of the 2 studies were exposed. The subjects in group I in our present study are mostly exposed to non-water based inks. In fact, the study of Wieslander et al[9] showed lower respiratory effect of water-based inks and paints. In addition, the effect of exposure to paper dust and to fumes from photocopiers and printers on increased breathlessness and upper respiratory infections has been demonstrated.[25]

There were some limitations in this present study. Only the measurement of PFT was fully explained for the information of the studied subjects and it took a long time in some cases. The evaluation of respiratory and allergic symptoms also required full explanation of the symptoms to other subjects.

In conclusion, the results of this study showed that working in a printing-house is associated with a high frequency of work related respiratory and allergic symptoms particularly during work period. The PFT values were also significantly reduced among printers. To find out the exact effects of printing job on respiratory and allergic status of the individual, on exposure to paper alone, different types of ink and printing machine fumes on PFT, respiratory and allergy must be studied. In addition, the respiratory and allergic status in workers of work place with different ventilation and other hygiene conditions should be compared.

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