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RESPIRATORY DISORDERS AMONG WORKERS IN A TOBACCO FACTORY

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Abstract:

Objectives: This work aimed to study respiratory disorders and pulmonary function tests among workers in a tobacco factory along with measurements of levels of serum IgE, and urinary cotinine and studying dust level inside the factory. **Subjects & methods**: The study was carried out on 79 randomly selected tobacco processing workers in a tobacco manufacturing factory in Menoufia Governorate and 80 voluntarily participating controls. Both groups matched for age, sex, residence, income and educational level and were subjected to a structured chest symptoms questionnaire, clinical chest examination, spirometric measurements and measurements of total serum IgE (IU/ml) and urinary cotinine (ng/ml) by Enzyme Immuno Assay (EIA). Environmental total and respirable dust was measured inside the factory. **Results**: Tobacco workers reported significantly higher respiratory symptoms and signs (cough, expectoration and wheezes), ($P<0.05$) as compared with controls and had lower mean values of predicted spirometric measurements (FVC, FEV_1 and FEV_1/FVC), $P<0.001$. Values of serum IgE level (IU/ml) and urinary cotinine (ng/ml) were significantly higher among tobacco workers (75.06 ± 43.69 and 1422.73 ± 1265.59) than controls (57.43 ± 38.55 and 84.33 ± 82.89, respectively), $P < 0.05$. Smoker and non-smoker tobacco-exposed workers had statistically significantly lower mean percentage values of predicted of FVC, FEV1 and FEV_1/FVC as compared with smoker and non-smoker controls, ($P <0.05$). In addition, urinary cotinine and serum Ig E were significantly higher among smoker and non-smoker exposed workers as compared with exposed and non-smoker controls. A negative weak and significant correlation between spirometric measurements and levels of serum Ig E is noted among tobacco workers. **Conclusion**: The respiratory impairments noted among tobacco processing workers might be due to their exposure to the work environment and sensitization to tobacco dust.

Key words: Respiratory, Tobacco, Workers, Ig E, Cotinine.

Introduction:

Respiratory impairment among workers was reported to be caused by exposure to varieties of dusts in small and large scale industries generated during their production processes; (Czeslawa et al., 1998).The nature of respiratory diseases caused by occupational dust is influenced by the type of dust and duration of exposure, (Mengesha and Bekele, 1998). Occupational diseases are caused by a pathologic response of the patients to their working environment, (Imbus, 1994). Health disorders among tobacco workers have been reported as early as the beginning of the 18th century. Ramazzini in 1713 wrote about diseases of tobacco workers especially respiratory ones. The health effects that tobacco workers complained of were associated with their workplace and in particular with the ill ventilated, damp conditions and with dust resulting from grinding of tobacco leave in the mill, (Jadranka et al., 2003). Tobacco dust contains various immunologically active as well as toxic substances, however the relationship between allergic reactivity, lung function with chronic exposure to tobacco dust remains unclear,(Quanjer et al., 1993).

In occupational respiratory diseases, spirometry is one of the most important diagnostic tools. It is the most widely used instrument to evaluate the pulmonary function status of a subject and can measure and judge the restriction or obstruction of lung function if any , (Ruppel, 1997).

Zaghloul and El- Samra (1974) stated that the urinary nicotine levels were significantly increased after the work shift in tobacco workers. Zuskin et al., (2004), found that cotinine (product of nicotine metabolism, which is used as an indicator that nicotine has been inhaled or otherwise introduced in the body) could be detected in urine two to four days after tobacco exposure.

Aim of the work:

This work aims to:

1- Study respiratory disorders among workers in a tobacco factory.

2- Measure serum IgE, and urinary cotinine levels in the studied groups.

3- Study dust level inside the factory.

Subjects and Methods:

This study was carried out from April 1st 2006 through December 2007 in a tobacco processing factory which produces

"Meaasel" (tobacco for handmade cigarettes and for chewing and snuffing) in Shebin El Kom city – Menoufia governorate.

Tobacco processing in the factory includes opening of tobacco leave bales, then cutting and grinding leaves by machine to different sizes according to the required end product and finally packing.

The only ventilation available is natural one through windows close to the roof. Working hours are from 8.00 am to 5.00 pm. Workers are exposed to tobacco mainly through inhalation and skin contact and none of the workers use skin or respiratory protection.

Subjects:

The workforce of the tobacco factory consists of 98 workers of whom 79 agreed to participate in the study (participation rate 81%); we also examined 80 control individuals who did not previously work in tobacco processing or smoke cigarettes and/or Shisha. Both exposed workers and controls were matched for age, sex, residence, income and educational level. Both groups agreed to participate voluntarily after explaining to them the objectives, tools and health risks and benefits and we also get approval from the factory administration and the Ethical Committee at Faculty of Medicine, Menoufia University.

Methods:

Each participant was subjected to the following:

1-Personal interview and filling an already prepared questionnaire, which included an inquiry about personal data, occupational history and medical history of respiratory and skin symptoms.

2- Clinical examination

General examination; weight, height, blood pressure, pulse, temperature in addition to local chest and skin examination.

3- Laboratory investigations:

A- Spirometry:

All parameters were measured using portable spirometer Spirolab II (Quest medical spirometry and equipment and supplies, MA, USA). The test was done in the sitting position and the subject was told, in simple words, the principles of the test. Measurements obtained were expressed as percentage of predicted for standing height, weight, age and sex of tested participants and include; VC, FVC, FEV1, FEV1/FVC and FEF 25-75.

B- Blood measurements of:

1- Total serum IgE level:

By using the Immunoglobulin-E (IgE) Enzyme Immunoassay. This is used for quantitative determination of Immunoglobulin E (IgE) concentration in human serum. Levels were expressed in IU/ml.

2- Urinary cotinine level:

By Enzyme Immunoassay (EIA) using Cotinine Urine Kit (M155u1) manufactured by COZART Bioscience Ltd, Oxfordshire, UK. Levels were expressed in ng/ ml.

4- Environmental studies:

Total and respirable dust was measured inside different departments of the Factory by the Hexhelt dust sampler through collection of three samples from each department and taking their average as the end result. Dust concentrations were expressed in mg / m3.

Statistical analysis:

The collected data were tabulated and analyzed by SPSS statistical package version 11 on IBM compatible computer. Quantitative data were expressed as mean and standard deviation ($\overline{X}$ +SD) and analyzed by applying student t-test for comparison of two groups of normally distributed variables and Mann Whitney U- test for non-normally distributed ones. Qualitative data were expressed as number and percentage and analyzed by applying Chi-square test. Spearman rank correlation (rs) was used to detect association between non-parametric quantitative variables.

Level of significance was set as $P < 0.05$.

Results:

The environmental dust studies at the different departments of the tobacco factory revealed that the averages of total and respirable dust concentrations (mg/m3) were highest in the bale opening department (42.50 and 13.10 respectively) followed by the cutting and grinding department (21.40 and 6.40, respectively) and were least in the packing department (10.20 and 1.98, respectively).

Exposed workers and control subjects were matched regarding age, anthropometric measurements, sex, marital status, residence, income and education level and smoking habit ($P > 0.05$). The mean age of exposed workers was 25.34 ± 8.30 compared with 24.30 ± 9.11 years for control subjects. The height (cm) and weight (kg) of exposed workers

and controls was nearly similar (166.81 ±10.31 and 166.39±11.45, respectively) and (69.35±17.89 and 67.53±11.82, respectively). Exposed workers and controls were also matched regarding their body mass index (BMI), (24.60±4.50 and 24.46±3.56, respectively). Forty eight workers (60.75%) were males and 31 (39.25%) were females compared with 55 (66.25%) male controls and 25 (33.75%) female controls, p >0.05. Forty percent of the tobacco workers were smokers, while 53.75% of the controls were smokers, p >0.05.

Chest manifestations among tobacco processing workers included cough, wheeze, expectoration and chest tightness, and were significantly more prevalent (46.80%, 40.50%, 40.50% and 22.78%) compared with controls (22.50%, 13.75%, 17.50% and 00.00%, respectively) (P < 0.05, table 1).

Mean values of spirometric measurements expressed as percentage of predicted values (FVC%, FEV1% and FEV1/FVC%) were significantly lower in exposed tobacco workers (74.23 + 17.19, 78.30 + 18.07 and 100.85 + 8.75,respectively) than controls (87.80 + 15.91, 91.15 + 16.94 and 105.54 + 11.08, respectively) ,(P < 0.001, table 2).

On studying the levels of biological markers, (serum IgE and urinary cotinine), there were statistically significantly increased values of serum IgE level (IU/ml) and urinary cotinine (ng/ml) among exposed (75.06 + 43.69 and 1422.73 + 1265.59, respectively) than controls (57.43 + 38.55 and 84.33 + 82.89, respectively), (P < 0.05, table 3).

Exposed smoking workers had statistically significantly lower mean percent of predicted values of spirometric measurements [FEV1% (72.57 + 16.84), FVC% (75.60 + 16.77) and FEV1/FVC % (101.13 + 7.91)], compared with smoking controls, [FEV1% (83.31 + 17.80), FVC% (84.41 + 16.51) and FEV1/FVC % (105.57 + 9.27)] (P < 0.05, table 4).

Nonsmoking tobacco exposed workers had statistically significantly lower mean values expressed as percentage of predicated FVC, FEV1 and FEV1/FVC (78.76 + 18.78, 84.31 + 20.63 and 100.55 + 9.64, respectively) as compared with nonsmoking controls (90.91 + 12.29, 96.14+ 14.44 and 107.66 + 12.51, respectively), (P <0.05, table 4).

Levels of serum IgE and urinary cotinine were statistically significantly higher

among exposed smoking workers (76.64 + 45.36 and 1585.79 + 1333.65, respectively) than among control smokers (68.50 + 46.36 and 136.14 + 80.86, respectively). Moreover, exposed non-smokers had statistically significantly higher values than controls non-smokers of serum IgE (IU/ml) (71.69+47.54 vs.47.54+27.74) and urinary cotinine (ng/ml) (1283.90+20.96 vs. 20.96+15.78) ($P < 0.05$, table 5).

The values of serum IgE were weakly but significantly correlated with FVC, FEV1, FVC/FEV1 and FEF25-75 measurements (rs= -0.258, -0.238,-0.233, -0.237 respectively, in exposed workers ($P<0.05$). On the other hand, urinary cotinine (ng/ml) had very weak and non-significant correlation with the percentage of predicted measured spirometric tests, (rs = 0.159, 0.085, 0.169, 0.174 and 0.144 respectively).

Table (1): Distribution of respiratory manifestations among studied groups

Chest manifestations	Studied groups				χ^2	P
	Exposed Workers n=79		Controls n=80			
	No	%	No	%		
Cough						
Yes	37	46.80	18	22.50	10.40	< 0.01*
No	42	53.20	62	77.50		
Wheezes						
Yes	32	40.50	11	13.75	14.83	< 0.001*
No	47	59.50	69	86.25		
Expectoration						
Yes	32	40.50	14	17.50	10.23	< 0.01*
No	47	59.50	66	82.50		
Crepitation						
Yes	15	18.98	7	8.75	3.49	> 0.05
No	64	81.02	73	91.25		
Chest tightness						
Yes	18	22.78	0	00.00	20.56	< 0.001*
No	61	77.22	80	100.00		

* = Statistically significant

Table (2): Mean values of spirometric measurements expressed as percentage of predicted among the studied groups

Spirometric measurements (Percent of predicted)	Group		t-test	P
	Exposed Workers n=79	Controls n=80		
	$\overline{X}$ ± SD	$\overline{X}$ ± SD		
FVC%	74.23 ± 17.19	87.80 ± 15.91	5.16	< 0.001*
FEV_1%	78.30 ± 18.07	91.15 ± 16.90	4.62	< 0.001*
FEV_1/FVC%	100.85 ± 8.75	105.54 ± 11.08	3.59	< 0.001*
FEF_{25-75}%	111.76 ± 39.61	121.57 ± 34.24	1.67	> 0.05

* = Statistically significant

Table (3): Comparison of mean ± SD of serum IgE and urinary cotinine among exposed and control participants

Studied variables	Group				Mann-Whitney U-test	P
	Exposed Workers n=79		Controls n=80			
	$\overline{X}$ ± SD	median	$\overline{X}$ ± SD	median		
Serum IgE (IU/ml)	75.06±43.69	46.76	57.43± 38.55	31.67	2.77	< 0.05*
Urinary Cotinine (ng/ml)	1422.7±1265.6	1234.12	84.33± 82.89	56.34	10.50	< 0.001*

* = Statistically significant

Table (4): Studied spirometric measurements (% of predicted) of exposed tobacco workers and controls according to smoking habit

parameter	Smoking habit	Tobacco workers	Smoking habit	controls	t-test	P
FVC (%)	Smoker n= 32	72.57±16.84	Smoker n= 43	83.31±17.80	2.64	<0.05*
	Non-smoker n=47	78.76±18.78	Non-smoker n=37	90.91±12.29	3.40	<0.05*
FEV1 (%)	Smoker n= 32	75.60±16.77	Smoker n= 43	84.41±16.51	2.27	<0.05*
	Non-smoker n=43	84.31±20.63	Non-smoker n=37	96.14±14.44	2.96	<0.05*
FVC/FEV1 (%)	Smoker n= 32	101.13±7.91	Smoker n= 43	105.57±9.27	2.18	<0.05*
	Non-smoker n=43	100.55±9.64	Non-smoker n=37	107.66±12.51	2.94	<0.05*
FEF 25-75 (%)	Smoker n= 32	101.52±36.56	Smoker n= 43	105.61±31.30	0.52	>0.05
	Non-smoker n=43	126.76±39.65	Non-smoker n=37	134.87±30.60	1.03	>0.05

* = Statistically significant

Table (5): serum Ig E (IU/ml) and urinary cotinine (ng/ml) levels of exposed tobacco workers and controls according to smoking habit

parameter	Smoking habit	Tobacco workers	Smoking habit	controls	Mann-Whitney U-test	P
Serum IgE (IU/ml)	Smoker n= 32	76.64±45.36	Smoker n= 43	68.50±46.36	2.36	<0.05*
	Non-smoker n=43	71.69±22.36	Non-smoker n=37	47.54±27.74	2.13	<0.05*
Urinary Cotinine (ng/ml)	Smoker n= 32	1585.8±1333.6	Smoker n= 43	136.14±80.86	6.66	<0.001*
	Non-smoker n=43	1283.9±1231.2	Non-smoker n=37	20.96±15.78	7.83	<0.001*

* = Statistically significant

Discussion:

Tobacco dust contains various immunologically active as well as toxic substances. It has been established that occupational exposure to the dust of tobacco leaves is associated with significant increase in the occurrence of mild obstructive ventilatory disturbances, (Ignacak et al., 2002). Tobacco dust mainly contains nitrosamines, which are readily absorbed by the body tissues like skin, respiratory epithelium and mucus membrane of mouth, nose and intestines. Exposure to tobacco dust is known to affect the respiratory tract in humans, (Umadevi et al., 2003).

The environmental study at the tobacco processing factory revealed that workers were exposed to high levels of respirable and total dust. These levels were higher than those reported by (Uitti et al., 1998) and (Chloros et al., 2004). There is no specified permissible exposure level of respirable tobacco dust; however, Popovic et al., 1992 recommended a permissible level as 0.5 mg/m^3.

Both exposed workers and controls were matched regarding age, sex, residence, and income and educational level, and they showed no statistically significant difference in anthropometric measurements, and smoking habit.

Tobacco processing workers had significantly more prevalent chest symptoms and signs compared with controls; (table 1).This could be due to exposure to high tobacco dust concentrations due to bad ventilation in the work place. Several investigators, [Lander and Gravesend (1988) and Osim et al., (1998)] reported an increased prevalence of respiratory findings including asthma and chronic obstructive bronchitis among tobacco workers when compared with control subjects. Jadranka et al., (2003), revealed that the most frequent chest manifestations among tobacco workers are cough (29.9%) and wheeze (16.50%). Chattopadhyay et al., (2006), found similar results of increased respiratory symptoms among exposed tobacco workers compared to control subjects.

Spirometric measurements among tobacco workers were significantly lower than those of controls regarding percentage of predicted values of FVC, FEV1 and FVC/FEV1.These results are in concordance with that reported by Jadranka et al., 2003 ,who found that the mean measured values of ventilatory capacity tests (FEV1, FEF50, FEF25) in tobacco workers were significantly decreased in relation to their predicted values. Also, Kjaergaard et al.,

1989 described significantly decreased FVC and FEV1 values in tobacco workers compared to their referents. In addition, Yanev, 1987 and Popovic et al., 1992 reported lower values of spirometric measurements mostly of the obstructive type in tobacco workers compared to their control referents.

Smoker and non-smoker tobacco workers had significantly lower values of FVC%, FEV1% and FEV1/FVC% as compared with smoker and non-smokers controls. This could be attributed to the effect of occupational exposure to tobacco dust on the respiratory system regardless of their smoking habit status.

Levels of serum IgE and urinary cotinine were significantly increased among tobacco processing workers than among controls, (table 3). Uitti et al., 1998, in their study of cigar factory workers revealed that titres of Ig E antibodies among tobacco workers were higher than those among referents. As regards cotinine, our results agree with those of Bahattin et al., 1999, who reported that tobacco workers had significantly higher urinary cotinine /creatinine ratios than controls. Also, Ghosh et al., 1985 found in their study on workers handling tobacco leaves that the rate of urinary excretion of nicotine and its metabolite cotinine is increased in most of the exposed persons.

Serum IgE and urinary cotinine were significantly increased among smokers and non-smokers tobacco workers than among controls. Bahattin et al., 1999, reported that non-smoking tobacco workers had significantly higher urinary cotinine/ creatinine ratio than non-smoking controls.

Cotinine is made only from nicotine that enters the body with cigarette smoke, it can be used as an indicator of a person's exposure to smoke and its measurements can provide evidence that tobacco entered the body (Caraballo et al., 1998). People who do not smoke or who are not exposed to other peoples' smoke should not have measurable cotinine. People who do smoke will have a cotinine level of 10 or higher in their blood, and a typical smoker has levels of 150 to 450 units, (Foundation for Blood Research, 2010). The values measured in the studied workers were far higher than 450 ng/ml, in both smoking and smoking workers.

Tobacco exposed workers showed a negative weak but significant correlation between serum IgE hand and spirometric measurements. This association may imply an immunogenic theory on the

pathogenesis of respiratory impairment among tobacco processing workers. Becker et al., 1986, stated that tobacco leaf itself consists of proteins that can act as allergens and produce immunoglobulin E (IgE) antibodies in exposed workers.

Conclusion:

Dust levels inside the tobacco factory were high as compared with the suggested permissible level. Exposure to tobacco dust may be the cause of increased prevalence of chest manifestations (cough, wheezes and expectoration), high serum IgE and urinary cotinine levels. Change in the mean values of different spirometric measurements among exposed workers compared with control group is possibly due to sensitization to tobacco dust.

Recommendations:

Respiratory disorders can be prevented or reduced by use of appropriate respiratory and hand protection , proper ventilation of work environment and the use of engineering control measures along with application of pre-employment and periodic medication examination with special emphasis on the respiratory system and measurement of serum IgE and urinary cotinine as markers of exposure.

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