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A STUDY OF CHANGES IN VENTILATORY CAPACITY OF WORKERS EMPLOYED IN VEGETABLE OIL REFINERIES IN TEHRAN*

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ABSTRACT

Lung function tests were performed in 122 workers of vegetable oil refineries in Tehran area. The results show an increase in respiratory impairment with age and length of exposure. Among the four indices of lung function that were calculated, $FEV_1\%FVC$ and $FEF_{25-75\%}$ $PFEF_{25-75}$ showed the greatest decrease with age and length of exposure, while FVC% PFVC and $FEV_1\%$ $PFEV_1$ were essentially within the normal range. These findings correspond with a state of chronic bronchospastic condition in these workers who are exposed to cotton and other dusts.

INTRODUCTION

The first quarter of this century saw the beginning of two great advances in the study of occupational diseases, the use of chest radiograph(1), and objective measurement of lung function(2).

Up to recent times it was considered that only clinical examination together with a chest of X-Ray was enough in diagnosing chest diseases. But today all believe that the lung function is often significantly disturbed when both the radiological and clinical evidence is negative(3).

Considering the fact that there is no effective treatment for the

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majority of occupational lung diseases, the early diagnosis has a great importance. To achieve this goal it is necessary in the workers exposed to any kind of dust in industry to carry out lung function tests along with clinical examination and completing a specially designed questionaire for respiratory diseases.

The purpose of this paper is to show the results obtained in a study carried out in vegetable oil refineries in Tehran in regard to ventilatory capacity of workers.

MATERIALS AND METHODS

125 male workers who were employed in the lint removal processes of 4 vegetable oil refineries in Tehran were recruited for this study.

The working conditions in these refineries were almost the same and the workers were exposed to the dust of cotton seeds, sunflower seeds, or soya beans for some months alternatively during the year.

Along with medical examination and completing a modified BMRC type questionaire for respiratory diseases, expiratory flows and volumes were measured with a vitalograph single breath instrument in the standing position by one of us throughout the study. Each manoeuver was performed three times after a complete instruction before the workshift, and as in our cases there was only little difference in the overall picture between the three blows, according to Gandevia and Milne(4), the best blow was considered for the calculation of the indices of lung function.

In each case gas volumes were corrected for body temperature and barometric pressure (BTPS). Height was measured in centimeters without shoes, and the age was recorded in years. Smoking habits were also studied, and each subject was placed in one of the following categories: Non-Smokers (NS), Ex-Smokers (ES), and Smokers (S).

Indices of Lung Function

The following indices of lung function were measured:

1. Forced Vital Capacity (FVC)
2. Forced Expiratory Volume over one second (FEV_1)
3. Forced Mid-Expiratory Flow (FEF_{25-75})

From the above data the following indices were calculated using the predicted values by Morris et al(5).

1. Forced Vital Capacity percent of predicted value (FVC%PFVC)
2. Forced Expiratory Volume over one second percent of Predicted Value (FEV_1%PFEV_1)
3. Forced Mid-Expiratory Flow percent of predicted value

($FEF_{25-75\%}$ $PFEF_{25-75}$)

4. Forced Expiratory Volume over one second percent of Forced Vital Capacity ($FEV_{1\%}$ FVC)

RESULTS

The analysis of data obtained from 125 workers examined in this study shows that 82 workers (65.6%) were non-smokers, 40 (32%) were smokers, and 3 (2.4%) were ex-smokers. Since the number of ex-smokers was not sufficient for statistical analysis, and the values of lung function tests in this group were within the normal range, they were discarded and the remaining 122 workers who were smokers or non-smokers were used for the analysis.

Table I shows the workers examined by age and length of exposure. As indicated in this table, the majority of workers, 36.07%, are aged 40-49 years. On the other hand, when considering the length of exposure, 44.26% of workers are with less than 10 years of exposure and as the length of exposure increases the number of workers decreases.

Table II shows the summary of age, height, and smoking data of 122 workers. As this table shows, the mean age for the non-smokers is 41 years with the range of 20 to 59 years, and for the smokers 43.4 years with the range of 25 to 59 years. Also, the mean amount smoked in terms of pack-years(6) was 11.94 pack-years for the smokers with the range of 0.3 to 35 pack-years.

Pack-years was determined by multiplying the duration of smoking in years by the subjects' assessment of the usual number of cigarettes smoked per day over their whole period of smoking then dividing this by 20 to convert from number of cigarettes to packs(6).

Tables III and IV show the results of the data obtained from a modified BMRC type questionaire covering 12 questions about cough, phlegm, dyspnea, history of asthma, bronchitis, symptoms of bussinosis, lung diseases or chest injury and operation, which were the only parameters considered for statistical analysis. As Table III shows, percentage of "yes" answers increases with age in smokers and non-smokers except the age group 50-59 years in smokers. On the other hand, Table IV shows that the percentage of "yes" answers increases with the length of exposure ($P < 0.01$), and the percentage of "yes" answers in smokers is greater than non-smokers.

The overall picture of these two tables reveals an increase in percentage of "yes" answers in regard to age and length of exposure.

Tables V to VIII show the summary of spirometric data by age groups. All FVC, FEV_1, and FEF_{25-75} values are expressed as percentage of the predicted values based on the study of Morris et al(5).

For these parameters, 80% is the generally accepted threshold value for spirometric impairment (7). All values greater than 80% indicate normality and those lower than 80% indicate impairment. For FEV_1% FVC the commensurate threshold value for the spirometric impairment is 75%(8).

For all age groups in smokers, non-smokers and 'all' categories, the mean values are within the normal range except the FEV_1%FVC and FEF_{25-75}% $PFEF_{25-75}$ for the age group 50-59 in non-smokers and FEF_{25-75}% $PFEF_{25-75}$ in age group 30-39 in smokers.

The overall picture that emerges from these four tables is that FVC% PFVC and FEV_1% PFEV data are close to 100 percent, while the FEV_1%FVC and FEF_{25-75}% $PFEF_{25-75}$ data are close to the lower range of the normal values.

Tables IX to XII show the summary of spirometric data by length of exposure. As indicated in these tables, all the mean values are within the normal range. However, there is a general tendency for a slight decrease in these parameters with the increase in length of exposure.

The overall picture that emerges from these four tables is that close to the lower range of the normal values.

Table XIII, summarizes the percentage of workers with spirometric impairment of different indices of lung function in regard to smoking habits. As indicated in this table, the percentage of workers having impairment of FEV_1%FVC and FEF_{25-75}%$PFEF_{25-75}$ is significantly higher than the similar values for FVC% PFVC and FEV_1% $PFEV_1$. The results of X^2 test for comparison of these values are:

- Between FEV_1%FVC and FVC% PFVC for non-smokers $P < 0.001$, for smokers not significant, and for 'all' $P < 0.001$.
- Between FEV_1%FVC and FEV_1% $PFEV_1$, for non-smokers $P < 0.05$, for smokers not significant, and for 'all' P 0.05.
- Between FEF_{25-75}% $PFEF_{25-75}$ and FVC% PFVC for non-smokers P 0.001, for smokers P 0.05 and for 'all' $P < 0.001$.
- Between FEF_{25-75}% $PFEF_{25-75}$ and FEV_1% $PFEV_1$, for non-smokers $P < 0.001$, for smokers $P < 0.05$, and for 'all' $P < 0.001$.

There was no significant difference between the percentage of impairment when FVC%PFVC was compared with FEV_1% $PFEV_1$ for all smoking categories.

Coefficient of correlation for length of exposure and different indices of lung function was computed. The results indicate that:

- Correlation between FVC% PFVC and length of exposure was not statistically significant for all smoking categories.
- Correlation between FEV_1% $PFEV_1$ and length of exposure was not statistically significant for all smoking categories.

- Correlation between FEV_1%FVC and length of exposure was highly significant for non-smokers ($P < 0.001$), not significant for smokers and significant for 'all' ($P < 0.01$).
- Correlation between FEF_{25-75}% $PFEF_{25-75}$ and length of exposure was not statistically significant for non-smokers and 'all' categories ($P < 0.05$) and not significant for smokers.

DISCUSSION AND CONCLUSION

In this study an attempt has been made to find any relation between percentage of 'yes' answers indicating symptoms and signs of chronic non-specific respiratory diseases (CNSRD) and changes in lung function indices in regard to age, smoking habit, and length of exposure in the workers of vegetable oil refineries in Tehran. Although due to the working conditions in these refineries the workers are not exposed during the whole year to the cotton dust, and there is no evidence in literature regarding the ill effects of dust of sunflower seed or soya beans, as has been proved for the cotton dust(9, 10, 11, 12), still there is an increase in the percentage of 'yes' answers in regard to age and length of exposure. On the other hand, although the mean values of spirometric data with some exceptions in FEV_1%FVC and FEF_{25-75}% $PFEF_{25-75}$ are within the normal values, when considering the persons suffering from some spirometric impairment which is illustrated in the tables by Δ , it is observed that there are persons with impairment in one or more spirometric data in all age groups in smokers and non-smokers.

Further study of Table XIII shows that the percentage of impairment is significantly higher when considering FEV_1%FVC and and FEF_{25-75}% $PFEF_{25-75}$ in comparison with FVC% PFVC and FEV_1% $PFEV_1$ data, which is commensurate with the results of Tables V to VIII which indicate that the values of the two former tests are close to the lower range of normal values. On the other hand, the results of coefficient of correlation for the four indices of lung function and length of exposure indicate that there is a relationship between FEV_1%FVC and FEF_{25-75}% $PFEF_{25-75}$ and length of exposure especially in non-smokers and 'all' categories. Therefore, by taking into account the pathophysiologic meaning of the indices FEV_1%FVC and FEF_{25-75}% $PFEF_{25-75}$ as opposed to FVC% PFVC and FEV_1% $PFEV_1$, it may be concluded that there is development of bronchospastic symptoms in the workers studied.

The reason that the spirometric data obtained in our study are within the normal range in the majority of cases may be explained as follows:

(1) As indicated before, the workers are not exposed during the whole year to cotton dust which its ill effect on respiratory system are well known(9, 10, 11, 12).

(2) The majority of workers have less than 10 years of exposure without any previous exposure to any environmental pollution.

(3) The mean amount smoked in smokers is 11.94 packs which is not enough for causing severe respiratory impairment.

(4) Since the machinery used in the refineries is fully automatic the workers are not required to be in the dusty working areas during the whole hours of their shift.

(5) Because the normal spirometric data for Iranians are not available so far, the data obtained in this study were compared with predicted values based on the study by Morris et al(5) for the non-smoking U.S. citizens. Therefore, there is a possibility that data for Iranians might be different from others, so it is recommended that necessary steps be taken for obtaining normal spirometric values for Iranians.

Since our study shows that only $FEV_1\%$ FVC and $FEF_{25-75\%}$ $PFEF_{25-75}$ are close to the lower range of the normal values, in conclusion it may be stated that a reasonably quantitative screening in the field studies for spirometric impairment in workers exposed to the cotton dust may be achieved by recording only the expired FVC manouver from which both $FEV_1\%$ FVC and $FEF_{25-75\%}$ $PFEF_{25-75}$ can be calculated.

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TABLE I: WORKERS EXAMINED BY AGE AND LENGTH OF EXPOSURE

LENGTH OF EXPOSURE (YEARS)	AGE GROUP (YEARS)					
	20-29	30-39	40-49	50-59	TOTAL	%
1-9	15	18	13	8	54	44.26
10-19	--	12	19	15	46	37.70
20-29	--	2	12	8	22	18.04
TOTAL	15	32	44	31	122	100.00
%	12.29	26.23	36.07	25.41	100.00	

TABLE II. SUMMARY OF AGE, HEIGHT, LENGTH OF EXPOSURE AND SMOKING DATA

		SMOKING CATEGORIES		
		NS	S	ALL
AGE (YEARS)	m	41.00	43.40	41.79
	SD	9.44	10.05	9.67
HEIGHT (cm)	m	164.07	166.25	164.79
	SD	5.81	4.50	5.49
LENGTH OF EXPOSURE (YEARS)	m	11.74	10.55	11.35
	SD	7.68	6.68	7.36
AMOUNT SMOKED (pack-yrs)	m	0	11.94	-
	SD	0	8.72	-
N		82	40	122

NS = Nonsmoker (never smoked). S = smoker. Pack-year, see text.

N = Number of workers. m = mean. SD = Standard deviation.

TABLE III. SUMMARY OF RESPIRATORY QUESTIONAIRE DATA BY AGE.

(% yes)		AGE GROUPS (YEARS)				
		20-29	30-39	40-49	50-59	ALL
NS	N	10	23	34	15	82
	m	0.83	2.90	4.17	6.66	3.86
	SD	2.62	5.96	6.58	9.55	6.83
S	N	5	9	10	16	40
	m	1.66	1.84	11.66	8.85	7.08
	SD	3.71	3.66	7.04	7.75	7.45
ALL	N	15	32	44	31	122
	m	1.11	2.60	5.87	7.79	4.92
	SD	2.92	5.37	7.33	8.59	7.17

Symbols same as table II.

TABLE IV. SUMMARY OF RESPIRATORY

QUESTIONAIRE DATA BY LENGTH OF EXPOSURE

(% yes)		LENGTH OF EXPOSURE (YEARS)			
		1-9	10-19	20-29	ALL
NS	N	37	29	16	82
	m	2.24	3.16	9.38	3.96
	SD	3.74	5.64	9.57	6.44
S	N	17	17	6	40
	m	3.42	6.37	13.77	6.25
	SD	6.62	9.10	11.38	9.00
ALL	N	54	46	22	122
	m	2.61	4.13	10.60	4.71
	SD	4.80	6.96	10.02	7.42

% = percent of 12 questions about subjective respiratory signs. Other symbols same as table II.

TABLE V. SUMMARY OF FVC%PFVC DATA BY AGE

FVC (% Pred.)		AGE GROUPS (YEARS)				
		20-29	30-39	40-49	50-59	ALL
NS	N	10	23	34	15	82
	m	94.30	99.30	101.59	97.53	99.32
	SD	9.52	15.74	12.09	9.44	12.58
	△	-	2	1	-	3
	%	-	8.70	2.94	-	3.66
S	N	5	9	10	16	40
	m	104.60	94.33	95.00	100.38	98.20
	SD	15.82	14.77	12.34	14.30	14.05
	△	-	1	1	3	5
	%	-	11.11	10	18.75	12.50
ALL	N	15	32	44	31	122
	m	97.70	97.90	100.09	99.00	98.95
	SD	5.72	15.27	12.32	12.08	13.03
	△	-	3	2	3	8
	%	-	9.38	4.55	9.68	6.56

△ = number of workers with spirometric impairment, defined as a percent of predicted normal value of less than 80%.

% = percent of workers with spirometric impairment. Other symbols same as table II.

TABLE VI. SUMMARY OF FEV % PFEV DATA BY AGE
1 1

FEV 1 (% PRED.)		AGE GROUPS (YEARS)				
		20-29	30-39	40-49	50-59	ALL
NS	N	10	23	34	15	82
	m	97.40	97.61	99.09	95.53	97.82
	SD	8.30	19.06	13.67	10.32	14.23
	△	-	4	4	1	9
	%	-	17.39	11.76	6.67	10.98
S	N	5	9	10	16	40
	m	103.60	91.67	93.90	103.94	98.63
	SD	20.67	17.66	15.74	19.74	18.51
	△	1	1	1	2	5
	%	20.00	11.11	10.00	12.50	12.50
ALL	N	15	32	44	31	122
	m	99.47	95.94	97.91	99.87	98.08
	SD	13.17	18.67	14.14	16.05	15.69
	△	1	5	5	3	14
	%	6.67	15.63	11.36	9.68	11.48

All symbols same as table V.

TABLE VII. SUMMARY OF FEV $_1$ %FVC DATA BY AGE

FEV $_1$ %FVC		AGE GROUPS (YEARS)				
		20-29	30-39	40-49	50-59	ALL
NS	N	10	23	34	15	82
	m	85.40	78.52	76.68	73.40	77.66
	SD	3.20	6.20	6.64	6.10	6.88
	△	-	5	9	7	21
	%	-	21.74	26.47	46.67	25.61
S	N	5	9	10	16	40
	m	80.60	76.22	75.70	77.06	76.98
	SD	3.85	5.63	7.26	8.52	7.09
	△	-	2	1	6	9
	%	-	22.22	10.00	37.50	22.50
ALL	N	15	32	44	31	122
	m	83.80	77.88	76.45	75.29	77.43
	SD	4.04	6.05	6.71	7.56	6.93
	△	-	7	10	13	30
	%	-	21.88	22.73	41.94	24.59

△ = number of workers with spirometric impairment, defined as a percent of measured FVC of less than 75%. All symbols same as table V.

TABLE VIII. SUMMARY OF FEF 25-75 % PFEF 25-75 DATA BY AGE

FEF 25-75 (% Pred.)		AGE GROUPS (YEARS)				
		20-29	30-39	40-49	50-59	ALL
NS	N	10	23	34	15	82
	m	106.30	85.35	87.79	76.40	87.28
	SD	17.01	25.64	21.86	17.55	22.94
	△	-	11	12	10	33
	%	-	47.83	35.29	66.67	40.24
S	N	5	9	10	16	40
	m	93.20	76.00	82.80	94.69	87.33
	SD	31.24	23.55	27.77	33.40	29.71
	△	2	5	4	5	16
	%	40.00	55.56	40.00	31.25	40.00
ALL	N	15	32	44	31	122
	m	101.93	82.72	86.66	85.84	87.30
	SD	22.46	25.06	23.08	28.07	25.23
	△	2	16	16	15	49
	%	13.33	50.00	36.36	48.39	40.16

All symbols same as table V.

TABLE IX. SUMMARY OF FVC % PFVC DATA BY LENGTH OF EXPOSURE

FVC (%Pred.)		LENGTH OF EXPOSURE (YEARS) 1-9	10-19	20-29	ALL
NS	N	37	29	16	82
	m	99.05	101.93	95.19	99.32
	SD	14.18	11.64	9.32	12.58
	△	3	-	-	3
	%	8.11	-	-	3.66
S	N	17	17	6	40
	m	101.53	96.71	93.00	98.20
	SD	14.36	13.57	14.60	14.05
	△	1	3	1	5
	%	5.88	17.65	16.67	12.50
ALL	N	54	46	22	122
	m	99.83	100.00	94.59	98.95
	SD	13.96	12.50	10.67	13.03
	△	4	3	1	8
	%	7.41	6.52	4.55	6.56

All symbols same as table V.

TABLE X. SUMMARY OF FEV $_1$ %PEV $_1$ DATA BY LENGTH OF EXPOSURE

FEV $_1$ (%Pred.)		LENGTH OF EXPOSURE (YEARS)			
		1-9	10-19	20-29	ALL
NS	N	37	29	16	82
	m	99.00	98.24	94.31	97.82
	SD	15.05	15.15	10.22	14.23
	△	4	4	1	9
	%	10.81	13.79	6.25	10.98
S	N	17	17	6	40
	m	101.65	96.82	95.17	98.63
	SD	16.17	21.79	16.10	18.51
	△	1	3	1	5
	%	5.88	17.65	16.67	12.50
ALL	N	54	46	22	122
	m	99.83	97.72	94.55	98.08
	SD	15.43	17.67	11.69	15.69
	△	5	7	2	14
	%	9.26	15.22	9.09	11.48

All symbols same as table V.

TABLE XI. SUMMARY OF FEV_1 %FVC DATA BY LENGTH OF EXPOSURE

FEV_1 % FVC		LENGTH OF EXPOSURE (YEARS)			
		1-9	10-19	20-29	ALL
NS	N	37	29	16	82
	m	80.32	75.17	76.00	77.66
	SD	5.99	6.99	6.77	6.88
	△	6	11	4	21
	%	16.22	37.93	25.00	25.61
S	N	17	17	6	40
	m	78.53	75.29	77.33	76.98
	SD	4.27	8.51	9.18	7.09
	△	2	6	1	9
	%	11.76	35.29	16.67	22.50
ALL	N	54	46	22	122
	m	79.76	75.22	76.36	77.43
	SD	5.53	7.49	7.29	6.93
	△	8	17	5	30
	%	14.81	36.96	22.73	24.59

All symbols same as table V.

TABLE XII. SUMMARY OF FEF_{25-75} % $PFEF_{25-75}$ DATA BY LENGTH OF EXPOSURE

FEF 25-75 (%Pred.)		LENGTH OF EXPOSURE (YEARS) 1-9	10-19	20-29	ALL
NS	N	37	29	16	82
	m	92.41	83.01	83.06	87.28
	SD	24.46	23.26	16.66	22.94
	△	12	15	6	33
	%	32.43	51.72	37.50	40.24
S	N	17	17	6	40
	m	92.12	83.06	85.83	87.33
	SD	22.98	34.47	35.35	29.71
	△	5	8	3	16
	%	29.41	47.06	50.00	40.00
ALL	N	54	46	22	122
	m	92.31	83.07	83.82	87.30
	SD	23.79	27.55	22.30	25.23
	△	17	23	9	49
	%	31.48	50.00	40.91	40.16

All symbols same as table V.

TABLE XIII. PERCENTAGE OF WORKERS WITH SPIROMETRIC IMPAIRMENT OF DIFFERENT INDICES OF LUNG FUNCTION BY SMOKING HABIT.

SMOKING HABIT	NO. OF WORKERS	FVC% PFVC	FEV_1 % $PFEV_1$	FEV_1 % FVC	$FEF_{25-75\%}$ $PFEF_{25-75}$
NS	82	3.66	10.98	25.61	40.24
S	40	12.50	12.50	22.50	40.00
ALL	122	6.56	11.48	24.59	40.16

All symbols same as table V.