Physiological study of the effect of employment in old brick factories on the lung function of their employees

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Summary

Spirometric measurements were done for (113)workers employed in five old fashion brick factories located in Najaf Province .Spirometric measurements were also done for (98) control subjects. The measurements included forced vital capacity (FVC), forced expiratory volume in first second (FEV1), forced expiratory volume ratio (FEV %) and peak expiratory flow rate (PEFR). The subjects investigated in the study were divided into four groups based on their duration of employment. Anthropometric data were collected for the participants, and questionnaires regarding respiratory diseases whether professionally diagnosed diseases or the common symptoms suggestive of them were applied to every participant whether being a worker or control subjects. Subjects with known or suspected respiratory disease on the basis of these questionnaires were excluded from the study
It was found that workers of the five brick factories scored lower values of the four spirometric variables than the control subjects and the differences were statistically significant. Significant differences were also found among workers with different work duration in years with the workers group of 11-15 years of employment scoring the lowest values.
It was concluded that workers engaged in the brick manufacturing industry are at risk of developing obstructive ventilatory impairment and/or restrictive ventilatory impairment and the degree of this impairment directly correlates with the duration of the employment.

Keywords: lung function test, Brick factories

Introduction

Spirometry is probably the most important tool used in screening for pulmonary disease and is the most frequently performed pulmonary function test (1). There is a sizable medical research literature regarding the occupational impact on the respiratory function of workers in various occupations like coalminers (2) , cotton textile workers(3), welders (4), farm workers (5), chemical workers (6), cement workers (7,8), and others.
Regarding the brick manufacturing industry, there are relatively few studies worldwide (9, 10) and in Iraq (11, 12), which show the grave respiratory effects on both the workers and the general population. Hence, this study aims to investigate and quantify the adverse respiratory effect of old brick factories within Najaf Province on their employees and its relation to the duration of employment.

Subjects, material and method

The study population falls into two main categories. The first one includes 113 male subjects working in five old fashion brick factories in Najaf Province, their duration of work ranges from one to fifteen years. The second category includes (98) male subjects who are not workers in the brick industry but were included in the study as control group .They were randomly chosen from the general population, and they were included in the control group if the subject answered "no'' to all of the following questions

1. Have you ever worked in a dusty occupation (e.g. brick, cement, or construction industry?
2. Have you ever been diagnosed to have chronic respiratory disease (e.g. asthma, chronic obstructive pulmonary diseases (COPD), tuberculosis) by a physician?
3. Have you recently experienced any respiratory symptoms like cough, dyspnea, wheeze, chest pain? (13, 14)

The study population was then classified into four major groups depending on the duration of work, being control or worker subject, and five year interval of work was considered suitable for classifying worker subjects into three groups in order to make comparison among workers with different work duration. Consequently, the study population was categorized into the following groups:

1. The control group composed of subjects never engaged in any dusty occupation.
2. G1: includes workers whose duration of employment ranges from one to 5 years.
3. G2: includes workers whose duration of employment ranges from 6 to 10 years.
4. G3: includes workers whose duration of employment ranges from 11 to 15 years.

Each of these groups is then subdivided according to the smoking status into smokers (those who smoked regularly and still smoking at the time of the study) and nonsmoker (those who never smoke), while exsmoker (those who smoke in the past but quit smoking at the time of the study) were excluded from the population of the study due to their small number which is inconvenient for statistical analysis in the setting of his study.

The number, smoking status and anthropometric characteristics of different study groups are shown in table -1-.

Spirometric measurements including FVC, FEV1, and PEFR were done with vitalograph spirometer produced by vitalograph medical instrumentation co., Ltd, Buckingham, England. After the subject sits for few minuets ,to allow the physiological steady state to be reached (8), Vitalograph spirometer is used to measure the two respiratory indices(FVC and FEV1) from which FEV% can be derived, while The Mini- Wright peak flow meter produced by Clement Carke international ,England, was used to measure PEFR of each participant in this study The maneuver is repeated for a minimum of three maneuvers; with the highest value of FVC and FEV1 recorded, alternatively if the subject fails to perform the correct maneuver ,the test was repeated for a maximum of eight times then the subject is either excluded from the study or assigned another occasion to perform the test (15).

The Results

THE NONSMOKER GROUPS

FVC, FEV1, FEV% and PEFR of the nonsmoker control and worker subjects participating in the study are shown in table (2.)

1- Forced Vital Capacity (FVC)

Significant difference exists between the control group and G2 and G3 ($p < 0.01$) the mean FVC measured for G1 differs significantly from both that of G2 and G3 (in both cases, $P < 0.01$). Significant difference is also found between the mean FVC of G2 from that of G3 ($P < 0.01$).

2- Forced Expiratory Volume In First Second (FEV1)

The mean FEV1 of the three worker groups is significantly lower than that of the control group ($p < 0.05$ for G1, $p < 0.01$ for G2 and G3).The greater difference is noticed between the control group and G3 .The mean FEV1 of G3 is significantly lower than that of G1 and G2 (both, $P < 0.01$), and that of G2 is significantly lower than the mean FEV1of G1 ($P < 0.01$).

Table-1- The number, smoking status and duration, age and some anthropometric characteristics of the study groups. NS: non-smoker, SM: smoker.

Parameter	Control		G 1		G 2		G 3	
Smoking status	NS	SM	NS	SM	NS	SM	NS	SM
Number	50	48	32	20	25	12	16	8
Smoking duration (year) (X±SD) duration(year) (X±SD) (X±SD)		9.26±4.02		9.30±4.97		9.33±4.72		11.25± 5.01
Age (year) (X±SD)	31.00 ±7.27	32.64±7.91	30.13±6.56	29.05±6.75	30.56±6.03	31.92±6.17	33.00 ±4.00	34.00 ±5.32
W (kg) (X±SD)	74.20 ±6.72	72.36±5.57	73.63±4.43	73.8±6.49	69.56±5.02	70.25±6.08	70.13± 6.55	68.50 ±5.78
H (cm) (X±SD)	171.14 ±6.72	170.08±4.31	172.72±3.99	171.8±5.11	171.72±4.76	169.33±5.85	172.56 ±5.45	172.13 ±7.28

Table-2- The spirometric variables of the nonsmoker subjects of the control and different workers groups.

parameter	CONTROL n =50	G 1 n =32	G 2 n=25	G 3 n =16
FVC (L) (X± SD)	4.71±0.37	4.60±0.42	4.24±0.41	3.53±0.33
FEV1 (L) (X± SD)	3.82±0.29	3.61±0.43	3.02±0.26	2.21±0.42
FEV% (X± SD)	81.38±3.99	78.30±4.74	71.53±5.99	62.70±10.22
PEFR (L/min) (X± SD)	514.40±32.24	500.63±39.02	467.40±31.26	395.63±25.42

3- Forced Expiratory Volume Ratio (FEV %)

The forced expiratory volume ratio (FEV %) of G3 is significantly lower than that of the control, G1, and G2 (p <0.01).the greater difference exists between G3 and the control group. Subjects in the control group also have significantly higher mean values of FEV% than those in G1 and G2 (P< 0.01).

Last, the mean FEV % of G2 is significantly lower than that scored for G1 (P< 0.01).

4- Peak Expiratory Flow Rate (PEFR)

The mean PEFR of G3 is lower than the control group, G1 and G2 and the difference in all these instances is significant (P< 0.01) .There is also a significant difference between the mean PEFR of G2 and that of G1 with the mean PEFR of G2 being lower than that measured for G1(P < 0.01).

THE SMOKER GROUPS

FVC, FEV1, FEV %, and PEFR of the smoker control and worker subjects participating in the study are shown in table (3).

1. Forced Vital Capacity (FVC):

The mean FVC of G3 and G2 are significantly lower than the mean FVC recorded for the control group (P< 0.01). Furthermore ,the mean FVC of G3 is significantly lower than the mean FVC of both G2 and G1 (P< 0.01) , meanwhile, the mean FVC of G2 is lower than that of G1 and again this difference is statistically significant (P< 0.01).

2. Forced Expiratory Volume In First Second (FEV1)

The mean FEV1 of G3 is significantly lower than the mean FEV1 recorded for the control group, G1 (P < 0.01) and G2 (P < 0.05). The mean FEV1 of G1 and G2 are both significantly lower than that of the control group (P < 0.01), and the mean FEV1 of G2 is significantly lower than that of G1 (P < 0.01).

3. Forced Expiratory Volume Ratio (FEV %)

The mean FEV% of the three smoker workers groups (G1, G2 and G3) shows a significant decline when it is compared with mean FEV% of the corresponding control group (P < 0.01 in the three instances), with workers in G3 scoring the lowest value of mean FEV%, followed by workers in G2 .On the other hand, workers in G3 achieved a mean FEV % which is significantly lower than that achieved by workers in G1.

4. Peak Expiratory Flow Rate (PEFR):

The results regarding the mean PEFR reveals a significant decline of the mean PEFR of G3 relative to that of the control group (P < 0.01). Likewise, the mean PEFR of G2 is significantly lower than that of the control group (P < 0.01). A less significant reduction in the mean PEFR is noticed for G1 in relation to the control group (P < 0.05).

G3 also shows a reduction in the measured mean PEFR as compared to that of both G2 and G1 (P < 0.01). G2 shows a mean PEFR which is significantly lower than that observed for G1 (P < 0.05).

All These results are shown in the graphs in figure -1- and -2-.

Table -3- The spirometric variables of the smoker subjects of the control and different worker groups.

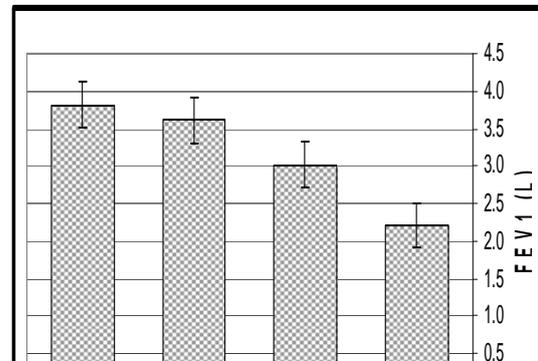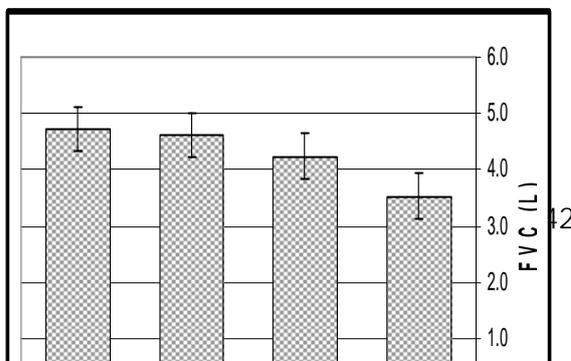| parameter	CONTROL n =48	G 1 n=20	G 2 n=12	G 3 n=8
FVC (L) (X± SD)	4.49±0.42	4.36±0.32	3.80±0.46	3.11±0.45
FEV1 (L) (X± SD)	3.40±0.38	2.92±0.44	2.40±0.54	1.75±0.42
FEV% (X± SD)	75.79±6.13	66.76±6.94	62.64±7.98	55.88±9.05
PEFR(L/min) (X± SD)	480.77±43.49	456.00±49.67	417.50±29.89	343.75±47.79

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Figure -1-
   A- Forced vital capacity (FVC) of the four study groups (nonsmokers).
   B- Forced expiratory volume in one second (FEV1) of the four study groups (nonsmokers)
   C- Forced expiratory volume ratio (FEV %) of the four study groups (nonsmokers)
   D- Peak expiratory flow rate (PEFR) of the four study groups (nonsmokers).

DISCUSSION

The worker subjects of this study were employees in 5 different brick manufacturing plants located in Najaf Province, all of these plants were old fashion factories operating for decades using out - dated techniques based on manual molding and making of brick from clay, transporting of raw bricks to the factories, then manual stacking of the brick patches in the fire kilns where liquid fuel is used as energy source for heat generation to help baking the bricks.

The burning of liquid fuel in the primitive kilns is responsible for the major

part of the mist of fumes and respirable particles in the plants and in the vicinity of them, in addition to dusts generated into the

environment of the workplace during the different stages of the processing of the clay into firebrick and it's carrying in vans.

Both types of air pollution are documented causes of respiratory morbidity and mortality in the form of obstructive and/or restrictive ventilatory disorders, e.g. chronic bronchitis, emphysema and silicosis, (16).

It is clear from table (3-1)and table (3-2) that the four spirometric variables are significantly lower in the workers group than the control group and as the differences in the height and age among different workers groups and the control group were not significant, then this difference in the four parameters of pulmonary function can be assumed to result from occupational exposure to dusts and fumes generated in the workplace .
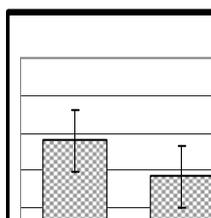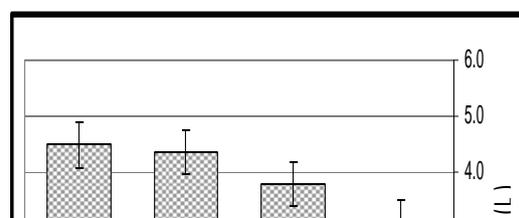
The decline in the respiratory function as measured by these four parameters increase in magnitude as the duration of employment increases. This finding is consistent with the finding of other studies performed in Iraq (17) or in other countries (9).

Figure -2-
   A- Forced vital capacity (FVC) of the four study groups (smokers)
   B- Forced expiratory volume in one second (FEV1) of the four study groups (smokers)
   C- Forced expiratory volume ratio (FEV %) of the four study groups (smokers)
   D- Shows the peak expiratory flow rate (PEFR) of the four smoker study groups.

Taking a good look at the two tables shows that each of the four variables that were taken as a measure of the respiratory function declines as the number of the years of employment increases although the relation is not linear as there are other important factors that affect the spirometric measurements like height, age, smoking status, and severity of exposure (18, 19).

There is more pronounced decline in the value of FEV1 of the three worker groups than that of the control group and that of each worker group than the other with lesser duration of employment and this degree of decline is more than that noticed for the value of FVC .This result is similar to the decline in FEV% giving the spirometric pattern characteristic of obstructive ventilatory defects ,although the obstructive

pattern is more obvious in the spirometric variables recorded for G3 (duration of 11- 15 years of employment) and FEV% falls below 70 %. (20, 21). This obstructive pattern is also evident from the lower value of PEFR of the worker groups than that of the control group (22).The concomitant lower values of FVC of the worker groups than that of the control group, however, implicates the presence of restrictive ventilatory impairment in addition to the obstructive pattern mentioned earlier and the presence of mixed pattern of ventilatory abnormalities is suggested (21).

This finding of mixed restrictive and obstructive ventilatory defects in employees of brick factories agrees in general with the results of previous studies on brick workers worldwide (9,10) and in Iraq (11)

It is concluded that employment in the old brick factories expose the workers to respiratory damage in the form of obstructive and /or restrictive ventilatory defects and the magnitude of this damage is directly proportional to the duration of employment for both smoker and non smoker workers.

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الخلاصة

أجريت فحوصات كفاءة الرئتين على (113) شخصا من العاملين في خمسة معامل طابوق قديمة الطراز في محافظة النجف الاشرف، كما أجريت هذه الفحوصات على (98) شخصا من غير العاملين في هذه المهنة أو المهن المشابهة (مجموعة السيطرة) .شملت هذه الفحوصات قياس السعة الحيوية القسرية و الحجم ألزفيري ألقسري في الثانية الأولى ومعدل التدفق ألزفيري بالغ الذروة .قسم المشاركون في الدراسة إلى أربعة مجاميع اعتمادا على طول مدة الخدمة .اجري التحليل الإحصائي على البيانات المجموعة وتم اختبار معنوية الاختلافات في متوسط القيم للمؤشرات التنفسية باستخدام اختبار(ت- ستيودنت).

تبين من خلال الدراسة أن العاملين في هذه المعامل الخمسة سجلوا قيما اقل معنويا من مجموعة السيطرة كما وجدت اختلافات معنوية بين مجاميع العمال الذين يختلفون في مدة خدمتهم حيث سجلت المجموعة ذات الخدمة التي تتراوح من 11-15 سنة القيم الاوطأ.