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Effect of Duration of Exposure to Vapors and Gases on Respiratory Symptoms and Pulmonary Function Test of Females

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Abstract—**The aim of this study is to investigate the effects of duration of exposure to fumes, gases and chemical vapourson lung function tests. For this study, 174 females are selected. Their ages ranged from 15 to 40 years. The participants are classified into two groups by the virtue of the distance from the factories .The first group (n=71) is residing close to the local factories and west Zawia Electrical Station in Azzawia city.Females in this group are exposed to gases, fumes and chemical vapours and are regarded as the experimental (exposed) group. The second group is healthy females randomly selected from other places located 25-30 km distant from the factories and an Electrical Station and is regarded as the control group (n = 103). Spirometric measurements including FVC, FEV1 and FEV1% are obtained by a standardized spirometer (Vitalograph limited-Spirometer), while measurements of PEFR are done with the use of a standardized Mini-Wright peak flow meter. Data are statistically analyzed by mean, standard error, and pairedt-test. All (P) values less than 0.05 were considered statistically significant. Statistical analyses revealed that FVC, FEV1 and PEFR are significantly higher in the control group (unexposed females) than in the experimental group. The mean values of FVC, FEV1, FEV1% and PEFR for the participantsof the control group are: 3.7 L, 3.1 L, 85 %, and 448 L/min respectively, whereas the results of their counterparts (exposed) are: 3.2 L, 2.7L, 81.1 %, and 412 L/min respectively.**

Index Terms— **FVC, FEV1, FEV1%, PEFR, lung function tests, fumes and chemical vapours.**

I. Introduction

The effects of poor air quality on human healthare far reaching, but principally it affects the body's respiratory system and the cardiovascular system.Although everyone is at risk of the health effects of air pollution, certain sub-populations are more susceptible. Individual reactions to air contaminants depend on several factors such as the type of pollutant, the degree of exposure and how much of the pollutants are present.ShyamBihari Sharma et.al (2013).

However, some studies in Libya investigated the effects of occupational exposure to asbestos dust and tobacco dust (Mukhtar et al, 1991 and 1996).Mostaghni et al (2000) investigated the effects of exposure ofKangan Sour Gas Refinery workers to sour components (e.g. H_2S) on lung function. The participants exposed to dust, gases or fumes for more than 15 years had lower lung function values compared to the non-exposed group. They found a negative effect of prolonged occupational exposures on lung function similar to other studies in industry populations.

To examine the effects of duration of exposure to gases and vapours, this study was carried out in Azzawia City - Libya. The area is very close the local factories and west Zawia Electrical Station,which releases gases and fumes mainly sulfur dioxide (SO_2) and hydrogen sulfide (H_2S). It has been found that a lot of respiratory problems such as asthma, bronchitis and sinusitis are common among the residents of this area.

II. Purpose of the Study:

The aim of this study is to evaluate the effect of exposure to gases and fumes on the lung function of females who reside close to the local factories.

III. Methodology

A. Participants

In this study, there are 174volunteers. Allof them are females and are residents close to the local factories inAzzawia City - Libya. Their ages range between 15 - 40 years.They are classified into two groups. The first group is the experimental (exposed) group and it consists of 71 participants. In this group, females have been exposed to gases, fumes and chemical vapors for different periods of time (15 to 25 years).The second group is the control group (unexposed) and consists of 103healthy females. They are selected from three other places located 25-30 km distant from local factories andwest Zawia Electrical Station. These places areTerfas, Nasser village and Subratha. The control group is selected so that it matches the experimental group in age and sex. They are not exposed to any air contaminants. Immediately before the lung function test was administered, a questionnaire had been filled out during an interview with the participants. Those who have any acute or chronic respiratory or cardiovascular diseases are excluded from the study.Both the control and experimental groups are separately divided into five age groups (15-19, 20-24, 25-29, 30-34 and 35-40 years) to determine the effects of durationofexposure to fumes, gases and chemical vapors on different ages.

B. Methods:

Physical Parameters: The physical parameters such as; body weight and standing height were obtained with a portable height and weighting scale (Seca.Mod.220, max 150 kg). Body height (cm) was measuredwith the person standing barefoot.

Lung function parameters: The spirometric measurements (FVC, FEV1, and FEV1%) were obtained

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with a vitalograph spirometer (Vitalograph limited-Spirometer, Germany, which consists of a mouthpiece and tubing connected to a recording device. A spirometer is an instrument used to measure the volume of air entering and leaving the lungs. To ensure accurate results only original vital gram charts were used. To ensure the safety and hygiene only approved disposable mouth pieces were given to individuals.

C. *Procedures:*

Respiratory measurements were performed in the morning at (09.00 a.m) and 3 hours later at (12.00 p.m).The procedure for the lung function test was explained individually to each personand three maneuvers were performed after adequate rest. Maneuvers were performed in a standing position with a nose clip and disposable mouthpieces were used for each individual. The person's lips should be held tightly around the mouthpiece, and nose clips should be worn to ensure that all the air inhaled or exhaled goes through the mouth. A person inhales deeply, then exhales forcefully as quickly as possible through the tubing while measurements are taken. This is the routine standard forceful expiratory maneuver (American Thoracic Society, 1995, National Institute of Occupational Safety and Health 1997 and Ruppel G.L.1998), which is allowed to be done in three trials and the best result was recorded (Crapo, R.O. 1994). Often, the test is repeated after a person takes a rest. These efforts are recorded and graphed on vital gram charts.

Peak Expiratory Flow Rate (PEFR) was obtained by using Mini- Wright peak flow meter and expressed in liters per minute. (Mini- Wright peak flow meter measures peak expiratory flow which is the biggest and fastest huff the participant can achieve after he takes a deep breath),

The same forceful expiratory maneuver was repeated after a period of rest. A minimum of one or two minutes rest was allowed, between the expiratory maneuvers. Each test is performed at least three times and the best performance is always selected.

D. *Statistical analysis:*

Analysis was performed with SPSS-PC software version 14.0, for Windows Evaluation Version. Graphs performed by Excel-Microsoft. Student's t-test was employed to compare the means of various parameters and statistical decisions were regarded significant when p values were < 0.05. Means and standard errors were calculated for all parameters in the whole study population and in the two study groups separately.

IV. RESULTS

For the purpose of this study, there are 174participants who are divided into two groups. First group is an experimental group. It consists of 71 volunteers (females) represented (40.8 %) of the sample. All of them are residents close to the local factories and west Zawia Electrical Station in Azzawia city. The residential populations of this area are exposed continuously to air pollutants (such as gases, fumes and chemical vapors) which are released from local factories. Duration of exposure ranged from 15 to 25 years. The second group is the control group (unexposed). It consists of 103 females represented (59.2%) from the total sample.

Description of the study and the percentage of each group are presented in table (1) and figure (1)

Table (1): Sample Description

Sample	Frequency	%
Exposed Females	71	40.8
Unexposed Females	103	59.2
Total	174	100

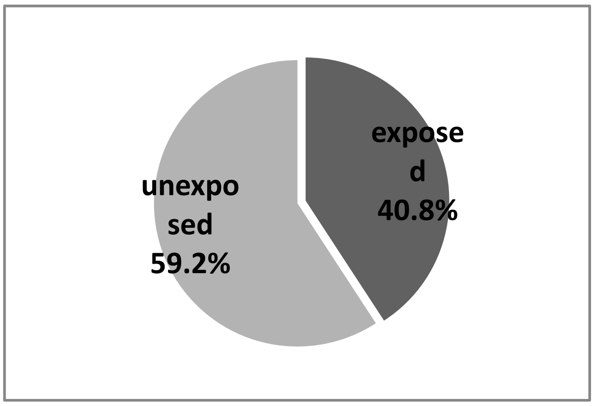

Figure (1): sample based on experimental and control.

The description of the sample age group is presented in table 2. About the cross-tabulation between age groups, the sample size of the unexposed participants is higher than that of the exposed participants.

Table (2): Sample age groups and the percentage for each sample.

Age group in years	Exposed	Unexposed
15-19	19 10.91%	13 7.47%
20-24	07 4.02%	26 14.94%
25-29	12 6.89 %	23 13.21%
30-34	07 4.02%	23 13.21%
35-40	26 14.94%	18 10.34%
Total	71 40.8%	103 59.2%

A. *Demographic characteristics;*

The age range of all participants in the present study is: 15 to 40 years (mean 27.98 ± 0.56 years). The average age of the unexposed females was; 27.4 ± 0.7 years and the average age of the exposed females was; 28.8 ± 0.9 years. The average height of unexposed females was; 159 ± 0.5 cm and the average height of exposed females was; 159 ± 0.7 cm. The average weight of unexposed and exposed was; 68 ± 1.5 kg and 69 ± 1.7 kg respectively. There were no significant differences in age, weight or height among the exposed and unexposedfemales. There were significant differences in weight and height among males and females.

The demographic characteristics of subjects are presented in table 3

Table (3): the demographic parameters of groups.

Variables	Unexposed Females N=103	Exposed Females N=71
Age (in years)	M ± SEM.	M ± SEM.
	27.4 ± 0.7	28.8 ± 0.9
Height (cm)	159 ± 0.54	159 ± 0.7
Weight (kg)	68 ±1.5	69.4 ± 1.7

1) *Respiratory function variables;*

a) The whole group:

The exposed participants showed a significant decrease in all lung function compared with the unexposed.The mean values (± SEM) of FVC, FEV1, FEV1% and PERF for unexposed and exposed groups (females) with statistical analysis (p) of the difference between the mean values and percent decrease are presented in table (4).

Table (4): t-test between Unexposed & Exposed Females and per cent decrease.

variables	Unexposed Females M ± SEM.	Exposed Females M ± SEM.	Decrease (%)	t	p
FVC in liters	3.7 ± 0.04	3.2 ± 0.06	13.51	6.654	S
FEV1 in liters	3.1 ± 0.04	2.7 ± 0.06	12.90	7.656	S
FEV1 % (FEV1/FVC)	85 ± 0.5	81.1 ± 1.51	4.59	2.774	S
PEFR in liters/min.	448 ± 4.8	412 ± 6.9	8.03	4.424	S

- **P < 0.05.**
- **S = Significant.**
- **M = Mean.**
- **SEM = Standard Error Mean.**
- **t = Student's t-test.**

The t- test results revealed a significant decrease between the mean values of exposed and unexposed females in different age groups in all respiratory parameters. Mean values (±SEM) of FVC, FEV1, FEV1% and PEFR for unexposed and exposed females in different age-groups and statistical analysis (p) of the difference between the mean values and the percentage of decrease are presented in table (5).

Table (5): t-test between age-groups 0f Unexposed & Exposed Females with per cent decrease.

Age in Years	Unexposed Females M ± SEM	Exposed Females M ± SEM	D. f	Decrease (%)	T	p
15-19						
FVC	3.7 ± 0.10	3.2 ± 0.10	31	13.5	3.940	S
FEV1	3.2 ± 0.12	2.6 ± 0.11	31	18.8	3.491	S
FEV1 (%)	85.6 ± 2.93	83 ± 3.5	31	5.04	0.586	NS
PEFR	428.6 ± 11.14	389 ± 10.11	31	9.2	2.611	S
20-24						
FVC	3.9 ± 0.08	3.3 ± 0.21	31	15.4	2.887	S
FEV1	3.3 ± 0.09	2.6 ± 0.3	31	21.2	3.537	S
FEV1 (%)	85.6 ± 1.04	76.60 ± 5	31	10.5	2.804	S
PEFR	452.3 ± 7.4	379 ± 19.8	31	16.3	4.222	S
25-29						
FVC	3.8 ± 0.12	3.5 ± 0.13	33	7.9	1.522	NS
FEV1	3.2 ± 0.09	2.9 ± 0.13	33	9.4	2.163	S
FEV1 (%)	84.5 ± 0.85	81.7 ± 2.8	33	3.3	1.202	NS
PEFR	446.5 ± 11.7	435 ± 23.7	33	2.6	0.490	NS
30-34						
FVC	3.5 ± 0.09	3.3 ± 0.20	27	5,7	0.961	NS
FEV1	3 ± 0.09	2.7 ± 0.21	27	9.4	1.247	NS
FEV1 (%)	85.1 ± 1.1	82.3 ± 2.3	27	3.3	1.231	NS
PEFR	448.2 ± 12.4	434.3 ± 29.6	27	3.1	0.578	NS
35-40						
FVC	3.5 ± 0.11	3 ± 0.09	42	14.3	3.635	S
FEV_1	3 ± 0.09	2.4 ± 0.09	42	19.2	4.289	S
FEV1 (%)	84.6 ± 0.2	80.5 ± 2.7	42	4.8	1.247	NS
PEFR	460.6 ± 10.7	421.7 ± 9.3	42	8.4	2.717	S

•S = significant. •NS = non- significant. • M = Mean. •SEM = Standard Error Mean.
• D. f = Degrees of freedom. • t = Student's t-test.

V. Discussion

Air pollution principally affects the body's respiratory system and individual reactions to air contaminants depend on several factors such as the type of pollutants, the degree of exposure and how much of the pollutant is present. Age and health are also important factors. Engagement in dusty occupations had well been documented to result in various pulmonary diseases (Beckett, W.S. 2000), and a decline in pulmonary function had been noticed in workers in cotton (Raza, S.N et al 1999), asbestos (Mukhtar et al 1996), tobacco (Mukhtar et al 1991).

Air pollution with various dusts and fumes had also its prominent attention in literature (American College of Occupational and Environmental Medicine. 1992), and one of the most hazardous sources of air pollution are the uncontrolled industrial dusts and fumes (Dasgupta, S et al. 1997) which dominates various regions. Thence, deterioration of lung function involved workers of pollutant factories (Al-Shamma Y M. et al 2006) and extended to affect the nearby residents as observed in the results of present research. Several studies have found impairment of lung functions in exposed compared to unexposed subjects (Mukhtar et al 1991and 1996, Rao et al 1992, Jaghabir 1998, Uitti et al 1998, Mostaghni et al 2000, Gomes et al 2001, Mustajbegovic et al 2003, Al-shamma et al 2005, Jaen et al 2006 and Zuskin et al 2007…etc).

The study investigates the effects of exposure to fumes, gases and chemical vapourson lung function test of females. The present study compromises 174 participants. Their ages range from 15 to 40 years. All of them areresidents close to the local factories and west Zawia Electrical Stationin Azzawia city. The period of exposure ranged from 15 to 25 years (mean = 20 years).

Demographic characteristics (age, height and weight) showed nosignificant differences between experimental and control groups. But there has been a statistically significant decrease in all parameters of lung function in the participants exposed to gases, fumes and chemical vapours as compared with their unexposed counterparts.

The results obtained from the present investigation are in agreement with the results of the study carried out in Libya by Mukhtaret al. (1991) and (1996). Also, those results are in agreement with other studies carried out in other parts of the world. Uitti et al. 1998 reported a significant decrease in FEV1 among non-smoking tobacco workers. A similar results obtained by Asrat et al (1998) who reported a decrease in FEV1, MMFR and PEFR of male workers exposed to tobacco dust. Jaen et al (2006) reported that the majority of respiratory symptoms (chronic bronchitis and obstructive lung disease) were associated with occupational exposures to vapours, gases, dust and smoking in a population with a high employment in the textile industry. These results are in consistence with other studies such asAl-Shamma et al (2005), Mostaghni et al (2000), Ulvasted et al (2001), Zuskin et al (2007) andJaghabir (1996). The same conclusion was reported by Jaen et al. (2006). They found a correlation between the duration of exposure to tobacco fumes and the symptoms of some respiratory diseases. These findings were also reported by Abu-Omar (1995).

VI. Conclusion

This study demonstrates that exposure to gases, fumes and chemical vapours are associated with a higher prevalence of respiratory symptoms and decline in lung function tests. It is also recommended carrying out an additional survey study among residents in regionclose to the local factoriesin Azzawia citywho are exposed to the same risk factors.

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