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The Prevalence of Occupational Lung Diseases among Pickles Factories' Workers in Palestine

انتشار أمراض الرئة المهنية بين عمال مصانع المخللات في فلسطين

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Abstract

Working in pickles factories is now recognized to be a determinant of occupational lung diseases (OLD). In Palestine, Many cases of pickles factories' workers were noticed to visit the hospitals frequently suffering from respiratory problems; including cough, dyspnea and chest pain. Acetic acid, which is known to be harmful to the respiratory system, is used in these factories in Palestine without airway protection. Moreover, there is a lack of researches conducted on the negative consequences of this career on the respiratory tract. This research aims to outline the effects on certain respiratory parameters resulting from working in pickles factories. A case-control study was performed with a population of 72 citizens. 27 workers in pickles factories were compared to 45 non-workers in pickles factories. Forced spirometry was used to measure the forced expiratory volume in one second (FEV1), forced vital capacity (FVC), and the FEV1/FVC ratio. A comparison of these values along with the prevalence of restrictive and obstructive lung diseases between the two groups was performed. It was observed that there is a significant increase in the prevalence of obstructive and restrictive lung diseases in

pickles factories' workers in comparison with non-workers (p=0.005). The values of FEV1 (p=0.001) are significantly lower among workers in pickles factories in comparison with non-workers, whereas the decrease in the values of FVC among workers is not significant in comparison with non-workers. We conclude that working in pickles factories leads to significant negative effects on the spirometrical readings, and an increasing prevalence of restrictive and obstructive lung diseases. In sight of these results, we recommend that workers in these factories should avoid chemicals exposure using protective devices such as wearing masksand ensuring adequate aeration in these factories.

Keywords: Pickles factories, Occupational Lung disease, Spirometry.

ملخص

بات العمل في مصانع المخللات يعتبر محددا للأمراض الرئوية المهنية وقد لوحظ ان العاملين في هذه المصانع في فلسطين اضحو يزورون المستشفيات بشكل متزايد يشكون من مشاكل في التنفس كالسعال وضيق النفس والام الصدر. في هذه المصانع يستخدم حمض الخليك والذي يعرف بآثاره الضارة على الجهاز التنفسي دون وجود تهويه كافيه. تهدف هذه الدراسه الى توضيح الآثار المترتبة على بعض المؤشرات التنفسية نتيجة للعمل في مصانع المخللات حيث لا يوجد دراسات سابقة في هذا المجال. ضمت هذه الدراسة المقارنة 72 شخصا منهم 27 عاملا و45 شخصا لا يعملون في مصانع المخللات. تم استخدام قياس التنفس القسري لحساب حجم الزفير القسري في الثانية الاولى (FEV1) والسعة الحيوية القسرية (FVC) والنسبة بينهما (FEV1/FVC) تم اجراء مقارنة بين العاملين وغير العاملين وفقا لهذه المؤشرات لمعرفة نسبة وجود التنفس المحدود والتنفس المغلق. اظهرت نتائج الدراسة ان نسبة ظهور مشاكل التنفس المحدود والتنفس المغلق كانت اعلى بكثير بين العاملين مقارنة بغير العاملين (p=0.005) كما اظهرت ان قيم حجم الزفير القسري في الثانية الاولى كانت اقل بكثير بين العاملين مقارنة بغير العاملين (p=0.001) بينما لوحظ ان التناقص في قيم السعة الحيوية القسرية لم يكن مختلفا بشكل كبير بين العاملين وغير العاملين. نستنتج من هذه الدراسة أن العمل في مصانع المخللات يؤدي إلى تأثيرات سلبية كبيرة على قراءات قياس التنفس، والانتشار المتزايد لأمراض الرئة كالتنفس المحدود والتنفس المغلق. في ضوء هذه النتائج، نوصي بتجنب العاملين في هذه المصانع التعرض للمواد الكيميائية باستخدام وسائل وقائية مثل ارتداء الأقنعة الواقية العمل على تهوية كافية لهذه المصانع.

الكلمات المفتاحية: الامراض الرئوية المهنية، مصانع المخللات، قياس مؤشرات التنفس.

Introduction

Working in pickles factories is now recognized to be a determinant of occupational lung diseases (OLD) (Groneberg DA., *et al*, 2006). Restrictive lung diseases are mainly characterized by reduced total lung capacity (TLC) and the loss of lung compliance (Raghu *et al*., 2011) while obstructive lung diseases (Colledge *et al*., 2010) are characterized by the obstruction of the airways and the inability to exhale properly. However, some lung diseases display both obstructive and restrictive characteristics (Gardner *et al*., 2011).

In some occupations, workers are constantly exposed to inorganic dusts, gases, fumes and other harmful substances, leading to anatomical and physiological changes in the respiratory system causing many acute occupational lung diseases from which are occupational asthma and pneumoconiosis (Colledge *et al*., 2010).

Lung function tests are the most commonly used tests for the evaluation of the activity of the lungs and the distinction between obstructive and restrictive lung diseases, which are measured using a spirometer (Holguin, 2012, Colledge *et al*., 2010). Measurements include: forced expiratory volume in one second (FEV1), forced vital capacity (FVC), the ratio of the two volumes (FEV1/FVC) (Schneider *et al*., 2009). FEV1 measures the maximum volume of air exhaled forcibly in the first second after full inspiration, this value shows great declination in obstructive diseases than in restrictive ones. Moreover, FVC measures the maximum amount of air exhaled forcibly after full inspiration (Pellegrino *etal*., 2005), and it declines more in restrictive diseases as a result of airflow obstruction and ventilation restriction (Derom *et al*., 2008). As for the most important test of PFTs which is the FEV1/FVC ratio, it is reduced in the obstructive diseases but remains normal or slightly increases in the restrictive ones because of the proportion change in both the nominator and the denominator (Longo *et al*., 2011).

Commercial pickling is usually performed using vinegar, which is essentially made of glacial acetic acid. Intense dermal exposure to glacial acetic acid causes extreme irritation to the skin and mucous membrane, and inhalation of the vapor of the acetic acid was found to cause acute tracheobronchitis, reversible airways obstruction, steroid responsive interstitial pneumonitis, and it results in diffuse alveolar damage. However, there is a wide range of symptoms and the severity of the results is highly dependent of the intensity of exposure to acetic acid (KG RAJAN and DAVIES, 1989). In Palestine, according to the authors' knowledge, there is no sufficient data regarding the effect of working in pickles factories and lungs function tests. This study aims to evaluate the influence of working in this occupation on the lung function in Palestine.

Materials and Methods

A comparative cross-sectional study was performed in order to achieve the study objectives. The comparison was made between the Pickles factories' workers group and the non-workers group. The cases involved 27 pickles workers in two factories in the West Bank located at Toulkarem and Toubas. According to the Ministry of Agriculture and Economy, these are the only two factories in the West Bank. The control group included 45 non-pickles factories workers (Abuzant *et al*., 2015) and each case (worker) was matched to two controls (ratio 2:1) reducing bias due to confounding Criteria used for subject selection included lack of involvement, during or before the time of the study, in similar occupations such as glassmaking, stone manufacturing or farming that may affect the lungs function.

For ethical considerations, an approval to conduct this study from the Institutional Review Board (IRB) of An-Najah National University was obtained. All test subjects were given information about the study, then asked for their signature on consent forms clarifying the study's aims and potential risks. Anonymity of the study subjects was guaranteed, and maintenance of the confidentiality during and after the study period was strictly achieved.

At the time of thespirometry, LFTs were conducted employing a Microlab Spirometer by Care Fusion that complies with ATS/ERS 2005 standards (Pellegrino *et al*., 2005).Following the typical guidelines for spirometer testing (Broekhuizen *et al*.),the subjects were seated during the test, and to prevent the air leakage through the nares, the subjects' noses were clipped. For each subject, FEV1, FVC, and FEV1/FVC ratio were made. The administration of bronchodilator – if used by any worker - was restricted for at least 4 hours before the test, as a result of its effect on the PFTs, especially by concealing the obstructive respiratory pattern (Longo *et al*., 2011).

The data was statistically analyzed by SPSS Statistics V.17.0 (SPSS Ink, Chicago, Illinois, USA), measuring the P value using Chi-square test to find out the significance of the associations. At a p value < 0.05, the level of significance was considered significant.

Results

This study was conducted on 27 pickles' factories workers, forming all the workers in two factories in the west bank, these workers represent the case group. Two of the workers were females. The mean age of the workers is nearly 34.7 years (17-69 years). The spirometrical readings were compared to 45 non-workers, representing the control group. The ages of the control group ranged from 17 to 53 years.

Table (1) shows the relation between working in pickles factories and the FEV1 as measured by the spirometer, by comparing between the workers and non-workers readings. The mean measured FEV1 value for the workers was 76, with 48% of the workers showing values less than it. Sixty-three percent of the workers showed decreased FEV1 values, compared to 4% of the non-workers ($p=0.001$).

Table 1: The impact of working in pickles factories on FEV1.

	Workers, n (%)	Non-workers, n (%)	p-value
DecreasedFEV1	17 (63%)	4 (8.9%)	0.001
NormalFEV1	9 (33.3%)	41 (91.1%)	0.001
IncreasedFEV1	1 (3.7%)	0 (0%)	NS
Total	27 (100%)	45 (100%)	
FEV1: forced expiratory volume in one second, NS: non-significant, n (%): number (percentage)			

The mean value for FVC among the workers is 77, with 59% of the workers showed readings lower than the mean. Table (2) shows the relation between working in pickles factories and FVC. 66% of the workers showed decreased values as shown by the spiromerter when compared to the mean of the measured predicted values. On the other hand, 33% of the non-workers showed decreased FVC values readings (p=0.02).

Table (2): The impact of working in pickles factories on FVC.

	Workers, n (%)	Non-workers, n (%)	p-value
DecreasedFVC	18 (66.7%)	15 (33.3%)	0.02
NormalFVC	9 (33.3%)	29 (64.4%)	0.02
IncreasedFVC	0 (0%)	1 (2.2%)	NS
Total	27 (100%)	45 (100%)	
FVC: forced vital capacity, NS: non-significant, n (%): number (percentage)			

Table (3) shows the relation between working in pickles factories and the FEV1/FVC. More than 40% of the workers showed FEV1/FVC readings more than the measured mean for this value, which is 97.5. When comparing between the readings of the workers and non-workers, it's found that the workers had more cases with decreased ratio (22.2%) compared to 0% among the non-workers (0.04).

Table (3): The impact of working in pickles factories on FEV1/FVC ratio.

	Workers, n (%)	Non-workers, n (%)	p-value
Decreased FEV1/FVC	6 (22.2%)	0 (0%)	0.04
Normal FEV1/FVC	16 (59.3%)	34 (75.6%)	NS
Increased FEV1/FVC	5 (18.5%)	11 (14.4%)	NS
Total	27 (100%)	45 (100%)	
FEV1/FVC: forced expiratory volume in one second/forced vital capacity, NS: non-significant, n (%): number (percentage)			

Regarding the effect of working in pickles factories and the lung function status as measured by the spirometer, there is a significant effect for working in these factories and the lung function. The prevalence of the restrictive and obstructive lung diseases was increased among the workers; as 22.2% of the workers had obstructive lung diseases compared to 2.2% of the non-workers(p=0.005), while 48.1% of the workers had restrictive lung diseases compared to 37.8% of the non-workers, as shown in table (4).

Table (4): The relation between working in pickles factories and the lung function status.

	Workers, n (%)	Non-workers, n (%)	p-value
Normal function	8 (29.6%)	27 (60%)	0.04
Restrictive pattern	13 (48.1%)	17 (37.8%)	NS
Obstructive pattern	6 (22.2%)	1 (2.2%)	0.04
Total	27 (100%)	45 (100%)	
NS: non-significant, n (%): number (percentage)			

Discussion

Working in pickles factories poses some health hazards on workers, especially on the respiratory system. The use of acetic acid in the process of pickling jeopardizes the workers who inhale its vapor. This exposure causes irritative effects (Ernstgard *et al*., 2006) and an outbreak of airway hyperresponsiveness and asthma like illness after glacial acetic acid spill has been reported (Kern, 1991). The pathogenesis of occupational lung diseases may explain these effects.

Acid anhydrides, such as the acetic acid, are respiratory irritants that cause an inflammatory response which may eventually lead to pulmonary fibrosis (Rom and Ryon, 2011), a common cause of restrictive lung diseases. Almost half the workers in our study showed a restrictive pattern in their lungs function. Twenty-two percentage of workers had a decreased FEV1/FVC ratio. And with a P value of 0.02, there was a significant decrease in FVC values among workers in comparison with the non-workers. This signifies a restrictive pattern; however, pathological evidence is needed. Furthermore, other workers showed an obstructive pattern, signified by the significant decrease in FEV1 values (p value=0.0001) among workers when compared to non-workers. This might be due to acetic acid vapor exposure which leads to airways hyper-responsiveness.

The result of this study supports previous studies. One of the studies was on 1991, which showed an outbreak that happened after a spill of glacial acetic acid and resulted in reactive airway dysfunction syndrome (RADS) in exposed subjects. (Kern, 1991). Another relevant experimental study was performed on guinea pigs. After a one hour exposure to acetic acid vapor, a decrease in pulmonary compliance along with an increase in pulmonary flow resistance and a bronchial constriction resulted (Amdur, 1961).

Based on these results, we recommend that safety precautions must be applied for workers in pickles factories, like the use of breath masksand ensuring adequate aeration in these factories. This study has only investigated the effects on respiratory parameters, so it is

recommended that further pathological and experimental clinical studies in this field to be carried on to increase our understanding of the results. Further studies on the other respiratory parameters, such as the forced expiratory volume in the third second (FEV3)/ FVC ratio are recommended to be conducted for the screening of airflow obstruction. We recommend as well for more studies on the effect of acetic acid on other systems like the skin and the eyes.

Conclusions and Recomendations

Working in pickles factories leads to significant negative effects on the pulmonary function of workers. The results of this study stress on the importance of adoption of protective measures to prevent the occurrence and progression of health problems among the workers and necessitate adequate intervention. Nevertheless, there is still a need for conduction of studies on the pathological changes that result from exposure to acetic acid in pickle industry in order to have an explanation of the spirometrical changes found in this study.

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