

SURVEY OF RESPIRATORY SYMPTOMS, SPIROMETRY, AND RAST AND THEIR RELATION TO OCCUPATIONAL EXPOSURES AMONG DETERGENT PRODUCTS STAFF

By

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Abstract:

Introduction: Respiratory disorders are one of the documented hazards affecting workers involved in the industry of washing products. **Aim of Work:** This study aims to assess the frequency of sensitization to enzymes in detergent industry. It also describes work-related respiratory symptoms and pulmonary function parameters among detergent workers in a detergent plant in Cairo, Egypt. **Materials and Methods:** A cross sectional study was carried out on all plant workers, where Radioallergosorbent testing (RAST) positive subjects underwent further detailed history taking, clinical examination, x-ray and pulmonary function measurements. **Results:** Among 1329 workers, 9 % of them were sensitized using RAST. Of those, 56.8% reported chest complaints. The RAST grading of workers revealed that 39.2 % of workers were grade I, 24 % were grade II and 36.8 were grade III. It was found that 75.2% of them were exposed to hazardous materials during work. The majority of them reported exposure to dusts and powders (58.4 %). Pulmonary functions testing revealed that 52% showed restrictive lesions and 2.4 % obstructive lesions. The majority of workers who had obstructive and restrictive lesions were RAST grade III (66.7 % and 52.3 % respectively where $P < 0.001$). By Comparing pulmonary functions of workers with dust exposure, it was evident that the majority of workers who had obstructive and restrictive lesions were exposed to dust within the workplace, 100 % and 83.1 % respectively ($P < 0.034$). The study of pulmonary functions among different RAST grades revealed a statistically significant lowered mean of FVC, FVC percentage and FEV1 among grade III workers than other grades ($P < 0.001$). **Conclusion:** Dust exposure in detergent producing plant has a negative impact on workers' respiratory systems.

Keywords: Detergent products, Occupational exposure, RAST, Respiratory, Spirometry.

Introduction

The respiratory health effects have been documented in workers exposed to a variety of occupational exposures in small and large-scale industries during their processing. Respiratory disorders caused by occupational exposures are influenced by the type of offending dust, dose, duration of exposure and genetic factors (Subbarao et al, 2009)

Hazardous substances used in washing products including enzymes and powder are respiratory sensitizers and are known to cause allergic rhinitis and occupational asthma among working staffs. It is also an irritant and may give rise to short term or long term respiratory disorder up to chronic bronchitis (Dykewicz, 2009)

Some cases were detected in accordance with high level of enzyme concentration in the surrounding environment (Vanhanen et al, 2000). Others were associated with low environmental monitoring of enzyme dust. This suggested the presence of other allergens apart from enzymes in detergent industry (Schweigert et al, 2000, Sarlo and Kirchner, 2002, Sarlo, 2003, Basketter et al, 2010).

Immunological assessment of workers exposed to cleaning and washing products was done using allergy blood testing which has excellent reproducibility; high specificity and sensitivity too, when compared to skin prick testing (Hamilton, 2010)

In occupational respiratory disorders, dynamic lung functions measurements by means of spirometry is beneficial. Lung function parameters are considered a cornerstone in the early recognition of pulmonary dysfunctions even if the workers may be clinically normal (Cotes, 1979).

Aim of Work

To assess the frequency of sensitization to enzymes in detergent industry. It also describes work-related respiratory symptoms and pulmonary function parameters among detergent workers in a detergent plant in Cairo, Egypt.

Materials and Methods

- **Study design:** It is a cross sectional study.
- **Place and duration of study:** This study was carried out on a detergent producing plant during the period from November 2014 to January 2015.

- **Study sample:** All the staff (1329 workers) in the plant was examined.
- **Study methods:**
 - A. All workers underwent Radioallergosorbent testing (RAST) which is a method employed in allergy testing (type 1 allergy - IgE mediated). The patient's serum is incubated with a solid phase allergen and the amount of occupational allergen-specific IgE is quantified with radiolabelled anti-IgE. By means of RAST, 119 workers (9 %) were documented to be sensitized. Those workers continued the study.
 - B. All of them were interviewed by a physician who filled a questionnaire including questions on occupational history, respiratory symptoms, and smoking status of the study participants. The occupational histories of the study participants were assessed through questions on previous and current job, work duration, job description, working conditions, methods of ventilation conditions, and personal protective equipments. Respiratory symptoms (cough, expectoration, dyspnea, wheezing, and chest tightness) were documented.
 - C. General and local examination of all body systems on emphasize of the respiratory system were carried out for all participants.
 - D. Weight and height of the study participants were measured and their body mass index (BMI) was calculated.
 - E. Investigations:
 - 1- Lung function parameters; Forced vital capacity (FVC), Forced expiratory volume in the first second (FEV1), FEV1/FVC, Forced Expiratory Flow at 25-75% (FEF 25-75) and Peak expiratory flow rate (PEF) were measured using digital COSMED spirometer. Predicted values for each worker were calculated using his/her gender, age and height. 80% of predicted values were the cutoff point.
 - 2- Plain chest X ray (both postero-anterior and lateral views) was done

for the examined group. If abnormal findings were present, CT chest was performed.

Data analysis:

All data was revised, coded, tabulated and introduced to a PC using Statistical package for Social Science (2001). Suitable descriptive statistics were done; Mean, standard deviation (\pm SD), minimum and maximum values (range) for numerical data and frequency and percentage for non-numerical data. The Independent-Samples T Test was used to assess the statistical significance of the difference between two study group means, Chi-Square test was used to examine the relationship between two qualitative variables, Fisher's exact test was used to examine the relationship between two qualitative variables when there's a cell with an expected frequency of less than 5, and One-Way ANOVA test was used to assess the statistical significance of the difference between more than two study group means. $P < 0.05$ was

considered significant and $P < 0.01$ was considered highly significant.

Consent:

Administrative approval of the detergent plant was obtained. The study participants were assured of the confidentiality of the data and their verbal consent was obtained.

Funding:

No funding sources for this research.

Ethical Approval:

The study protocol was approved by the department of Community, Environmental & Occupational Medicine, Faculty of Medicine, Ain Shams University, Cairo, Egypt.

Results

This study was carried out on 1329 male workers in a detergent factory who underwent RAST testing. One hundred and nineteen (9%) workers were RAST positive and continued the rest of the study.

Table (1): General characteristics of the studied workers

		N.	Percent (%)	
Age (years)	Mean ± SD	38. 3± 6.6		
	Range	23-56		
Smoking status	Non smoking	62	49.6	
	Smoker	46	36.8	
	Ex-smoker	17	13.6	
Complaints	Chest complaints	Overall	71	56.8
		Dyspnea on effort	31	24.8
		Expectoration	18	14.4
		Cough	12	9.6
		Wheezes	4	3.2
		Pain	6	4.8
		Sneezing	5	4
	Allergy	21	16.8	
Rhinitis		67	53.6	
Dust exposure	Unexposed		31	24.8
	Exposed	Overall	94	75.2
		Packaging materials	1	0.8
		Dusts and powders	73	58.4
		Liquid chemicals	11	8.8
		Enzyme exposure	2	1.6
		Carbonates – sulphates – odor smells	7	5.6
RAST grade	Grade I	49	39.2	
	Grade II	30	24	
	Grade III	46	36.8	
Pulmonary functions	Normal	55	44	
	Obstructive	3	2.4	
	Restrictive	65	52	
	Mixed	2	1.6	
Small airways affection	Yes	123	98.4	
	No	2	1.6	
Recommendation	Repeat after 1-3 months	62	49.6	
	No recommendation	50	40	
	Remove from exposure	13	10.4	

RAST = Radioallergosorbent test

Table (1) shows that the mean age of the group (\pm SD) was 38.3 (\pm 6.6) years, with a prevalence of smoking among them was 36.8%. It was reported that 75.2% of them were exposed to hazardous materials in work (dust and powders, liquid chemicals, enzymes...). Chest complaints were reported by 56.8 % workers where the most common manifestation was dyspnea on efforts and expectoration. Pulmonary functions testing of workers revealed a prevalence of restrictive lesions among of 52 % of workers.

Radiological examination in the form of x-ray revealed that all of them were normal except one worker showed reticulo-nodular pattern. On further investigation, he showed moderate restrictive pattern on spirometry and he was diagnosed as interstitial lung disease.

Table (2): Spirometry study findings of workers

	Mean	\pmSD	Minimum	Maximum
FVC	3.9	0.94	2.0	6.7
FVC %	76.4	17.6	3.9	124.0
FEV1	3.5	0.7	1.6	5.3
FEV1/FVC Ratio	90.3	7.6	69.2	100.0
PEF	9.1	11.4	2.9	97.8
FEF 25-75	4.4	1.3	1.6	8.8

FEV₁ = Forced expiratory volume in the first second, FVC = Forced vital capacity, PEF= Peak Expiratory Flow, FEF25-75= Forced Expiratory Flow between 25% and 75% of FVC

Description of some lung function parameters was shown in Table (2), where FEV₁/FVC ratio range from 69.2% up to 100%.

Table (3): Comparative study between types of respiratory disease as diagnosed by spirometry testing and RAST grades among studied workers

Normal (n=55) Obstructive (n=3)			Pulmonary function				X ²	P
			Restrictive (n=65)	Mixed (n=2)				
RAST grade	Grade I	No	28	0	20	1	19	<0.001*
		%	50.9%	0.0%	30.8%	50.0%		
	Grade II	No	18	1	11	0		
		%	32.7%	33.3%	16.9%	0.0%		
	Grade III	No	9	2	34	1		
		%	16.4%	66.7%	52.3%	50.0%		

*: Highly Significant difference

Comparison of pulmonary functions of workers with RAST grades revealed that the majority of workers who had obstructive and restrictive lesions were RAST grade III (66.7 % and 52.3 % respectively where $P < 0.001$) (Table 3).

Table (4): Comparative study between types of respiratory disease as diagnosed by pulmonary functions testing and dust exposure among studied workers

Normal (n=55) Obstructive (n=3)			Pulmonary function				Fisher's exact	P
			Restrictive (n=65)	Mixed (n=2)				
Dust exposure	Unexposed	No	16	0	11	1	1.521	0.034*
		%	29.1%	0.0%	16.9%	50.0%		
	Exposed	No	39	3	54	1		
		%	70.9%	100.0%	83.1%	50.0%		

*: Highly Significant difference

Table 4 showed that the non-exposed group who didn't report exposure to any hazardous material during work, were compared to exposed workers regarding chest complaints and spirometry. By comparison of pulmonary functions of workers with dust exposure, it was evident that the majority of workers who had restrictive lesions and all of the workers who had obstructive were exposed to dust within workplace, 100 % and 83.1 % respectively ($P < 0.034$).

Table (5): Comparative study between pulmonary functions and RAST grades among studied workers

		No	Mean	SD	F§	P
FVC	Grade I	46	4.0	0.8	11.284	0.001*
	Grade II	28	4.3	1.0		
	Grade III	45	3.4	0.9		
FVC %	Grade I	46	80.1	14.8	6.889	0.001*
	Grade II	28	81.9	22.6		
	Grade III	45	69.1	14.2		
FEV1	Grade I	46	3.6	0.6	9.197	0.000*
	Grade II	28	3.8	0.8		
	Grade III	45	3.1	0.7		
FEV1/FVC Ratio	Grade I	46	90.4	6.7	0.705	0.496
	Grade II	28	88.9	8.5		
	Grade III	45	91.0	7.9		
PEF	Grade I	46	9.7	13.0	1.005	0.369
	Grade II	28	11.1	16.4		
	Grade III	45	7.4	2.0		
FEF25-75	Grade I	46	4.6	0.9	2.478	0.088
	Grade II	28	4.7	1.6		
	Grade III	45	4.1	1.4		

*: Highly Significant difference

§ ANOVA test

The study of pulmonary functions among different RAST grades revealed a statistically significant lowered mean of FVC, FVC percentage and FEV1 among grade III workers than other grades ($P < 0.001$) (Table 5).

Table (6): Comparative study between presence of chest complaints and dust exposure among studied workers

Present (n=67)			Chest complaints		X ²	P
Absent (n=52)						
Dust exposure	Unexposed	N.	14	15	1	0.215
		%	20.9%	28.8%		
	Exposed	N.	53	37		
		%	79.1%	71.2%		

By comparing the presence of chest complaints among the studied workers according to their exposure, it was found that there is no statistical difference between exposed and unexposed groups regarding their symptoms (Table 6).

Discussion

Working in the industry of detergents exposes the workers to dust, powders, liquid chemicals and other materials as proved by the current study where the overall exposure rate among RAST positive workers was 75.2% of them. Some studies mentioned that dust concentration is high during mixing and packing of detergents (Vanhanen et al, 2000, Vanhanen, 2010, Van Rooy, 2009).

Using RAST, we found that 119 (9%) of the plant workers were sensitized to the used enzymes. The frequency of enzyme sensitization was similar to a study done in Denmark by Johnsen et al, 1997.

Although Detergent enzymes have a very good safety profile as mentioned by researches (Basketter, 2012). Material Safety Data Sheet mentioned that inhalation of dust/aerosols may induce sensitization in susceptible individuals or may cause irritation of the respiratory tract (Fishersci, 2014). Regarding the workers' complaints, 76% of the studied workers reported work related symptoms where 57% were chest symptoms. Almost similar results were reported in Nigeria (87%) and lower rate in Finland (22%) (Vanhanen, 2010). Those findings may be explained by the fact that Finland is a developed country where lines of hazard prevention and health education of workers on symptoms of work

related respiratory disorders might take place. Chest complaints were reported by 56.8% of the workers and the most common manifestation was dyspnea on efforts and expectoration (24.8 % and 14.4 % respectively). The current study revealed that 53.6 % of workers reported rhinitis. Similar rates were reported in Nigeria by Babashani et al, 2008 (57%) and in Finland by Vanhanen, 2010 (47%). At the same time, another study in Finland (Vanhanen et al, 2000) reported higher rates of rhinitis (89%). Other studies reported higher prevalence of itching nose, sneezing and wheezing among exposed workers but a rate lower than the current study (Van Rooy, 2009).

Our research work revealed that restrictive and obstructive lesions among workers were associated with dust exposure (61 % and 34 % among exposed workers respectively) with a statistical significant difference ($P < 0.034$).

Similarly in Nigeria, Bamidele (2002) and Oleru (1984) concluded that the significantly lower value of some respiratory function measurements among production workers of detergent industry might be due to the exposure to

some materials used in industry. FEV1, FVC and PEFr were significantly reduced among exposed detergent workers (Babashani et al, 2008, Oleru, 1984). While others didn't find any abnormality in the respiratory function testing due to enzyme exposure (Cathcart, 1997)

In the current study, no association was found between exposure to hazardous materials during work and chest symptoms. On the contrary, other studies revealed a positive relation between symptoms and dust exposure (Van Rooy et al, 2009).

Conflict of interest

Authors have declared that no conflict of interests exists.

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