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OCCUPATIONAL HEALTH DISORDERS AMONG WORKERS IN TEXTILE DYEING INDUSTRY

By

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Abstract

Introduction: In textile dyeing industry ; workers are exposed to chemical, physical, and mechanical hazards that can affect their health . **Aim of Work :** To assess health status, changes in selected blood parameters of occupationally exposed workers in textile dyeing industry, and to evaluate the implementation of safety measures at the workplace. **Materials and Methods:** A comparative cross-sectional study was carried out in textile dyeing units in Miser Spinning and Weaving Company at El Mahala El Kobra, Gharbyia Governorate, Egypt. The study included 100 exposed and 100 non-exposed workers as a comparison group from administrative sector. All workers were subjected to an interview-administrated questionnaire which included sociodemographic, occupational characteristics and some reported health complaints. Their liver enzymes, kidney functions, and complete blood counts were also measured. **Results:** All studied workers were occupationally exposed to chemicals, vapors, gases and noise, while 58% were exposed to dust , and 68% to humidity and heat. Exposed workers suffered from runny nose (22%), watery eye (36%), difficult hearing (30%) . Liver enzymes (AST, ALT, and GGT) were high in 11% of the exposed group . Regarding CBC; neutropenia with relative lymphocytosis was the most frequent CBC findings among the exposed group (8%) of cases. No statistical significant differences were found between the two studied groups regarding CBC findings and renal function tests including urea and creatinine. Assessment of work place environment by inspection checklist detected that only 38.5% of physical hazards items, 50% of chemical hazard items, 57%of of fire hazards safety measure items were fulfilled at the work place. **Conclusion and Recommendations:** Textile dyeing industry has adverse health effects on the exposed workers. So, applying the standard safety measures, regular environmental monitoring and periodic examination for workers are mandatory.

Keywords: Organic solvents, Liver function, Textile dyeing industry worker and Safety measures.

Introduction

Through several production processes, the textile industry transforms fibers into yarn, yarn into garments, and finally dyeing and finishing these materials (Madhav et al., 2018). Egypt has been a leader in the textile industry for many years. The earliest textiles ever discovered date of approximately 5000 before century and were found in Egyptian caves as pieces of linen fabric (El-Gohary et al.,2013).Nowadays, the textile industry employs over 500,000 workers across 6,742 companies and makes over 4% of Egypt's total economy. In 2018, exports of such industry amounted to about 3 billion US dollars (USD), or around 12% of total exports (Grumiller et al., 2020) . The textile sector consumes about 70% of dyestuffs. A variety of chemicals and dyes are utilized to create popular hues of fabrics for a competitive textile industry (Benkhaya et al., 2017) . There are several health hazards in textile dying units, which can be classified as physical hazards (noise, high degrees of temperature, humidity, poor illumination, and electrical danger), chemical hazards (dyestuffs, salts, bleaching agents, acids, alkalis, finishing chemicals, solvents, and heavy metals, fiber dust, and gaseous emissions); fire and explosion hazards (flammable dyestuffs and solvents); ergonomic hazards (posture force, repetition, poorly designed work procedures, and tasks); mechanical hazards (slippery surface, serious scalding injuries, housekeeping injuries, and fault of moving equipment); and psychological stress hazards (Babel and Tiwari et al .,2014) .

Textile dyes can irritate the eyes, skin, and upper respiratory tract (Tang et al.,2018) . Workers exposed to reactive dyes have also reported contact dermatitis, allergic conjunctivitis, rhinitis, occupational asthma, and other allergic responses (Hassaan and ElNemr 2017). Furthermore, employees involved in textile dyeing units are vulnerable to various musculoskeletal conditions, including back and joint pain, gastrointestinal tract irritation, chemical cystitis, renal failure, cytotoxic effects on the central nervous system, chromosomal abnormalities, genotoxicity, mutagenicity, and carcinogenicity (Bhattacharya et al., 2016) .

Textile dyeing industry has adverse health effects on the exposed workers especially in developing countries like Egypt with defect in the implementation of effective safety measures (El-Feky et al., 2021)

Searching electronic databases relieved, few published studies have been previously conducted in Egypt to detect these health problems. Therefore, the present study will be carried-out to, assess health condition of workers occupationally exposed to chemical and physical hazards in dyeing industry.

Aim of Work

To assess health status, changes in selected blood parameters of occupationally exposed workers in textile dyeing industry**,** and to evaluate the implementation of safety measures at the workplace.

Materials and Methods

Study design: It is a comparative cross-sectional study.

Place and duration of the study: This study was carried out in The Textile Dyeing unit at Textile Wet Processing sector of Miser Spinning and Weaving Company (MSWC) at El Mahala El Kobra City, Gharbyia Governorate, Egypt. This company is the largest and oldest enterprise of its kind in Africa and the Middle East. The study started from the first of January 2021 till the end of July 2023.

Study sample:

The whole workforce (100 workers) of the textile dyeing unit employed for at least one year were included in the study. A sample of 100 non exposed workers, taken as control, were selected fromadministrative sector as a comparative group . They were matched to the exposed group regarding age and sex. All workers were male.

Study methods:

I-The data were collected from workers using validated **predesigned structured questionnaire** sheet patterned according to International Commission on Occupational Health (ICOH) (Nafees et al., 2022). The questionnaires were filled by the researcher via direct personal interviews with the employees .The questionnaire consists of the following sections**:**

Section 1. Socio-demographic information included: age, sex, marital status, place of residence, education level and smoking habit.

Section 2. Present occupational history included the following items:

- Current job, work duration in years, and type of exposures.
- Availability of appropriate

personal protective equipment (PPE) and its regular use.

- Pre-placement and periodic medical examinations.
- Availability of training programs on safe dealing with different exposures at the work place.

Section 3. Past occupational history which included:

- Previous occupations, place and duration of employment.
- Previous occupational chemical exposures if present.

Section 4. Health related symptoms regarding different occupational exposures

The questionnaire included symptoms such as: Chest , Eye, Ear, Nasal, Oral, Skin ,Cardiovascular, Renal ,Gastrointestinal and musculoskeletal symptoms .

II - Laboratory Investigations

- Measurement of liver enzymes level (SGOT, SGPT and Gamma GT), Kidney function as (Creatinine level) and CBC were performed on 170 workers who agreed to give blood samples, whereas thirty workers refused.
- Each worker gave a 5 ml venous blood sample, it was divided into 4 ml in a dry tube for the evaluation of liver and kidney function and 1 ml in an EDTA-containing tube for complete blood counts (CBC).
- A CBC test was performed using the DH36 automatic cell counter Dymind 3-hematology analyzer (Shenzhen Dymind Biotechnology Co., Ltd, China). We compared the measured results to age-based male reference value ranges CDC (2016).
- Clear serum without hemolysis was obtained by centrifuging blood samples for three minutes at 3000 rpm. The Robonik Prietest Touch Biochemistry Analyzer (ROBONIC, PVT. Ltd, India) and a commercially available kit were used in accordance with the manufacturer's instructions to analyze the samples in order to determine the serum levels of Aspartate Aminotransferase (AST), Alanine Aminotransferase (ALT), Gamma-Glutamyl Transferase (GGT), and serum creatinine. The measured findings were compared to reference value ranges for males.

III - Work place inspection checklist:

To verify that safety precautions were in place and being implemented in the workplace,the most recent version of the Occupational Safety and Health Inspection Checklist (OSH) was utilized. The checklist has eighteen items, each one has its own set of questions that could be responded with "Yes," "NO," or "Not applicable." if "Yes," give 1 if "NO," or "Not applicable" give 0 and finally sum all items that take 1 to calculate the final score of each item (ILO, 2016).

IV- Environmental monitoring of work areas:

Environmental monitoring of work areas was carried out by Occupational Health and Safety officials in the studied factory by supervisors from national labor office. Environmental measurements were done in each work shift in different workplaces in the factory according to the emitted hazards and recorded in the measurement records and the data was taken from these records. Environmental measurements included:

a) Noise measurements: By sound level meter, type B&K2240.

b) Light intensity ,relative humidity and heat stress was monitored by Kestrel 4200- meter apparatus.

c) Gas emission from chimneys by flue gas analyzer 01024723/GB.

Consent

The study's goal and methodology were explained to the participants to get their consent. Participation was voluntary, and formal written consent was taken from each individual . The collected data will be only utilized for scientific research.

Ethical Approval

Before starting the research, Tanta Faculty of Medicine's Ethical Committee granted approval

for the research.

Data Management

Data were collected, coded, and SPSS version 24 was used for analysis. The normality of data was examined by one-sample Kolmogorov-Smirnov test using numbers and percentages for describing the Qualitative data . Numbers and percentages were used for describing the Qualitative data Chi-square tests and Odds ratio (95% CI) were used to test the association between categorical variables .An alternative to the Chi-square test was the

Fisher's Exact Test if a cell has expected counts below 5. For parametric data, continuous variables were presented as mean ± standard deviation (SD), and for nonparametric data, continuous variables were presented as median (minimum to maximum).For parametric data, the mean difference (95% CI) and independent t-test were used to assess the association between the variables. The difference is considered significantwhen P- value ≤ 0.05.

Results

Table (1): Distribution of studied workers according to sociodemographic characteristics and duration of work.

Sociodemographic characteristics	Exposed Group		Control Group		Test of significance	P-value
	No.=100	%	No.=100	%		
Age (years): < 30 30- 40- >50	5 16 29 50	5.0 16.0 29.0 50.0	6 19 35 40	6.0 19.0 35.0 40.0	**χ2 Test** 2.022	0.568
Mean ±SD Range	47.99±9.625 22-60		46.24±8.936 22-60		**U-Test** 4322.00	0.097
Residence: Urban Rural	27 73	27.0 73.0	32 68	32.0 68.0	**χ2 Test** 0.601	0.535
Marital status: Single Married Widow	4 90 6	4.0 90.0 6.0	2 95 3	2.0 95.0 3.0	**χ2 Test** 1.802	0.406
Education: Illiterate Primary Secondary University	8 12 65 15	8.0 12.0 65.0 15.0	6 18 63 13	6.0 18.0 63.0 13.0	**χ2 Test** 1.660	0.646

Smoking:						
Non-smoker	49	49.0	60	60.0	**χ2**	
Ex-smoker	6	6.0	1	1.0	**Test**	0.078
Smoker	45	45.0	39	39.0	5.110	
Duration of work(years):						
≤10	23	23.0	22	22.0	**χ2 Test** 4.726	0.193
11-20	27	27.0	40	40.0		
21-30	36	36.0	30	30.0	**U-Test**	
>30	14	14.0	8	8.0	4256.00	0.068
Mean ±SD	20.80±10.368		18.38±9.396			

Table (1) showed that exposed workers' ages ranged from 22 to 60 years with a mean age of 47.99±9.625 years vs 46.24±8.936 among the control. Most of workers in the exposed group (73.0%) were from rural areas vs (68.0%) in the control group. Most of the exposed group (65.0%) had secondary level of education and above vs (63.0%) in control group. There was n o significant difference between the two groups regarding sociodemographic characteristics. One thirds of the exposed workers (36%) had duration of work which ranged from 21 to 30 years with a mean of 20.80±10.368 vs 18.38±9.396 in control group

Table (2): Distribution of type of exposure among the exposed workers.

Type of exposure	Exposed Group	
	No.= 100	%
Liquid chemicals	100	100
Vapors	100	100
Gases	100	100
Dust	58	58.0
Humidity	68	68.0
Heat	68	68.0
Noise	100	100
Vibration	23	23.0
inadequate light	59	59.0

Table (2) showed that all workers were exposed to liquid chemicals, vapors, gases and noise while 58% were exposed to dust 68% to humidity and heat and 59% to light and only 23% of them were exposed to vibration .

Table 3: Distribution of nasal, eye, and ear manifestations among workers in bothexposed and control groups.

Symptoms	Exposed Group No.=100		Control Group No.=100		χ2 test	P-value
	No.	%	No.	%		
Nose						
Runny nose	22	22.0	14	14.0	2.168	0.197
Sneezing	6	6.0	7	7.0	0.082	1.000
Itchy	12	12.0	5	5.0	3.150	0.126
Blocked	20	20.0	11	11.0	3.092	0.117
Bleeding	5	5.0	3	3.0	0.521	0.721
Troubles in smelling odors	12	12.0	6	6.0	2.198	0.216
Off work days improvement	38	84.4	10	43.5	12.304	**0.001***

Eye						
Burning	11	11.0	6	6.0	1.607	0.311
Itching	17	17.0	5	5.0	7.354	**0.011***
Watery	36	36.0	15	15.0	11.607	**0.001***
Chemical splash	8	8.0	0	0	8.333	**0.007***
Off work days improvement	49	96.1	6	37.5	28.425	**<0.001***
Ear						
Difficult hearing	30	30.0	6	6.0	19.512	**<0.001***
Tinnitus	8	8.0	2	2.0	3.789	0.101
Pain	3	3.0	2	2.0	0.205	1.000
Discharge	3	3.0	5	5.0	0.521	0.721

Table (3) showed that most of nasal symptoms were higher among the exposed group compared to the control , but it didn't reach a statistical level of significance ;these symptoms were improved during off work days. All eye symptoms were higher among the exposed group compared to the control with statistically significant difference ;these symptoms were improved during off work days . All ear symptoms were higher among the exposed group compared to the control, but it didn't reach a statistical level of significance except for difficult hearing.

Table (4): Liver enzymes and kidney function and CBC of the studied workers.

Studied variables	Exposed Group No.=100	Control Group No.=70	Total	t-test	P-value
ALT (U/L): Mean ±SD Range	26.18±14.21 12-100	24.96±9.93 13-55	25.68±12.61 12-100	0.621	0.535
AST (U/L): Mean ±SD Range	25.26±8.39 12-60	23.94±6.44 12-43	24.72±7.66 12-60	1.105	0.271
GGT (U/L): Mean ±SD Range	25.93±11.94 12-72	24.39±11.08 11-70	25.29±11.58 11-72	0.853	0.395
Creatinine (mg/dL): Mean ±SD Range	0.89±0.15 0.60-1.30	0.91±0.17 0.70-1.60	0.895±0.16 0.60-1.60	0.861	0.391
Liver enzymes: Normal High	89 (89.0%) 11 (11.0%)	65 (92.9%) 5 (7.1%)	154(90.6%) 16 (9.4%)	0.719	0.397
Renal function tests: Normal High	100(100.0 %) 0(0.0%)	70 (100.0%) 0(0.0%)	170(100.0%) 0(0.0%)	- -	
CBC:					
Normal	76 (76.0%)	52 (74.3%)	128 (75.3%)		
Anemia	4 (4.0%)	5 (7.1%)	9 (5.3%)		
Anisocytosis	6 (6.0%)	6 (8.6%)	12 (7.1%)		
Leukocytosis	6 (6.0%)	6 (8.6%)	12 (7.1%)	14.53	0.560
Leukopenia	3 (3.0%)	1 (1.4%)	4 (2.4%)		
Lymphocytosis	8 (8.0%)	5 (7.1%)	13 (7.6%)		
Neutrophilia	3 (3.0%)	2 (2.9%)	5 (2.9%)		
Neutropenia	8 (8.0%)	(5.7%)	11 (6.5%)		

Table (4) showed that liver enzymes and renal function tests of the studied workers were higher among the exposed group compared to the control, but it didn't reach a statistical level of significance.

Regarding CBC neutropenia with relative lymphocytosis was the most frequent CBC findings among the exposed group (8%) of cases while leukocytosis and anisocytosis were the most frequent CBC finding among the control group (8.6 %). No statistical significant differences were found between the two studied groups regarding other CBC findings and renal functions.

Table (5): The percentages of fulfilled items of the Occupational Safety and Health (OSH) Inspection Checklist.

Main domains of OSH Inspection Checklist	Total No. of items in each domain	No. of fulfilled items in each domain	%
Physical hazards	13	5	38.5
Mechanical hazards	5	2	40.0
Chemical hazards	4	2	50.0
Storage and warehouses	6	3	50.0
Negative (indirect) risks#	5	1	20.0
Fire hazards	7	4	57
Electrical hazards	7	6	85.7
Emergency plans, disaster, and natural crises management	4	2	50.0
Occupational Safety and Health Management System	7	4	57.1
Training and awareness	3	1	33.3
Medical examinations	6	5	83.3
Personal protective equipment	4	2	50.0
Mean + SD of all items	53. 39% ± 16. 4		

#: Negative (indirect) risks: refers to the potential for adverse outcomes or unfavorable events that may occur within an organization, such as project delays, cost overruns, legal disputes, market downturns, or reputational damage.

Table (5) showed the score percent for each of the checklist items of safety measures. The Mean ± SD for all checklist items were 53.39% ± 16. 4. It was found that electrical safety measures were the most items to be covered followed by medical examinations, negative indirect risk item was the least one (20%).

According to environmental measurements records in 2022 in dyeing sectors and the Egyptian work law; noise level exceeded the permissible level at two measurements points in the dyeing unit. Light intensity was from 200-500 lux at five points according to the factory measurement records in 8 points in the dyeing unit. The measurements of heat and relative humidity in the unit were within the permissible levels according to the Egyptian law number 4 for year (2011). Measured levels of nitrogen dioxide (NO2), carbon monoxide (CO) and sulfur dioxide (So2) as gases emitted from chimneys, were within permissible limits (non tabulated results).

Discussion

Because of the diversity of substrates, methods, apparatus and components required, and finishing procedures performed, the textile dyeing business is one of the most valuable and technologically complicated sectors. Workers in the textile dyeing sector face several dangers and risks as a result of exposure to noise, chemicals such as dyes, solvents, optical brighteners, finishing agents, and a variety of natural and synthetic fiber dusts that can harm their health (Saini et al.,2017).

Regarding the distribution of type of exposure among the studied workers (Table 2), it was found that all workers in dyeing unit were exposed to liquid chemicals, vapors, gases and noise . More than half of them were exposed to dust, humidity, heat and light and only 23% of them were exposed to vibration.

The current results were supported by the study of Ibrahim et al., 2017, who conducted their research in the textile plant in Damietta City, Egypt, the research involved 108 employees and they detected that fewer than three-quarters of the studied group was exposed to physical hazards (in the form of heat, humidity), slightly more than two-thirds to chemical hazards, two-thirds to mechanical hazards, and more than half to psychological hazards. These findings might be due to the nature of textile dyeing industry where large number of chemicals are used such as caustic soda, hydrogen peroxide, formic acid, sodium nitrate, azo dyes, direct dyes, reactive dyes and mordents , lack of awareness of workers about the risks of their occupations, lack of sanitation in the workplace, lack of orientation around the universal precautions of the occupational health hazards in addition to lack of training program attendance.

This also were in agreement with studies done by Koka, and Srivastava,(2012) in their work on occupational health hazards of textile workers of Pali District ,India; Marmot, and Blatt, (2013) in Tanzania , who found that the workers were exposed to various types of occupational health hazards in their workplace such as physical, chemical, mechanical and psychological hazards.

Regarding nasal, eye and ear symptoms (Table 3), the most frequent nasal symptoms was runny nose and block nose among the studied group . These symptoms were improved during off work. The most frequent

eye symptoms were watery eye and itching among the studied group these symptoms were improved during off work. The most frequent auditory symptoms were difficult hearing and tinnitus but only difficult hearing which showed highly statistically significant differences.

The current results were supported by the study done by Biswas (2018) , as they reported several health problems resulting from exposure to chemical hazards, as skin diseases, respiratory ,nasal problems, headache ,auditory ,eye problems ,in addition musculoskeletal disorder .

Laboratory investigations of the studied group showed that liver enzymes and renal function tests were higher among the exposed group compared to the control, but it didn't reach a statistical level of significance (Table 4).This was in agreement to the study done by Mohammed et al., 2019 on 50 male workers of various ages who were subjected to textile dyeing at Borg Al-Arab City's textile factories and compared to 50 other male workers who served as a control group and were not exposed to textile dye. They detected that AST, ALT, total bilirubin, and alkaline phosphatase were significantly higher among their studied group compared to the control indicating acute hepatocellular injury as a result of necrosis induction. Elevated permeability of cell membranes to ALT and AST from the cytoplasm into the blood circulation, as well as enhanced lipid peroxidative damage on the hepatocytes caused by organic components (necrosis) and toxic metals as certain dyes contain heavy metal ions such as lead, mercury, chromium, cadmium, and arsenic (Timbrel et al., 2009).

Also, in the study done by El-Hadidy et al., 2022 on dyeing units of textile factories in Dakahlia, Egypt ; they detected that liver enzymes (AST and ALT) were significantly higher among textile dyes-exposed workers than those of the comparison group. Lastly, liver enzymes of workers in the dyeing unit with the poorest industrial hygiene score were significantly higher than those of workers in the other two units.

According to the Egyptian Inspection Checklist of the workplace that was conducted by the researcher, the present study reported defective safety measures regarding most of the safety items recorded in the Checklist

(Table 5).These results may be explained by a variety of issues, including an insufficiently committed management system, inadequate training for OSH committee members, a lack of worker awareness and training, and inadequate financial support.

These results were supported by a study done by El-Feky et al., 2021 Egypt, in textile factory located in Tanta City to evaluate workplace safety procedures and exposure to various hazards . They detect that, in terms of the majority of workplace safety standards, 37.5% and 50% of the departments under study provided a reasonable degree of protection; while only 12.5% of the buildings were sufficient regarding work place in general, evacuation routes, respiratory protection, environmental conditions, electrical safety, and health and safety training. This is due to the concept of occupational health and safety in developing countries which are restricted and limited resulting in increased incidence of occupational diseases (Ammayappan et al., 2016)

This is consistent with a research done in 2006 by Parimalam et al., which involved 216 workers in 18 garment manufacturing facilities in Madurai City, India. They noticed that the majority of the units were lacking in effective safety features including first aid kits, fire extinguishers, and alarms, which put the workers in grave danger in an emergency. Also, another study done by Ahsan et al .,2019 from Bangladesh; they found that, in a few facilities, workers were not given gloves or other protective gear .

As regard medical examinations; it was found that the primary medical examination was done for nearly all workers. Emergency medical services were available in the facility. There were semi-annual qualitative statistical records for work injuries, occupational diseases, ordinary, chronic diseases and serious accidents.

Two studies done by Akhter et al., 2010 from Bangladesh, and Joseph 2021 from India, revealed a different findings . Concerning health facilities Akhter et al., 2010 found that 43% of respondents were unaware of the medical facilities; only 44% were getting first aid treatment.In the research of Joseph 2021 it was found that five garment factory workers were not provided with access to treatment facilities. While first aid kits were available in every factory to handle minor injuries, there was no regular doctor present. There were

also no childcare facilities. There was just one item of clothing that strictly required mask and glove wear, but other companies did not supply masks for their employees.

About environmental measures (non tabulated) similar to the current study results ,Shaikh et al. 2018 indicated in their study that textile dyeing workers in Pakistan perceived noise as a "greater extent" hazard. Lack of efficient maintenance of machinery is one of the major reasons behind the noise pollution in most of the units. However, in contrast to the present study,Ahmad et al. (2020) study from Pakistan noted that temperature exceeded the permissible ranges set by Occupational Safety and Health Administration (OSHA) and heat stress was considered risky for textile dyeing workers while the relative humidity in textile dyeing halls remained at threshold of prescribed range by OSHA . In accordance with the current study, Shah et al. 2015 study from Pakistan showed high levels of NO_2 and particulate matter (PM) exceeded the limits while SO_2, NH_3,chlorine (Cl_2), and carbon monoxide (CO) were within limits.

Conclusion

Because of poor working conditions and a lack of knowledge, workers in textile dyeing industry are often exposed to different occupational health hazards at the work place, which lead to a negative impact on their health and cause problems with their hearing, eyesight, and respiratory systems.

Recommendations

1. The administrator should regularly check and document regulations concerning workplace safety.

2. All workers occupationally exposed should receive training programs on safe work practice with the hazards in factory and proper use of personal protective equipments.

3. Ensuring that chemicals are appropriately stored in a cool, dry, well ventilated and secured area and make certain that chemical containers are properly labeled indicating the hazards of the substance and what should be done in case of an emergency.

4. Periodic medical examination and a regular check-up of workers should be done every year for early detection of any changes.

5 .First-aid kits, facilities and emergency alarms should be available for any emergency.

6. All work areas should be adequately illuminated.

Conflict of Interest

None to be declared.

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