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ORIGINAL ARTICLE

Dermatological Morbidities and sharp injuries among Workers at Medical Waste Incinerators

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ABSTRACT

Background: Metal exposure during medical waste collection, handling, and burning poses a skin danger to individuals working in the waste incineration industry. Medical waste incineration ash contains about 30 distinct metals, the majority of which are toxic to humans. This study attempts for improving the health of workers at medical waste incinerators through identifying some occupational morbidities among workers at medical waste incinerators.

Methods: A comparative cross-sectional study was conducted at medical waste incinerators at Sharkia governorate. The target population composed of exposed group (n=56), including workers at medical waste incinerators who are involved in all steps of handling, management and processing of medical waste and non-exposed group (n=56), including administrative employees working at Faculty of Medicine, Zagazig University. Pre-constructed questionnaire was filled by all participants for their occupational history and dermatological presentations.

Results: A statistically significant increase in frequency of burn (OR=5.34), urticaria (OR=7), exposure to sharp injuries (OR=85), pruritis and fatigue among exposed compared to non-exposed group. Also, a statistically significant increase in dermatological morbidities were found among workers who had previous job & not wearing protective personal equipment (PPE) compared to workers without (p=0.01).

Conclusion: It can be concluded from the results of the study that incinerator workers at Sharkia governorate are at risk for dermatological disorders and sharp injuries who pose them to risk of Hepatitis B (HBV) and Hepatitis C (HCV) infection.

Keywords: Dermatological, Sharp Injury, Medical waste, Incinerators

INTRODUCTION

Used needles and syringes, tissue and organs, medications, blood, synthetic materials, synthetic compounds, medical equipment, radioactive materials, surgical masks, and diagnostic tests are all components of medical waste (MW). Additionally, it can be thought of as a subset of the total waste produced by healthcare institutions. An estimated 15% of the total MW is considered hazardous MW, with this percentage

potentially rising to 35% based on waste type, while the rest is considered nonhazardous. [1].

Metal exposure during toxic waste collection, handling, and burning poses a skin danger to individuals working in the waste incineration industry. Approximately 30% of the entire burden of occupational disease is believed to be attributable to occupational dermatitis, making it one of the most common work-related issues [2]. Contact dermatitis can be either allergic or irritating, with the latter being the more prevalent of the two. Irritative and allergic dermatitis can manifest in a worker at the same time, in separate parts of the body, or even at the same time and place [3]. Medical waste incineration ash contains about 30 distinct metals, the most of which are toxic to humans. These include mercury, arsenic, cadmium, chromium, and lead. Metals like mercury, which can irritate the skin and organic mercury compounds, which can be lethal when they come into touch with the skin, are among the many that can build up over time and expose workers to metals like these [4].

Workers at waste disposal sites face the risk of inhalation and skin contact exposure due to the discharge of ammonia. When energy is produced, contaminants including nitrous oxide, nitric oxide, and nitrogen dioxide can be discharged into the air. These gases are extremely damaging to the skin. Severe surface burns and eye damage can be caused by sulfur dioxide, which is generated during garbage incineration procedures. On top of that, waste incineration workers run the risk of skin contact exposure to some volatile organic chemicals. Benzene and toluene are only two examples of the many volatile chemical compounds that are known to cause skin cancer [5]. Famous pollutants such as polychlorinated dibenzofurans (furans) and polychlorinated dibenzo-p-dioxins (dioxins) are created during garbage incineration at temperatures below 800 °C or due to incomplete combustion. These substances cause allergic dermatitis, chloracne, and other skin conditions [6].

Workers in the field of incineration who are in direct contact with medical waste from the collection, transportation, treatment and disposal are more susceptible to infectious injuries resulting from medical waste. They are more vulnerable to cases of pricking, scratching and cutting the skin with needles, scalpels and sharp materials contaminated with patient fluids [7].

Sharp injuries due to infectious waste may be associated with diseases like viral hepatitis and other life-threatening viral infections as well as pyogenic and enteric infections [7]. A person's risk of contracting HBV, HCV, and human immunodeficiency virus (HIV), respectively, is 30%, 1.8%, and 0.3% after experiencing a single needle stick injury from a needle used on an infected patient [8].

Additional risks can be encountered when scavenging at landfills or when manually sorting hazardous waste from hospitals and other healthcare institutions. Many parts of the world, particularly those with low or medium income levels, engage in these behaviors. Personnel involved in the handling of medical waste face the constant danger of needle sticks and exposure to harmful substances throughout the whole waste management process, from collection to treatment to disposal [9].

When healthcare waste handlers hoist plastic bags containing needles without covers, they primarily injure their hands. It has been demonstrated that improper management of hospital waste can cause harm to the environment. Everyone in the neighborhood, not just the medical staff, is in danger because of it [10]. So, this study aimed at improving the health of workers at medical waste incinerators through identifying some occupational morbidities among workers at medical waste incinerators, finding association between these morbidities and demographic characters and occupational history of workers at medical waste incinerators, and assessing the safety and health measures used for prevention of these occupational morbidities among workers at medical waste incinerators.

METHODS

A comparative cross-sectional study was conducted at medical waste incinerators at Sharkia governorate. The target population composed of exposed group (n=56); workers at medical waste incinerators who are involved in all steps of handling, management and processing of medical waste and non-exposed group (n=56); administrative employees working at Faculty of Medicine, Zagazig university.

The sample size was calculated using G power 3.1.9.7 according to the following expected moderate effect size between exposed and non-exposed group in frequency of dermatological symptoms (d=0.5), CI 95%, power 80% and allocation proportion 1:1 the sample size was calculated to be 112, 56 in each group. All workers at medical waste incinerators working for at least 1 year were included as exposed group and all employees who agreed to participate in the study & not exposed to incinerators` emissions were included as non exposed group in the study. While incinerator workers with past history of having dermatological problems before joining the current job were excluded. All participants were asked to participate in the current study after obtaining their verbal informed consent. This study was approved by Zagazig University Institutional Review Board (IRB) (ZU-IRB # 10530/12/3/2023). The research was conducted under the World Medical Association's Code of Ethics (Helsinki Declaration) for human research.

Tools of data collection:

A) Pre-constructed questionnaire sheet: all subjects were interviewed personally and asked about:

1. Socio-demographic data as age, sex, residence, level of education, marital status, and smoking habits. According to smoking habits, subjects were categorized as: current smokers & non-smokers.

2. Occupational history: Job title, duration of employment in current occupation, number of working hours /days, previous occupation and its duration, second job in addition to current job, occupational safety and health measures used to prevent occupational diseases, using personal protective equipment, history of HCV and HBV among workers and history of pre-employment and periodic medical examination.

3.Present history and local examination: Dermatological health problems as (burn, skin rash, chloracne, others) Sharps and needle stick injury.

Statistical Analysis:

All statistical analysis was conducted using SPSS version 27.0, which was used to digitize the data. The relative frequencies (%) and absolute numbers (#) were used to represent categorical qualitative variables, while the mean ± SD or median and range were used to represent continuous quantitative variables. We estimated the risk using the odds ratio (OR) and compared the categorical data using the chi-square test. In order to determine if the data was normally distributed, we utilized the Kolmogorov-Smirnov test. Then, we used the independent sample t-test and the Mann Whitney test to see if the quantitative data was statistically significant. A p-value of more than 0.05 was deemed statistically insignificant (NS) when determining statistical significance. The results were deemed significant (*) when the p-value was less than or equal to 0.05, and highly significant (**) when the p-value was less than 0.001.

RESULTS

As regards sociodemographic characteristics, the age of the exposed group ranged from 18 to 57 years with a mean 41.68 years while in the non-exposed group it ranged from 30 to 60 years with a mean of ٤٣.٩ years. There were no statistically significant differences between the two groups in age, residence, education level, marital status and smoking (Table 1).

Regarding occupational history Table (2), years of work experience ranged from 1 to 12 with a mean of 4.89, while number of working hours/days ranged from 7 to 16 with a mean of 10.46 hours. Most of the workers had a previous job (76.8%) while none of them had additional jobs. All the workers had rest time during work and 96.4% of them reported presence of rest places. Half of the workers reported the presence of pre-employment medical examination while only 23.3 % of them reported the presence of periodic medical examination. About 60.7% received health education about hazards of their jobs. PPE was used by 82.1% of workers (12.5% using facial mask and 69.5% using respirator) while 17.9% didn't use PPE (17.9%) all of them who didn't use reported that they were not available. About two thirds of the workers received hepatitis B vaccine.

As regards frequency distribution of dermatological symptoms among studied groups (Figure (1), there was a statistically significant increase in the frequency of burns (OR=5.34, CI: 1.43-19.96) and urticaria (OR=7, CI: 1.06-25.13) among exposed compared to non-exposed group.

As regards frequency distribution of sharp injuries and frequency of hepatic symptoms among the

studied groups (Figure (2), there was a statistically significant increase in the frequency of exposure to sharp injuries (OR=85, CI: 24.37-296.4) as well as pruritus and fatigue among the exposed compared to the non-exposed group.

Relationship between demographic data, history and dermatological morbidities among the exposed group, Table (3) showed that there was a statistically significant increase in dermatological morbidities among workers who had a positive family (p=0.02) and a pulmonology history (p=0.001).

Relation between occupational history and dermatological morbidities among the exposed group (Table (4) showed that there was a statistically significant increase in dermatological morbidities among workers who had previous job experience (p<0.001) and not wearing PPE (p=0.01).

After logistic regression analysis it was concluded that workers with +ve pomological history, +ve family history and not wearing PPE at increased risk of dermatological morbidities (OR=3.19, 2.28 & 4.92) respectively.

Table (1): Sociodemographic characteristics of the studied groups:

Sociodemographic characteristics		**Exposed (n = 56)**		**Non exposed (n = 56)**		**Test of significance**	**P**
Age (years)	Mean ±SD	41.68± 9.56		43.95 ± 8.41		1.33	0.19
	Range	18-54		30-60			
Variable		**N**	**%**	**N**	**%**	χ^2	**p**
Residency:	Urban	17	30.4	22	39.3	0.98	0.32
	Rural	39	69.6	34	60.7		
Marital status:	Married	54	96.4	51	91.1	1.37	0.24
	Un married	2	3.6	5	8.9		
Education level:	Illiterate & Read write	21	37.5	10	17.9		
	Middle education	8	14.3	10	17.9	6.05	0.11
	Secondary	25	44.6	31	55.4		
	University	2	3.6	5	13.9		
Smoking status:	Non smoker	9	16.1	14	25		
	Smoker	45	80.4	37	66.1	3.14	0.21
	Ex smoker	2	3.6	5	8.9		
Shisha:	No	47	83.9	52	92.8	2.18	0.14
	Yes	9	16.1	4	7.2		

SD: Standard deviation t:Independent t test χ^2: Chi square test NS: Non significant (P>0.05)

Table (2): Occupational History of the exposed group:

Occupational History		**Exposed (MW incinerator workers) (56)**	
Years of experience:	Mean ±SD Median (Range)	**4.89±2.52** **5 (1-12)**	
Number of working hours/ day:	Mean ±SD Median (Range)	**10.64±3.10** **12 (7-16)**	
Variable		**N**	**%**
Previous job history:	Yes No	43 13	76.8 23.3
Having rest during work:	Yes	56	100
Available rest places:	Yes No	54 2	96.4 3.6
Local exhaust ventilation:	Yes No	51 5	91.1 8.9
Pre employment medical examination:	Yes No	28 28	50 50
Periodic medical examination:	Yes No	13 43	23.2 76.8
Health education about hazards of job:	Yes No	34 22	60.7 39.3
PPE:	Yes No	46 10	82.1 17.9
Type of PPE:	Mask Respirator Gloves Protective shoes	39 7 0 0	**69.5** **12.5** **0** **0**
Cause of not wearing PPE:	No (Unavailable)	10	17.8
Received Hepatitis B vaccine:	Yes No	37 19	66.1 33.9
Presence of environmental assessment in workplace :	Yes No	2 54	3.6 96.4

PPE: Personal Protective Equipment

Table: (3): Relation between Sociodemographic characteristics and dermatological morbidities among the exposed group:

Variable		**Dermatological morbidities (n = 20)**		**No dermatological morbidities (n = 36)**		**t**	**P**
Age (years)	Mean ±SD	40.35±12.91		42.42±7.19		0.77	0.44 N.S
Variable		**N**	**%**	**N**	**%**	χ^2	**p**
Residency:	Urban Rural	3 17	17.6 43.6	14 22	82.4 56.4	3.47	0.06
Marital status:	Married Un married	18 2	33.3 100	36 0	66.7 0	Fisher	**0.12** **NS**

Variable		ermatological morbidities (n = 20)		No dermatological morbidities (n = 36)		t	P
Education level:	Illiterate & Read write Middle education Secondary University	7 5 8 0	33.3 62.5 32 0	14 3 17 2	66.7 37.5 68 100	3.81	0.28
Smoking:	Non smoker Smoker Ex smoker	7 13 0	77.8 28.9 0	2 32 2	22.2 71.1 100	3.96	0.11
Shisha:	Yes No	2 18	38.3 22.2	7 29	77.8 61.7	0.85	0.36
Comorbidity:	Yes No	5 15	38.5 34.9	8 28	61.5 65.1	0.06	0.81
Pulmonology history:	Yes No	12 8	66.7 21.1	6 30	33.3 78.9	**11.07**	**0.001***
Family history:	Yes No	3 17	100 32.1	0 36	0 67.9	**5.71**	**0.02***

PPE: Personal Protective Equipment
SD: Standard deviation t:Independent t test χ^2: Chi square test
NS: Non significant (P>0.05) *:Significant (P<0.05) **: Highly significant (P<0.001)

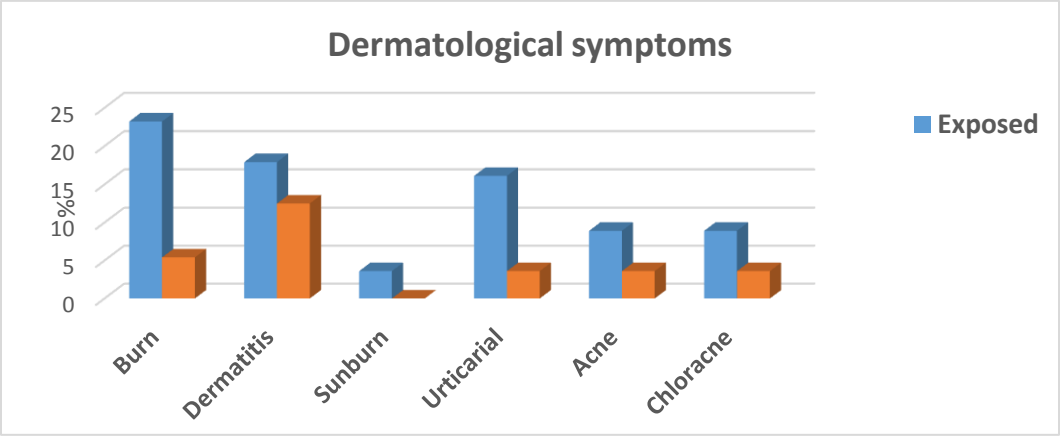
Table (4): Relation between Occupational History and dermatological morbidities among the exposed group:

Variable		dermatological morbidities (n=20)		No dermatological morbidities (n=36)		MW	P
Years of experience:	Median (Range)	5 (2-7)		5 (1-12)		0.71	0.48 NS
Number of working hours/day:	Median (Range)	10 (7-16)		12 (7-16)		1.55	0.18
Variable		**N**	%	**N**	%	χ^2	**P**
Job categories:	Collection of waste Burning of waste Disposal of waste	2 9 9	20 31 52.9	8 20 8	80 69 47.1	3.55	0.17
Previous job:	Yes No	11 9	84.6 20.9	2 34	15.4 79.1	**17.63**	**<0.001 ** **
Local exhaust ventilation:	Yes No	17 3	33.3 60	34 2	66.7 40	1.41	0.24
Pre employment medical examination:	Yes No	8 12	42.9 28.6	20 16	71.4 57.1	1.24	0.27
Periodic medical examination:	Yes No	6 14	46.2 32.6	7 29	53.8 67.4	0.80	0.37
Health education about hazards of job:	Yes No	13 7	38.2 31.8	21 15	61.8 68.2	0.24	0.63
PPE:	Yes No	13 7	28.3 70	33 3	70 30	**6.23**	**0.01***
Hepatitis B vaccine:	Yes No	10 10	27 52.6	27 9	73 47.4	3.59	0.06
Presence of environmental assessment at work place:	Yes No	0 20	0 37	2 34	100 63	1.15	0.28

PPE: Personal Protective Equipment
Sd: Standard deviation MW: Mann Whitney test χ^2: Chi square test
NS: Non significant (P>0.05) *:Significant (P<0.05) **: Highly significant (P<0.001)

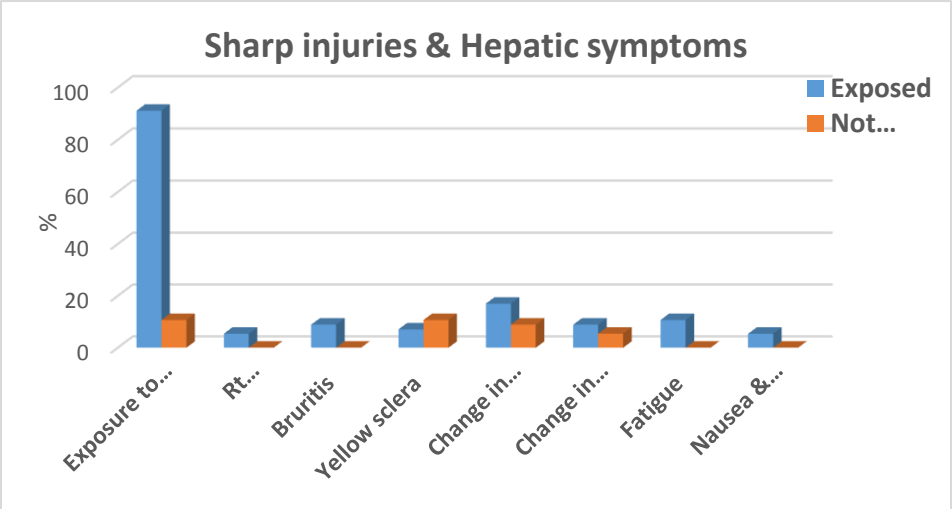
Table (5): Logistic regression analysis for significant predictors of dermatological morbidities among the exposed group:

Independent factors	B	S.E	Wald	O.R (95%C.I)	P
Pulmonology history:	0.84	0.36	3.30	3.19(1.13-8.98)	**0.02***
Family history	1.24	0.58	4.62	2.28 (1.01-5.12)	**0.04***
Previous job	0.71	0.36	2.7	2.03 (0.90-4.19)	**0.07 NS**
PPE	**1.93**	**0.82**	**5.54**	**4.92 (1.38-34.63)**	**0.01***



Frequency of burns (OR=5.34, CI: 1.43-19.96) and urticaria (OR=7, CI: 1.06-25.13) among exposed compared to non-exposed group.

Figure (1): Frequency distribution of dermatological symptoms among the studied groups.



Frequency of exposure to sharp injuries (OR=85, CI: 24.37-296.4) as well as pruritus and fatigue among the exposed compared to the non-exposed group.

Figure (2): Frequency distribution of sharp injuries and hepatic symptoms among the studied groups.

DISCUSSION

Large populations and employees could be exposed to harmful compounds generated during the mass burn incineration of healthcare waste, which is a major cause for concern for undesirable health impacts [11]. This study was conducted at medical waste incinerators at Sharkia governorate. It was conducted on 56 exposed waste incinerator workers (exposed group) and 56 administrative employees (non-exposed group), all of them were males, this could be attributable to the physical nature of the work in incinerators in which females in Egypt are not involved in this type of work [12] .That was consistent with Martine et al.where the workers were all males. In contrast, Chrysovalantis et al. [13] reported in their study in Greece that both sexes were involved (males:46 and females:4).

Regarding dermatological symptoms, there was a statistically significant difference among both groups as 23.2%, 0% of exposed workers compared to 5.4%, 3.6% of controls had burn and urticaria respectively together with statistically significant increase in the frequency of burn (OR=5.34, CI: 1.43-19.96) and urticaria among exposed compared to non-exposed group **(figure(1)**. Similarly, **(Hours et al., 2003)** [14] reported elevated ORs for skin symptoms among "maintenance and effluent" workers (OR =4.85; 2.04–11.51) and furnace group (OR =5.03; 2.00–12.67) which were more often observed than non-exposed group.

Regarding frequency distribution of sharp injuries and hepatic symptoms among studied groups, there was statistically significant difference among both groups in exposure to sharp injury as 91.1% of exposed waste incinerator workers previously exposed to sharp injuries compared to 10.7% among their controls.

In the current study, only 8.9% of exposed waste incinerator workers in this study had pruritus compared to 0% among their controls with high statistically significant difference (p=0.02). That was in agreement with Hours et al. [14] who found that incinerator workers group had systematically more complaints of cutaneous or mucous irritation symptoms.

Conclusion

It can be concluded from the results of the study that incinerator workers at Sharkia governorate are at risk for dermatological disorders and sharp injuries who pose them to risk of HBV and HCV infection.

Recommendations

Based on the findings of the current research study, the following recommendations are suggested:

For ministry of health and director of incinerator: Pre-placement medical examinations and training for the newly hired workers should be carried out by the occupational health and safety teams in incinerator. Essential PPE for waste handlers and incinerator operators: Face mask to protect eyes and mouth, heavy duty gloves to protect hands, aprons to prevent damage to clothing and heavy duty boots to protect feet. HBV vaccinations to all workers.

For incinerator workers: There is an urgent need for collaboration with incinerator managers in identifying risk factors of chemical and biological hazards in the workplace and developing a workplace prevention policy. Regularly inspect the incinerator system for any signs of damage, corrosion, or blockages. Clean the incinerator chamber, flue gas path, and air pollution control devices to remove ash, soot, and other residues.

Higher education levels are required for incinerator workers to be capable of gaining better knowledge, follow rules, proper use of PPE and be ready for any challenges in the future. It is recommended to change incinerator workers' culture and attitudes towards reporting needle stick injuries and using PPE through attending health education and training programs.

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