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Evaluation of Some Pulmonary Functions among Morticians in Teaching and General Hospitals Exposed to Formaldehyde in Benin City, Nigeria

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ABSTRACT: Formaldehyde is the key chemical substance used by morticians to prevent known post-mortem changes. Hence, the objective of this paper is to evaluate some pulmonary functions among morticians in Teaching and General Hospitals exposed to formaldehyde in Benin City, Nigeria using appropriate standard methods. Results revealed significant increase in respiratory rate and significant decrease in forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), $_{FEV1}$/FVC ratio, peak expiratory flow rate (PEFR), and forced expiratory flow between 25 and 75 percent (FEF_{2575}) among morticians of the Teaching hospital and General hospital when compared to the control while those of the General hospital morticians were found to be lower than those of the Teaching hospital morticians. It was therefore concluded that exposure to formaldehyde has deleterious effects on the respiratory health of morticians especially those in the General hospital hence, there is an urgent need to seek ways of reducing formaldehyde air levels in our mortuaries especially the General hospital mortuary in order to protect the respiratory health of the morticians.

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Formaldehyde is a known volatile organic compound that is used as a chemical fixative to prevent tissues from undergoing post-mortem changes (Farooqui, 1983). At death cells and tissues usually undergo post-mortem changes, however, these changes can be prevented through the use of different chemical fixatives which can help to preserve the tissues and retain their form they held while the individual was still alive (Farooqui, 1983). The property of formaldehyde in delaying the decomposition of cadavers makes it useful for embalming of bodies in the mortuaries as well as for the purpose of study during anatomy dissections in medical schools. Morticians who work in the mortuaries utilized formaldehyde continuously for the preservation of dead bodies thereby making them prone to high exposure to formaldehyde fumes owing to their occupation. The hazards of formaldehyde on the respiratory health has been reported by several authors (Pourmahabadian *et al.*, 2006; Wei *et al.*, 2007; Mathur and Rastogi, 2007; Patil *et al.*, 2012; Shrivastava and Saxena, 2013; Neginhal *et al*., 2013; Ebojele and Iyawe, 2022a; Ebojele and Iyawe, 2023) and also several organizations have established standards which defined the limit to which an individual can be exposed to formaldehyde in order to protect occupationally exposed individuals from any possible harmful health effect of formaldehyde which could be acute or chronic. Occupational Safety and Health Administration (USA-OSHA) suggested a Time Weighted Average Concentration of 0.75ppm and Short Term Exposure Limit of 2ppm as legal standards (OSHA, 1994), while the American Conference of Governmental Industrial Hygienist (USA-ACGIH) suggested a ceiling limit of 0.3ppm as recommended standard (ACGIH, 2002). The National

Institute for Occupational Safety and Health (USA-NIOSH) suggested a ceiling limit of 0.1ppm and Time Weighted Average Concentration of 0.016ppm as recommended standard (NIOSH, 1986), while the Japan Society for Occupational Health suggested a ceiling limit of 0.5ppm (JSOH, 2003). Also in Japan, the Ministry of Health, Labour and Welfare set limit values for environmental exposure to formaldehyde at 0.08ppm as an average for general workplaces and 0.25ppm for specific workplaces like formaldehyde factories and gross anatomy laboratories (Naya and Nakanishi, 2005).

In a previous study, the present authors investigated the atmospheric levels of formaldehyde in some selected hospital mortuaries in Benin City, Nigeria which included a Teaching Hospital, General Hospital, and a busy Private Hospital mortuary (Ebojele and Iyawe, 2022b) where it was observed that the atmospheric level of formaldehyde in the Teaching hospital mortuary was significantly lower compared to the General hospital and Private hospital mortuaries. Hence, the objective of this paper is to evaluate some pulmonary functions among morticians in Teaching and General hospitals exposed to formaldehyde in Benin City, Nigeria.

MATERIALS AND METHODS

Study Stations: Morticians exposed to formaldehyde in the Teaching hospital and General hospital in Benin City, Nigeria were recruited for this study. Subjects were apparently healthy, non-smokers, had no history of cardiopulmonary disease, and had not undergone any recent abdominal or chest surgery.

Informed consent was obtained from the subjects who participated in the study while ethical approval was obtained from the College Research Ethics Committee, University of Benin as well as from the Edo State Hospital Management Board before commencement of the work. Subjects were divided into three groups A, B, and C with ten subjects in each group. Group A served as control (non-morticians) while groups B and C served as the test groups respectively. Group B consisted of morticians working in the Teaching hospital while group C consisted of morticians working in the General hospital.

Evaluation of Pulmonary Functions: Their anthropometric parameters were measured as well as some indices of pulmonary function which included respiratory rate, FVC, FEV_1, FEV_1/FVC, PEFR, and FEF_{2575}. The respiratory rate was counted for one minute in all the subjects by simple observation of the chest movement during respiration while FVC, FEV_1, FEV_1/FVC, PEFR, and FEF_{2575} were obtained with the aid of a digital spirometer. Test results were given as measured values in litres. The tests were carried out after a detailed explanation of the procedure to the subjects. Each subject was instructed on the need to put in maximum effort at blowing into the instrument. Each subject was asked to adopt a sitting position and thereafter place the mouth piece of the spirometer tightly around the mouth to prevent leakage of air. The subject was then asked to inspire maximally and then exhale forcefully through the mouth into the spirometer. Three trials were done for each subject and the best of the three readings was selected. This is as described by the American Thoracic Society in 1995.

Statistical Analysis: Data obtained were analysed using Graph pad prism version 8.0.1. Results were presented as Mean ± SEM. Analysis of Variance was used to compare the means of test and control values while post hoc test was done using Tukey's multiple comparisons test and a p-value of less than 0.05 was considered as statistically significant.

RESULTS AND DISCUSSION

Results revealed a significant increase in respiratory rate among Teaching hospital morticians and General hospital morticians when compared to the control and that of the General hospital morticians was seen to be higher than that of the Teaching hospital morticians (figure I). FVC, FEV_1, PEFR and FEF_{2575} were significantly reduced in both Teaching hospital morticians and General hospital morticians when compared to the control and those of the General hospital morticians were seen to be lower than those of the Teaching hospital morticians (figures 2, 3, 4 and).

Table 1. Anthropometric parameters of morticians exposed to formaldehyde in the Teaching hospital and General hospital

Parameters	Group A n=10	Group B n=10	Group C n=10	P-value
Age (yrs)	46.30±1.04	46.00±1.53	47.80±1.77	0.6576
Weight (kg)	78.10±2.04	76.10±4.55	78.20±4.28	0.9074
Height (m)	1.67±0.03	1.68±0.02	1.68±0.02	0.9262
Chest Circumference (cm)	99.50±2.67	97.80±2.53	98.20±3.69	0.9167
BMI (kg/m^2)	26.91±1.18	25.51±1.34	26.34±1.46	0.7580
BSA (m^2)	1.91±0.03	1.88±0.05	1.89±0.05	0.9422

BMI – Body Mass Index; BSA – Body Surface Area

In a previous study by current authors (Ebojele and Iyawe, 2022b) the atmospheric levels of formaldehyde was measured across some selected hospital mortuaries in Benin City and it was reported that the atmospheric level of formaldehyde in the General hospital (4.60ppm) was significantly higher than that of the Teaching hospital (1.13ppm). This was attributed to the fact that the Teaching hospital mortuary was well ventilated and it had air extractors that were functional whereas in the General hospital mortuary the ventilation was poor and they had no air extractors.

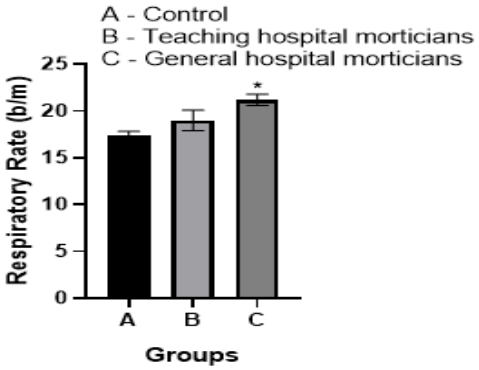

Fig. 1: Mean respiratory rate (b/m) of morticians exposed to formaldehyde in the Teaching Hospital and General Hospital
Significant values are mean ± SEM compared to control (* = p < 0.05, n = 10)

From the differences in the design and functionality of these mortuaries it was speculated that the health of the morticians in the General hospital mortuary may be more at risk owing to poor working environment. This speculation led to this present study where some indices of pulmonary function were measured among morticians in the Teaching hospital and General hospital.

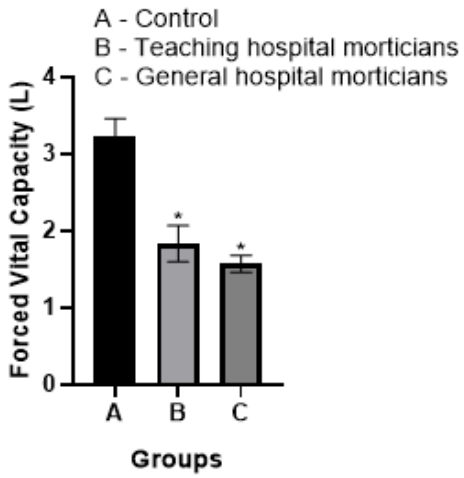

Fig. 2: Mean forced vital capacity (L) of morticians exposed to formaldehyde in the Teaching Hospital and General Hospital
Significant values are mean ± SEM compared to control (* = p < 0.05, n = 10)

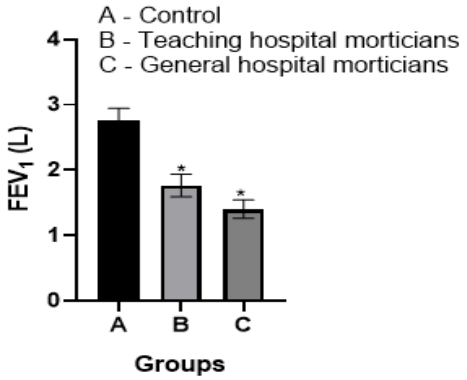

Fig. 3: Mean forced expiratory volume in one second (L) of morticians exposed to formaldehyde in the Teaching Hospital and General Hospital
Significant values are mean ± SEM compared to control (* = p < 0.05, n = 10)

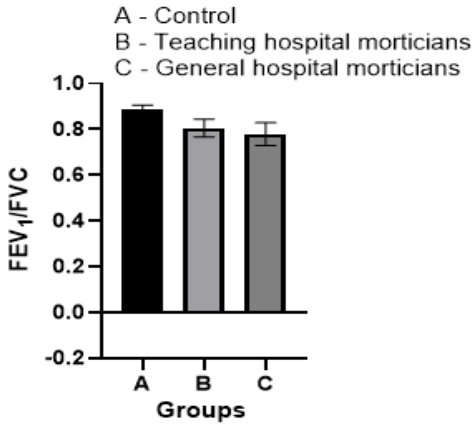

Fig. 4: Mean (FEV_1), $_{FEV1}$/FVC ratio of morticians exposed to formaldehyde in the Teaching Hospital and General Hospital
Significant values are mean ± SEM compared to control (* = p < 0.05, n = 10)

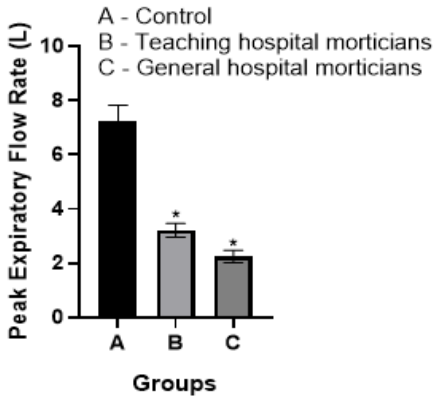

Fig. 4: Mean peak expiratory flow rate (L) of morticians exposed to formaldehyde in the Teaching Hospital and General Hospital
Significant values are mean ± SEM compared to control (* = p < 0.05, n = 10)

The result of this present study revealed a significant increase in respiratory rate and a significant decrease in FVC, FEV_1, PEFR and FEF_{2575} (figures 1-5) of both

Teaching hospital morticians and General hospital morticians when compared to the control and those of the General hospital morticians were found to be lower than those of the Teaching hospital morticians.

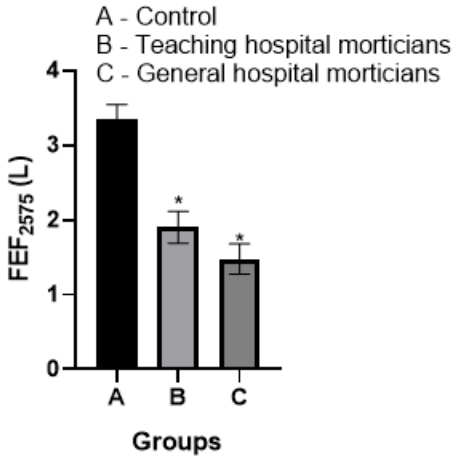

Fig. 4: Mean forced expiratory flow rate between 25 and 3 percent (L) of morticians exposed to formaldehyde in the Teaching Hospital and General Hospital
Significant values are mean ± SEM compared to control (* = $p < 0.05$, n = 10)

These findings actually suggest that the respiratory health of the General hospital morticians that were studied is more at risk than those of the Teaching hospital morticians. The exposure level to formaldehyde in the Teaching hospital mortuary although lower than the General hospital mortuary is still above the recommended standard prescribed by some international organizations that were mentioned earlier. High level of exposure to formaldehyde above the recommended limit is not perculiar to this study alone as some other studies carried out in places where formaldehyde is utilized have equally reported high levels of formaldehyde that were above the recommended ceiling limits(Akbar-Khanzadah *et al.*, 1994; Tanaka *et al.*, 2003; Ohmichi *et al.*, 2006; Hafiz, 2011). Alot need to be done in the General hospital mortuary to bring the atmospheric level of formaldehyde to the desired level and also improve on the working environment while the morticians on their own part should adopt measures to reduce their personal exposure by wearing personal protective equipment like plastic gown, facemasks and face shields. They can also reduce the number of hours they spend in the mortuary.

*Conclusion***:** From the findings of this study we therefore conclude that measure should be taken to improve on the working environment of morticians especially those in the General hospital in order to protect their respiratory health.

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