International Journal of Research in Medical Sciences
Okafor IM et al. Int J Res Med Sci. 2022 Apr;10(4): 813-818
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012
DOI: https://dx.doi.org/10.18203/2320-6012.ijrms20220970

Original Research Article

Platelet count and platelets indices of mortuary workers exposed to formaldehyde: a study in Calabar, Nigeria

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Received: 31 December 2021
Revised: 02 February 2022
Accepted: 02 March 2022

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ABSTRACT

Background: Embalming chemicals such as formaldehyde has been shown to be toxic to human system. It's carcinogenicity effect and ability to cause adverse health conditions has been reported. Formalin is the aqueous solution of formaldehyde and it is converted to $H_2C(OH)_2$ when dissolved in water. This study was done to provide information on the effect of formaldehyde on the platelet count and platelet indices of mortuary workers.
Methods: Total of 64 subjects were recruited for the study based on convenience sampling method in Calabar, Cross River State. The test group comprised of 32 mortuary workers with age ranging from 18-60 years from University of Calabar Teaching Hospital, General Hospital, Navy Hospital, Anatomy Department-University of Calabar and Infectious Disease Hospital, all in Calabar Meteropolis and 32 non-mortuary workers of the same age bracket from Calabar municipality served as control. Sample collection was by venipuncture and method of analysis was by the use of automated haematology analyzer.
Results: This study shows that mean platelet volume (MPV) and platelet distribution width were significantly increased $p<0.01$) in mortuary workers. The platelet count of mortuary workers were also significantly decreased ($p=0.918$) when compared to non-mortuary workers. Three out of thirty two mortuary workers had giant forms of platelet. The result also shows that long term exposure to formaldehyde can cause a reduction in the platelet count and platelet indices of mortuary workers.
Conclusions: This study has shown that exposure to formaldehyde has a negative alteration on the platelet count and platelet indices of mortuary workers.

Keywords: Platelets, Platelet indices, Mortuary workers, Formaldehyde

INTRODUCTION

Dead bodies are preserved through the use of chemical compounds that delays putrefaction and this process is known as embalmment.[1] These embalming chemicals which are employed in modern embalming procedures to delay decomposition of dead bodies and maintain a natural appearance for viewing comprise of a varieties of preservatives, sanitizers and disinfecting agents/additives.[2] Disinfection, preservation and restoration of the body are the main three goals of modern embalming technique.

A mixture of methanol, ethanol, formaldehyde, phenol and other solutions forms the basic components of modern day's embalming fluid. The embalming fluid

contains about 9-56% formaldehyde and it preserves/fixes tissues or cells by covalently binding a primary amine group in a protein molecule with nearby nitrogen or deoxyribonucleic acid (DNA) through the methyl linkage called the Schiff base.[3,4] The concern for exposure is mostly observed in embalming chemicals that contain formaldehyde and phenol. Formaldehyde is easily absorbed through the respiratory and gastrointestinal routes but not significantly through the skin while phenol is readily absorbed through the dermal route. However, both are irritant chemicals with possible genotoxic, carcinogenic and hemotoxic properties.[1] Occupational hazards that involves long term exposure to high level of formaldehyde has been reported to cause pain and irritation especially irritation of upper and lower air, that of the eyes, cough, soreness of the body, chest/abdominal pain, degenerative diseases and appetite loss.[5,6] Long term formaldehyde exposure in occupational settings has also been implicated in serious and chronic health conditions like chronic pharyngitis, loss of olfactory functioning , inflammatory and hyperplastic changes of the nasal mucosa, chronic rhinitis, pharyngeal congestion, lacrimation and cornea disorder.[7,8] Previous studies have revealed that exposure to formaldehyde resulted in a decrease in blood cell of the three cell lines.[6] Huang and his colleagues reported that a previously apparently healthy woman had decreased level of platelet counts and platelet indices after living in a newly remodeled apartment for three months. It was observed that the level of formaldehyde in the apartment was about four times higher than the National standard set for indoor environment in China (0.08 ppm).[7] Contrary to this finding, another study reported no significant differences in platelet count and platelet indices in potential exposed groups such as wood workers.[8] Mortuary is a high risk working environment as workers are exposed to hazards such as haemotoxicity, genotoxicity and carcinogens amongst others, which had the potential to affect their blood cells especially platelets hence the need for this study. Therefore, this study seeked to provide information on the effect of formaldehyde on the platelet count and platelet indices of mortuary workers working in selected mortuaries in Calabar, Cross River state.

METHODS

Study area

This research was conducted in mortuaries in Calabar Metropolis. Calabar is the capital of Cross River State. The mortuaries visited consist of well-structured buildings with enough windows for adequate ventilation but the windows were closed most of the times reducing the ventilation.

Study design

A case-control study design was employed in this study and a total of 64 subjects were recruited for the study based on convenience sampling method in Calabar, Cross River state. The test group comprised of 32 mortuary workers with age ranging from 18-60 years from three different mortuaries within Calabar Cross River state Nigeria. Thirty-two non-mortuary workers of the same age bracket from Calabar municipality served as control. The subjects were grouped based on duration of work/exposure to the embalming chemical formaldehyde.

Sample collection and processing

Two millilitres (2 ml) of blood was collected from each subject aseptically from the median cubital vein by a standard venipuncture technique. A sterile dry 5 ml syringe was attached to the needle, the subject made a tight fist to make the vein prominent, using the index finger, a suitable vein was felt and located, the chosen puncture site was cleaned with methylated spirit and allowed to dry, a soft tubing tourniquet was applied to the upper arm and care was taken that the tourniquet was not too tight. With the thumb of the left hand holding the skin below the puncture site, the venipuncture was made with the bevel of the needle directed upwards in the line of the vein. The plunges of the syringe were steadily withdrawn at the speed with which it took the vein to fill. Two milliliters (2 ml) of blood was collected, the tourniquet was released and the subject was instructed to open her fist. The needle was removed and the punctured site was immediately pressed with a dry cotton wool. The tourniquet was completely removed. The needle was removed from the syringe and the blood carefully dispensed into ethylenediamine tetra acetic acid (EDTA) anticoagulated bottle, the blood was mixed immediately and sample container labeled accordingly. Samples collected were carefully placed in the rack and stored inside a cooler with icepack placed in-between the icepack and the rack containing the blood sample to avoid lyses. The samples were taken to the laboratory and analysed within six hours of collection.

Samples were analyzed using automated hematology analyzer (Abacus-580). The anticoagulated sample was mixed properly by gentle inversion and 100 micro/ml was sucked into the machine through a probe. The blood was diluted and the various cell types were counted. The result was displayed on the computerized screen in standard units.

Ethical consideration

This study was conducted in accordance with declaration of Helsinki.

Statistical analysis

Data generated was presented as mean±standard deviation using tables. Student's t test and one way ANOVA were used to test the hypothesis. An error probability <0.05 was considered significant.

RESULTS

Table 1 shows that MPV and platelet distribution width were significantly increased (p<0.01) in mortuary workers when compared to non-mortuary workers. The table also shows that the platelet count of mortuary workers was also decreased when compared to non-mortuary workers. Table 2 shows the mean platelet count, plateletcrit (PCT), MPV and platelet distribution width (PDWC) of mortuary workers that has worked for 1-5 years and >5 years. The table shows that long term exposure to formaldehyde caused a significant (p<0.05) reduction in the platelet count, MPV, PCT and PDWC of mortuary workers. Table 3 shows the variation of platelet count, PCT, MPV and PDWC in mortuary workers based on age. Platelet count and PCT varied significantly (p<0.05) among and within the groups. Figure 1 shows the morphological distribution of platelets of mortuary workers: 3 out of the 32 (9.0%) subjects had giant forms while 29 (91.0%) had normal forms. Figures 2 and 3 shows a correlation plot of age against platelet count and PCT of mortuary workers. There was a significant negative correlation (r=-0.528; -0.549 respectively) between age and platelet count and PCT.

Table 1: Mean values of platelet count, PCT, MPV and PDWC of mortuary workers and non-mortuary workers.

Groups/parameters	Mortuary workers (n=32)	Non-mortuary workers (n=32)	P value
Platelets ($x10^9$/L)	189.63±77.35	191.47±65.43	0.918
PCT (%)	0.19±0.08	0.17±0.06	0.142
MPV (fl)	10.05±1.19	8.74±0.74	0.000*
PDWC (%)	32.94±10.96	16.12±1.14	0.000*

Values are expressed as mean±SD, where PCT=plateletcrit, MPV=mean platelet volume, PDWC=platelet distribution width, *=significant at p<0.05.

Table 2: Mean values of platelet count, PCT, MPV and PDWC of mortuary workers based on duration of exposure.

Groups/parameters	1-5 years (n=14)	>5 years (n=18)	P value
Platelets ($x10^9$/L)	216.14±86.69	169.00±64.30	0.087
PCT (%)	0.23±0.09	0.16±0.06	0.009*
MPV (fl)	10.79±0.94	9.47±1.05	0.001*
PDWC (%)	39.86±2.18	27.44±11.96	0.001*

Values are expressed as mean±SD, where PCT=plateletcrit, MPV=mean platelet volume, PDWC=platelet distribution width, *=significant at p<0.05.

Table 3: Variation of platelet count, PCT, MPV and PDWC in mortuary workers based on age.

Groups/parameters	23-33 years (n=13)	34-44 years (n=14)	>44 years (n=5)	F ratio	P value
Platelets (×109 /l)	236.69±75.9	179.79±47.75	94.80±53.80	9.868	0.001*
PCT (%)	0.24±0.08a	0.17±0.04	0.10±0.07	9.493	0.001*
MPV (fl)	10.29±0.68	9.71±1.26	10.36±1.91	1.027	0.371
PDWC (%)	34.12±10.76	32.43±10.79	31.32±14.02	0.137	0.873

Values are expressed as mean±SD, *=significant at p<0.05, a=significantly different from 34-44 years and >44 years, b=significantly different from >44 years; where PCT=plateletcrit, MPV=mean platelet volume, PDWC=platelet distribution width.

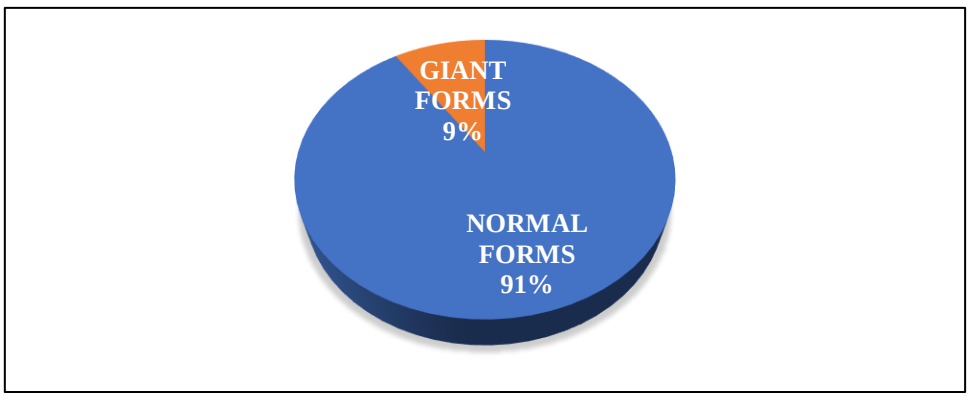

Figure 1: Morphological distribution of platelets of mortuary workers.

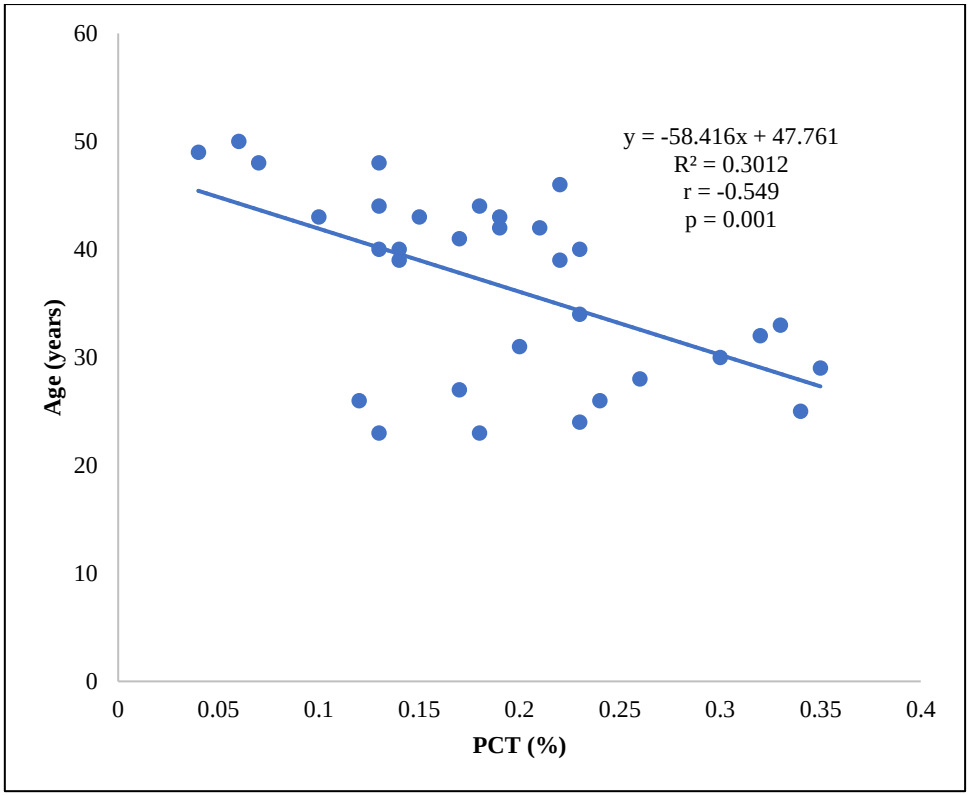

Figure 2: Correlation plot of age against PCT of mortuary workers.

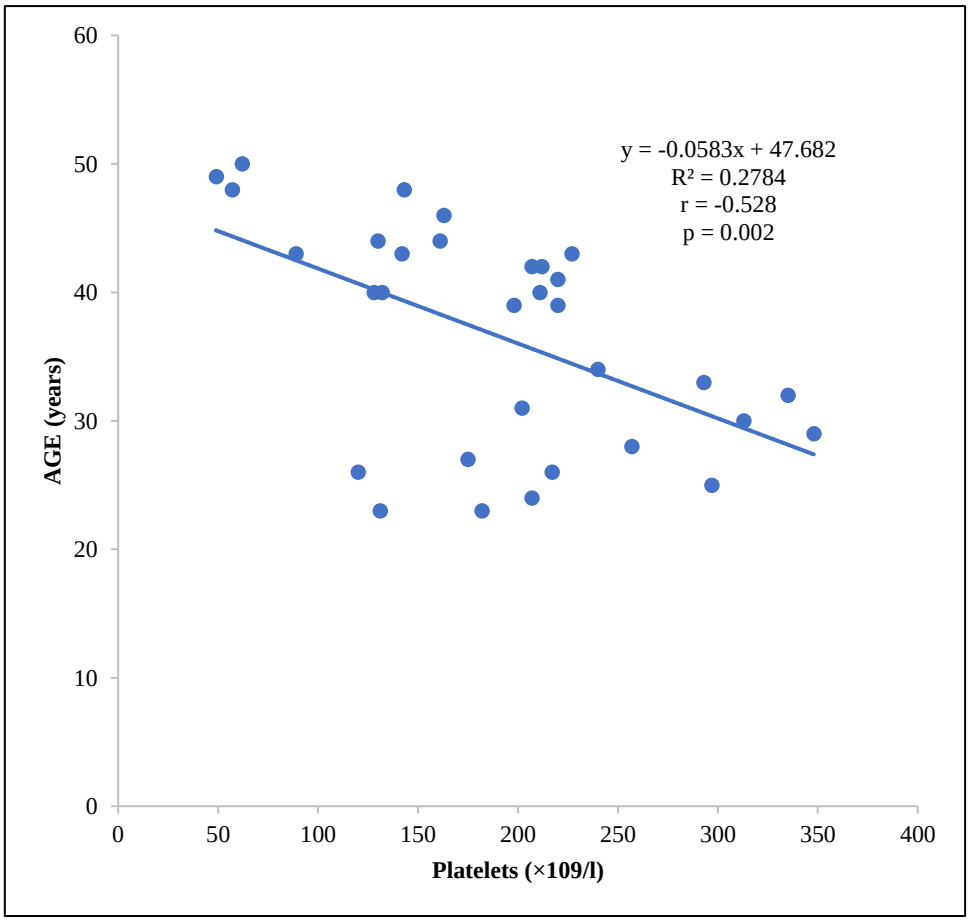

Figure 3: Correlation plot of age against platelet count of mortuary workers.

DISCUSSION

The negative impact of exposure to formaldehyde which was one of the embalming chemicals on human health had been reported.[5] Nevertheless, there was paucity of information on the impact of this embalming chemical on the haemapoietic tissues/cells because only very few studies had focused directly on the assessment of the impact of this chemical on haematopoietic functions. This research was designed to detect possible changes in the haemopoietic profiles specifically the platelet count, MPV, PDWC and PCT of mortuary workers exposed to formaldehyde. In this study, the MPC was lower when compared to the control group but the values were within normal range. Some studies found similar results showing a significant decrease in platelets count.[6,7,9] However, Odiegwu et al in their work reported increase in platelets count.[10] The decrease in the platelet count found in this study may be due to the exposure to formaldehyde and it's deleterious effect on the bone marrow.

The results of the study also showed that the mean values of MPV, PDWC and PCT of the exposed group were higher compared to the control group (Table 1). MPV and PDWC depicted the average size and variation in size of platelet, respectively. When there was acute stimulation of platelets production in the bone marrow, platelet count was increased with release of giant platelets in circulation which increased the MPV. The PDWC denoted the variation in the morphology of the platelet as a result of the presence of giant platelets along with normal-sized platelets. It can be clinically related to platelet activation. Giant platelets were usually more reactive than smaller ones due to the increased number and size of the pseudopodia, leading to increase in the platelets volume and PDWC value.[11] About 9.0% of the studied group had giant platelets, PDW reflected degree of anisocytosis of platelets, which may occur due to acute increase in the production of platelets in bone marrow resulting in formation of giant platelets. PCT depicted total platelet mass and was a product of platelet count and MPV which reflected changes in both the parameters. PCT also had been shown as an indicator of platelet activity in blood, low PCT reflected low platelet activity, therefore, increased PCT though within normal range observed in this study was suggestive of increased platelets activity among the studied group. An increase in these parameters suggested that the bone marrow produced platelets and rapidly released them into the circulation probably to compensate for the low count in the peripheral circulation. The above findings was similar to work of Odiegwu and colleagues but contradicted the work of which observed lower levels of platelet indices in exposed individuals.[7,9,10]

The mean values of platelet count and platelet indices in workers who had worked for over 5 years were lower though within normal range when compared to those who had worked for less than five years indicating that these platelets parameters decreased as the duration of exposure increase. The decrease in both the platelet count and platelet indices may be due to the long term exposure to formaldehyde. A reduction in platelet count and PCT indicated that platelet had been excessively consumed from the circulation while a decrease in MPV was associated with the degree of thrombocytopenia. The number of giant platelets being formed by bone marrow as a compensatory mechanism, was not enough in comparison with small platelet to indicate an increase in MPV while a decrease in PDWC was associated with exposure to toxic chemicals. Similar observations were seen in the work, which showed lower counts in platelet and platelet indices in workers who had been exposed to formaldehyde for a long time.[6]

Platelet count and PCT varied significantly ($p<0.05$) among and within age groups in our study. Platelet count and PCT decreased significantly as the age of the participants increased with those in oldest age bracket having thrombocytopenia (platelets count lower than normal). This fact was also buttressed by a significant negative correlation between age, platelet count and PCT. Platelet count and platelet indices had been reported to remain relatively stable during middle age (20-60 years) but fell at old age.[12] In this study the highest age observed among the participants was 59 years therefore the significant decrease in platelets count and PCT may be attributed to increased exposure to formaldehyde.

Limitation

The number of mortuary workers (32) that participated in the study was a bit low. The authors were not able to do platelet aggregation as part of the study.

CONCLUSION

This study has shown that exposure to formaldehyde has a negative alteration on the platelet count and platelet indices of mortuary workers.

We recommend periodic monitoring of platelets count and platelet indices of mortuary workers in order to forestall any negative health condition that may emanate in future.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

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Cite this article as: Okafor IM, Ogon BE, Okoroiwu HU, Ogar OC. Platelet count and platelets indices of mortuary workers exposed to formaldehyde: a study in Calabar, Nigeria. Int J Res Med Sci 2022;10:813-8.