

Comparative Study of Haematological Parameters in Exposed Fossil Fuel Bakery Workers and Administrative Officers of a Government Ministry in Benin City Nigeria

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ABSTRACT

Introduction: Most developing countries are dependent on fossil fuels for household and commercial cooking. **Objectives:** This study compared the haematological parameters of bakery workers exposed to fossil fuel (wood-burning, coal) with those of non-exposed, healthy workers in Benin-City, Nigeria. **Method:** Two hundred participants; one hundred bakery workers representing the case group and one hundred non-exposed, apparently healthy matched individuals representing the control group. A five-milliliter sample of venous blood was collected from all participants and placed into an ethylenediamine tetraacetic acid (EDTA) container. Full blood counts (FBC), red blood cells (RBC), packed cell volume (PCV), haemoglobin (Hb), platelets, total white blood cells (TWBC), eosinophils, and neutrophils were performed on the samples. **Results:** The results revealed that the mean Hb concentration ($P = 0.001$), RBC ($P = 0.001$), and PCV ($P = 0.002$) of exposed participants were significantly lower than in the non-exposed, while the platelet ($P = 0.001$), total white cell counts (TWBC) ($P = 0.002$), eosinophil ($P = 0.005$), and neutrophil ($P = 0.004$) counts were significantly higher in the exposed than in the non-exposed. **Conclusion:** It was obvious that exposure to wood-burning smoke had an effect on the haematological values of the bakery workers. The findings are important in that they demonstrate the extensive need for preventive measures such as the use of appropriate personal protective devices.

Keywords: Bakery workers, Fossil fuel, Haematological parameters

INTRODUCTION

Fossil fuel existed from time immemorial. Despite civilization and urbanization, most developing countries continue to use fossil fuel materials such as wood, sawdust, and coal for private and commercial cooking. ^[1] Heat in an enclosed environment causes increase in temperature, humidity, and level of carbon

monoxide. ^[2] Several health-hazardous pollutants released by burning of fossil fuels include particulate matters (PM), already declared carcinogenic by the International Agency for Research on Cancer, Carbon Monoxide (CO), and Volatile Organic Compounds (VOCs). ^[3] World Health Organization (WHO) estimated that more

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than 4.3 million deaths annually were caused by smoke-induced diseases.^[4]

Bakery environments also emit dusty substances of various sizes. Numerous studies have mentioned that (PM_{2.5}) product of incomplete solid biomass fuel combustion is a component associated with climatic impacts and health effects.^[5, 6] According to WHO, high levels of exposure to PM_{2.5} may be the cause of about 3.8 million premature deaths annually; Pollution from combustion of fossil fuel, such as exposure to wood smoke represents a major source of ill-health and death worldwide^[4] It has been associated with irritation of the mucous membranes, physiological and neurological effects in humans.^[7]

Exposure to air pollution in the baking environment has been linked with a multitude of haematological alterations. According to Ishii, exposure to hypoxia influences sensitivity of the human hematopoietic system causing rapid synthesis of blood cells destruction.^[8] Environmental temperature increases with bakery processes causing reactions of gaseous constituents in the air. This results in increase production and inhalation of particulate matter.

Also, CO, a colourless gas has serious effects, causing tissue hypoxia due to high binding capacity to haemoglobin. Continuous exposure to CO may result in neuropsychiatric impairment.^[9] In India, low red blood cell (RBC) was reported among persons exposed to wood smoke.^[10] Pedersen et al,^[11] recorded that smoke exposure increases total white blood cells. Bakery workers are vulnerable to dust inhalation which may lead to activation of allergic responses. According to Allakverdi and Delespesse,^[12] allergic airway inflammation causes increased number of eosinophils.

Most bakeries in Benin-City Nigeria use fossil fuel (mainly wood). So, this present study compared the haematological profiles of bakery workers, who worked one year or more using wood/coal exposed to burning smoke and non-exposed individuals.

METHODOLOGY

Design: This is a comparative cross-sectional descriptive study carried out in Benin-City, Nigeria.

Sampling method

Two hundred male respondents were recruited. One hundred bakery workers chosen conveniently served as the case group, and one hundred Ministry workers not exposed to dusty areas, apparently healthy, sex and age-matched, were employed as control group. All bakery workers working in Benin-City exposed to smoke from fossil fuel for one or more continuous years were participants in the study. Participants diagnosed with cardiovascular disease, concurrent blood diseases; smokers, alcoholics, children, and all who declined to participate were excluded.

Data Collection

Structured questionnaire was used to collect data. It included personal and clinical information along with laboratory investigations.

Laboratory Analysis

Five millilitres of venous blood samples were collected from each participant into Ethylene Diamine Tetra Acetic Acid (EDTA) containers, labeled, mixed, and checked for absence of clots, and examined immediately for full blood counts (FBC) using automated haematology analyzer (Erma Zion Automation Machine for Full Blood Count, 2008 Model USA).

Statistical analysis

Laboratory and demographic data were analyzed by Statistical Package for the Social Sciences (SPSS), IBM version-25. Mean, standard deviation and frequency distribution were performed. The comparison was done by applying two tailed Student's t-test to know the difference between traditional bakery workers' haematological values and the healthy control group laboratory results. The alpha error of 0.05 and P-value ≤ 0.05 was considered as a level of significance.

RESULTS

The mean age and standard error of bakery workers were 36 ± 0.68 while that of non-bakery workers was 35.6 ± 0.62 (p-value = 0.40). The mean weight and standard error of subjects and control workers were 66 ± 0.98 and 65.9 ± 0.69 respectively (p-value = 0.91). The mean height and standard error

of the bakery workers and control group were 165.2 ± 0.64 and 161.6 ± 0.65 respectively (p-value = 0.001). The body Mass Index of the subjects and control groups were 24.1 ± 0.27 and 25.5 ± 0.42 respectively (p-value = 0.003). (Table 1)

Table 1: Demographic Data of study and control groups N 200

Basic characteristics	Case (n=100)	Control (n=100)	Significance value	p-value
Age in years	36 ± 0.68	35.6 ± 0.62	0.86	0.40NS
Height (cm)	165.2 ± 0.64	161.6 ± 0.65	3.89	0.1S 00
Weight (kg)	66 ± 0.98	65.9 ± 0.69	0.11	0.N 91 S
BMI (kg/m ²)	24.1 ± 0.27	25.5 ± 0.42	2.93	0.003S
	Duration of exposure	Case n (%) Exposure of bakery	Control n (%) Non-Exposure to bakery	
	1-3 years	25 (25)	10 (10)	
	4-6 years	35 (35)	42 (42)	
	7-9 years	40 (40)	48 (48)	
	Total	100	100	

All values are expressed as Mean \pm Standard Error. Analysis of parameters was done using independent t test. NS = Not Significant; (p<0.05)

Haematological indices of bakery workers and control group

The results of haematological parameters indicated that the mean, hemoglobin concentration (t-value 5.59, p-value 0.001), packed cell volume (t-value 5.2, p-value 0.001) and platelet count (t-value 4.19, p-value 0.001) showed statistical significance comparing the subjects to control. Total count of WBC showed increased number of eosinophils (t-value 3.35; p-value 0.004) and neutrophils (t-value 2.9; p-value 0.005) among bakery workers when compared with that of control (Table 2).

Table 2: Comparison of Haematological indices between bakery workers and control group N =200

Hematological indices	Bakery workers Mean \pm SE	Control group Mean \pm SE	T-test value	P-value
Packed Cell Volume (%)	46 ± 0.66	40 ± 0.61	5.20	0.000, S
Haemoglobin (g/dl)	13.3 ± 0.08	12.2 ± 0.14	5.59	0.000, S
Red Blood Cell ($\times 10^6$)	5.9 ± 0.08	5.2 ± 0.14	4.55	0.002 S
Platelets ($\times 10^9/l$)	282.6 ± 20.5	196.6 ± 5.6	4.19	0.001 S
Total White Blood Cells ($\times 10^9/l$)	4.4 ± 0.3	3.8 ± 0.2	5.67	0.002 S
Eosinophils (%)	2.75 ± 0.28	2.17 ± 0.2	4.35	0.005, S
Neutrophils (%)	59 ± 3.8	55.7 ± 3.4	2.9	0.004, S

S = Significant; SE = Standard Error; % = Percentage; dl = deciliter; g = gram, l = litre

DISCUSSION

In this study, 200 participants; 100 bakery workers and 100 administrative officers in a government ministry, all males were employed for this study. Most bakeries workers in Benin City use wood as fuel and become exposed to air pollutants and high temperature. The exposure to fossil fuel smoke and polycyclic Aromatic Hydrocarbons (PAHs) causes haemolysis as a result of discrepancy between pro-oxidative and anti-oxidative systems.^[13] The authors further stated that free heme is released during haemolysis which guise as pro-oxidant and increases vascular adhesion molecules during haemolysis.

The result of haematological parameters revealed that there were significant increase in RBC, HB, and PCV of bakery workers compared with the control group. The findings of this study are like a previous study which stated high RBCs count among traditional bakery workers in Pakistan.^[14] However, the result is not in agreement with studies done in Ghana and Pakistan which reported low haemoglobin related to wood smoke respectively.^[15, 16] The result of this study may be due to poor ventilation and pulmonary oedema that led to alveolar hypoxia. Hypoxia increases renal erythropoietin secretion which stimulates bone marrow production of more RBC, HB and PCV. Kent et al,^[17] reported that hypoxaemia causes secondary polycythemia in patients with chronic obstructive pulmonary disease which is a complication of prolong exposure to smoke as in cigarette smokers. Thus, a combination of flour dust and smoke from fossil fuel increased FBC, Hb and PCV.

Furthermore, the present study indicated that there were significantly elevated platelet counts, TWBCs, eosinophil and neutrophil in bakery workers than the control. The present result is similar to the findings of Jagadishnaik et al,^[18] who a significant increase in the mean value of TWBC among cement workers in India. Also, Elkhalfa,^[13] reported increased TWBCs counts of traditional bakery workers in exposed to biomass burning hazards in Sudan Cement contain similar

hazardous materials that can damage to the lungs and haematological indices. Some authors have shown alterations in the haematological indices of cement in relation to unexposed group.^[19,20]

Elkhalfa,^[13] found decreased platelet and neutrophil counts in Sudanese bakers in contrast, high Platelet count was found among occupants exposed to wood smoke compared with healthy control persons in Pakistan. Rabha, et al,^[21] in India revealed that platelet counts had a significant positive association with emissions released during cooking with fuel wood.

The present results on white Blood Cells (WBC) may have been influenced by the exposure to fuel smoke which influenced active phagocytic activity causing an extremely vigorous respiratory burst. The respiratory burst involves the activation of an oxidase enzyme, which produces large quantities of superoxide, a reactive oxygen species and attracts WBC congregation at a focus of infection. The peripheral blood leukocyte count is a marker of inflammatory response.

Also, the result on platelet count may be attributed to platelets acting as innate inflammatory cells in responses smoke and allergen stimulus. Exposure to flour dust as respiratory sensitizer and exposure to could affect all the systems of the body and stimulate allergic responses. A combination of fossil fuel smoke and allergic responses are associated with platelets recruitment to the lungs. This was observed in an experimental animal model.^[22, 23] Further to this, it was explained that platelet accumulation is an event that precedes histamine and exposure to smoke release from mast cells^[23] suggesting that allergen may directly activate platelets.

The study showed increased number of eosinophils among bakery workers compared with the control. Eosinophil may have increased by these two mechanisms. The first is the imitation of hematopoietic maturation that gives rise to mature eosinophils within the bone marrow known as eosinophilopoiesis.^[13] The second is the trafficking of the progenitor through the peripheral circulation and migration into the allergic tissue where they

undergo the hematopoietic maturation under the control of specific local mediator known as in situ hematopoiesis.^[24] The study on Eosinophil, their progenitors and T helper cells in allergic airway inflammation showed an increased number of eosinophils in the airways, suggesting a continuous systemic eosinophilic inflammation from bone marrow up to airways.^[25] In addition, eosinophils demonstrate numerous immune regulatory functions, such as the production of cytokines and chemokines that leads to the exacerbation of inflammation, mucus hypersecretion, and lung remodeling.^[26]

Neutrophils constitute the most abundant leukocytes in the human body. The present study showed increased number of neutrophils (p-value 0.005) among bakery workers when compared to the control. A study in 2019 reported similar result of significant increase in neutrophils among grilled fish sellers exposed to smoke in Indonesia.^[27] Earlier, Mukae et al.,^[28] reported that repeated exposures of PM₁₀ in rabbits stimulate the increase production of neutrophils in the marrow and accelerate the release into the circulation. Various in vivo studies have shown that particulate matter exposure promotes neutrophil migration and lung infiltration. Neutrophils play an important role in lung immune responses.^[29] The cells migrate to the lung, destroy the foreign agents and initiate an inflammatory response. Consequently, the combination of several pollutants present in flour dust and wood smoke may have caused the increase in neutrophils.

CONCLUSION

The present study has shown apparently significant effects in all haematological parameters among traditional bakers exposed to wood-burning smoke. Increase in RBC, HB, PCV, and Platelet counts, Neutrophils Eosinophils and TWBC values were caused by exposure to fossil fuel and particulate matters from flour dust. There is an urgent need for bakery directors to provide workers with personal protective equipment; ensure a clean and well-ventilated environment. Further study to

evaluate the inflammatory air diseases that may be associated with exposure to fossil fuel is recommended.

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Conflict of interest

The authors declare no conflict of interest

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