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Evaluation of Some Haematological and Coagulation Profiles of Occupationally Heat Stress Individuals of Bakery Industries in Kano, Nigeria

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Abstract

Bakers are exposed to heat stress in their work places, which can result in a variety of outcomes ranging from mild heat cramps to heat stroke. There is paucity of published data on the wallop of heat stress on haematologic and haemostatic parameters of individuals occupationally exposed to heat stress from bakery industries. This study attempted to evaluates some haematological and coagulation parameters of bakery workers who are occupationally exposed to heat stress in the baking industries. One hundred (100) individuals who consented to participate among which are: 70 bakers and 30 non-bakers were enrolled into the study. Blood samples were obtained using aseptic venepuncture and assessed for haematologic and haemostatic parameters by Haematology-analyser for full blood count parameters and manual standard coagulation method for Prothrombin time (PT) and activated partial thromboplastin time (aPTT) respectively. The data obtained was analyzed using IBM SPSS version 23. The results are presented as mean and standard deviation and p-value was set at ≤0.05as statistically significant. Platelets, red and white blood cells counts and their indices were counted along with some coagulation parameters (PT and aPTT). A statistically significant increase (p≤0.05) in platelets counts were observed in bakers compared with controls. Similarly, some coagulation parameters were found to be reduced and was statistically significant (p≤0.05) in bakers compared with non bakers as controls. The findings of the study showed insignificant changes in haematologic parameters coupled with altered coagulation parameters. This may be suggestive that individuals occupationally exposed to heat stress are prone to hypercoagulable state and its attending consequences.

Keywords: Bakers, Controls, Haematologic, Haemostatic and Heat stress

INTRODUCTION

Workers in different industrial works of life are exposed to high temperature around them, as a result of technical processes which heat the atmosphere. Workers in bakery industry are not an exception. This high temperature from industrial environment may interfere with the mechanism of heat loss from human body system, and this consequently necessitate for

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adaptive mechanism that will promote loss of appropriate amount of heat, which in the long run expand blood vessels surrounding the skin to increase its ability to lose heat and increase the amount of sweat. In an attempt to increase heat loss by evaporation, the body's ability to adapt is overwhelmed and disturbances and disease state might occur (Marwan *et al.,* 2020). Haematologic profiles are standard values that evaluate blood sample for variety of basic measurements of blood cells which gives information about different cells type of a given blood sample. A haematological profile determines the amount of haemoglobin and the counts of red blood cells, white blood cells and platelets (https://www.medical-diagnosis.co.uk/exam/profiles/health-checks-profiles/hematology-profile/). The tests for haemoglobin and red blood cells are essential means of identifying anaemia, a condition that may be caused by insufficient iron in the patient. Testing for white blood cells and differential counts can reveal some information regarding an indication of infections, failure of production, haematologic pre-malignant and clonal disorders (http://www.lls.org/managing-your-**cancer**/lab-and-imaging-**tests**/). While haemostatic disorders may be accompanied by low or high platelet counts and other coagulation parameters.

Essentially, oxygen is taken-up by red blood cells from the lungs to the body tissues, and carbon dioxide is removed from the tissues and organs of the body by the deoxygenated red blood cells to the lungs for elimination among other functions. On the other hand, white blood cells are indispensable for fighting infections in the bloodstream either directly by phagocytosis or via mediated immunity (Lugos *et al.,* 2019).

The evaluation of haematological parameters is very necessary because, they are important proxy indicators useful in the assessment of immune status, therapeutic purposes and monitoring of disease progression and treatment outcome for proper patient management. The developmental stages of life vary directly with basic biological variables of age and sex independently. In pursuant of effective health care through accurate diagnosis, haematological parameters are routinely assessed (Amilo *et al.,* 2021).

On the other hand, measurement of PT, aPTT, and fibrinogen concentration are the most commonly employed laboratory tests in patients with a suspected coagulopathy (Furlanello *et al.,* 2006). Prothrombin time is a laboratory screening test used to detect disorders involving the activity of the factors I, II, V, VII, and X of the extrinsic and common pathways (Hinchcliff *et al.,* 2004). Activated partial thromboplastin time is used to screen for abnormalities of the intrinsic and common clotting systems and to monitor the anticoagulant effect of circulating heparin. It measures the activities of factors I, II, V, VIII, IX–XI, and XII of the intrinsic and common pathways (Iazbik *et al.,* 2007). Measurement of Prothrombin (PT) and activated partial thromboplastin (aPTT) are markers of extrinsic and intrinsic pathway (Dhule *et al.,* 2014).

Bakers are exposed to heat stress in their work environment, which can result in a variety of outcomes ranging from mild heat cramps to heatstroke (Argaud *et al.,* 2007). Baking requires a lot of physical effort, and bakers are exposed to excessive heat, especially in traditional bakeries, with uncovered ovens (Rabeiy, 2019). Bakers are additionally at high risk of developing musculoskeletal illnesses from repetitive movements during their daily work (Ghamari *et al.,* 2010). There is paucity of published data on the wallop of heat stress on haematologic and haemostatic parameters of individuals occupationally exposed to heat stress from bakery industries. This study was aimed at evaluating the impact of heat stress on

some haematological and coagulation profiles of bakery workers who are occupationally exposed to high-temperature industrial settings.

MATERIALS AND METHODS

Study area

The study was conducted in Kano Metropolis. Kano is a state located in North-western part of Nigeria. The state laid on latitude 12° 0' 0.0000" N, 8° 31' 0.0012" E. It is bordered by the states of Jigawa to the north and east, Bauchi to the southeast, Kaduna to the northwest, and Katsina to the northwest (https://www.britannica.com, 2024). According to the national census done in 2006, Kano is the most populous (with 9,401,288) state in Nigeria (NPC, 2006 and https://en.m.wikipedia.org/wiki/Kano State, 2024).

Study design and sampling technique

The study was a comparative cross-sectional study, and a random sampling method was used

Collection of Blood Samples

Ten milliliters of venous blood samples were collected aseptically using disposable syringes from each participant. Five milliliters of blood samples were transferred into labeled ethyline diamine tetraacetic acid (EDTA) containers for measurands of haematological parameters) and mixed gently to prevent clotting and haemolysis. These were kept at room temperature (22°C) for 4 hours prior to assay.

While, the remaining five milliliters (5ml) of blood were dispensed in a vial containing 0.5ml of 3.2% tri-sodium citrate to make a dilution of 1:9 and mixed properly. Then, platelet-poor plasma was separated from citrated blood by centrifugation for 15 min at 3000 rpm and stored at frozen at -20°C and allowed to thawed prior to assays. APTT and PT profiles were assayed by manual methods in accordance with manufacturer's instructions. Samples analyses were done at Laboratory Department of Murtala Muhammad Specialist Hospital, Kano.

Study population

The study population comprised of seventy (70) bakers from bakery industries across various job positions in different bakery setting within Kano metropolis and thirty (30) apparently healthy individuals were used as controls.

Inclusion criteria

Individuals working on varied job positions within the bakery, such as dough mixers, pastry chefs and oven operators. Both gender between the age of 18 to 50 years were recruited, individuals who have been working in the bakery for a minimum of one year, bakery workers who provide voluntarily consent to participate in the study.

Exclusion criteria

Individuals not directly involved in bakery operations (e.g., administrative staff or managers), Workers who are employed in the bakery less than a year, Pregnant women working in the bakery industry, as pregnancy an inherent impact on blood parameters, Individuals with underlying disease conditions were all excluded

Ethical consideration

The ethical approval to conduct this study was sought from the Research and Ethics Committee of Kano State Ministry of Health prior to commencement of the study. Consent of

the participating individuals based on revised Helsinki declaration, 2013 on use of human subjects for research was also obtained before recruitment in to the study.

Laboratory Procedures

The blood samples for haematological profiles were analysed using Orphee Mythic 18 (Switzerland) automated haematology analyser.

When tissue thromboplastin and calcium ions are added to plasma at 37°C, extrinsic clotting factors are activated, resulting in generation of thrombin and the formation of fibrin clot and the time taken for the clot to form is recorded in seconds (Cheesbrough, 2009).
Kaolin (surface activator) and platelet factor 3 substitute (phospholipid) are incubated with citrated plasma at 37°C for the time specified in the test method. Calcium chloride is added and the time taken for the mixture to clot is recorded in seconds (Cheesbrough, 2009).

Statistical analysis

Data was entered into an excel work sheet, sorted and subjected to normality testing. Inferential statistics was done for each parameter and student t test was also done for comparison between two groups, p value ≤ 0.05 was set as statistically significant. All statistics was by IBM SPSS version 23.0 software.

RESULTS

One hundred (100) participants were enrolled into this study. Seventy (70) were bakers while thirty (30) were apparently healthy controls. Among the test group, sixty-five (65) were males while five (5) were females. For the controls group, twenty-nine (29) were males and one (1) was female.
Table 1 showed age distribution of study participants (bakers as subjects and non bakers as controls). The mean ± SD age of bakers was 24.15±5.83 and for controls was 25.60±5.08. comparison of age distribution between bakers and non-bakers was not statistically significant (p≤0.05).

Table 1: age distribution of bakers as subjects and non bakers as controls.

Variables	Subjects n (%)	Control n (%)	p value
Age			0.258
18-25	58 (83)	23 (77)	
26-33	7 (10)	5 (17)	
34-41	3 (4)	1 (3)	
42-50	2 (3)	1 (3)	
Total	70 (100)	30 (100)	

Keys: n = Frequency, % = Percentage, p value = probability value

Table 2: shows distribution by gender of subjects and controls. Out of total 100 participants studied, among bakers, sixty-five (65) were males and five (5) were females. While for controls (non-bakers), twenty-nine (29) were males and one (1) was female and this was not statistically significant (p ≥0.05).

Table 2: Distribution of subjects and controls based on gender

Gender	Subjects n (%)	Controls n (%)	p value
Male	65 (93)	29 (97)	
Female	5 (7)	1 (3)	
Total	70 (100)	30 (100)	0.467

Keys: , n = Frequency, % = Percentage, p value = probability value

Table 3: shows comparison of Mean ± SD of haematological parameters in bakers and non-bakers. The red blood cells and its indices showed no statistically significant difference in comparison between bakers and non-bakers (p≥0.05). This similar with white blood cell and its differentials counts except for monocytes which shows statistically significant decrease among bakers compared to non-bakers (p≤0.05). However, the platelets count was found to be statistically significant in comparison between bakers and non-bakers (p≤0.05), respectively.

Table 3: Comparison of mean haematological parameters among bakers and non-bakers.

Parameters	Bakers (n=70)	Non bakers (n=30)	t-test	p value
WBC ($\times10^9$/L)	6.06±1.574	6.04±1.482	0.069	0.946
Neutrophils ($\times10^9$/L)	3.02±1.226	2.79±1.193	0.866	0.389
Lymphocytes($\times10^9$/L)	2.41±0.802	2.44±0.654	-0.146	0.884
Monocytes ($\times10^9$/L)	0.33±0.134	0.53±0.219	-5.447	0.001*
Eosinophils ($\times10^9$/L)	0.27±0.228	0.26±0.355	0.092	0.927
Basophils ($\times10^9$/L)	0.72±5.974	0.00±0.010	0.658	0.512
PLT (10^3/uL)	2.87±97.281	2.22±78.437	3.216	0.002*
RBC (10^{12}/L)	4.70±0.578	4.48±0.644	1.627	0.107
HGB (g/dL)	13.07±1.570	12.90±1.485	0.497	0.620
HCT (%)	38.83±4.439	38.29±4.222	0.563	0.574
MCV (fl)	82.96±6.905	84.94±5.245	-1.401	0.164
MCH (pg)	27.96±2.771	28.63±2.290	-1.170	0.245
MCHC (g/L)	3.36±14.054	3.36±14.437	-0.064	0.949

Keys: t-test= Independent t test, p value= Probability value, WBC= white blood cell, PLT= platelet, RBC=red blood cell, HGB= haemoglobin MCV= mean corpuscular volume, MCH= mean haemoglobin concentration, MCHC= mean corpuscular haemoglobin concentration

Table 4: showed comparison of Mean ± SD of coagulation parameters in bakers and non-bakers. The mean of prothrombin time (PT) in bakers was 11.67±2.198 seconds and 12.96±1.884 seconds for non-bakers, respectively. The mean ± standard deviation of activated partial thromboplastin time (aPTT) in bakers and non-bakers were 37.61±5.809 seconds and 40.73±3.289 seconds respectively. Upon comparison the results of bakers with non-bakers indicated statistically significantly reduced (p≤0.05) of PT and aPTT among bakers.

Table 4: Comparison of Coagulation parameters among bakers and non-bakers

Parameters	Bakers n=70	Non-bakers n=30	t-test	p value
PT (secs)	11.67±2.198	12.96±1.884	-2.813	0.006*
aPTT (secs)	37.61±5.809	40.73±3.289	-2.753	0.007*

Keys: t-test = independent t test, p value = Probability value, Prothrombin time (PT), activated partial thromboplastin time (aPTT), secs = seconds.

DISCUSSION

A study on impact of heat stress on haematologic and coagulation parameters among seventy occupationally exposed heat-stressed individuals from bakery industries as subjects and thirty non bakers as controls making one hundred participants was carried out in this present study. In both cases and controls, the majority of the participants were in the ranges of between their second to third decades, and some were in their third to fourth decades. While, few were between fourth to fifth decades.

In this present study, the red blood cells and white blood cells counts and associated parameters particularly RBCs, HCT, neutrophils and eosinophils were slightly increased in bakers compared with non-bakers but not statistically significant (p≥0.05). Contrastingly, MCV, MCH and MCHC together with lymphocytes were slightly decreased, but not statistically significant (p≥0.05).

These findings were in agreement with the work of Marwan *et al.* (2020) on apparently healthy bakery workers. In their study, the variables related to the white blood cells showed increase in total number of white blood cell count, monocytes, granulocytes and decreased lymphocytes among their subjects compared with controls. The possible reason for this increase was suggested to be due to exposure to processed raw materials and other allergens in bakery environment that can trigger an immune response, leading to inflammation and increased in the production of white blood cells, specifically the monocytes and granulocytes, while decreased in lymphocytes count may be due to stress which can suppress the immune system and reduce the number of circulating lymphocytes.

The findings from this study have also demonstrated that the mean platelets count is significantly higher ($p \leq 0.05$) compared with the controls. Our result is in agreement with the work of Anne *et al.* (2007) on effect of heat stress on platelet function and coagulation potential. The reasons may be due to the demanding nature of baking, especially in professional settings, which can lead to increased stress levels. Chronic stress has been linked to alterations in platelet function coupled with increased platelet counts due to the release of stress hormones like cortisol.

A study by Sultan (2022) on haematologic parameters in a population of bakers occupationally exposed to excessive heat stress reported higher Hb, HCT and RBC counts compared with controls and this is concurring with the findings of this currents study. The increased Hb and HCT levels could possibly be linked to dehydration caused by sweat. It could also be due to compensatory response mechanism to chronic contact with airborne irritants. An increased in red blood cell production may be due to physiological adaptation to improve oxygen-carrying capacity in response to respiratory stress caused by exposure to allergens.

This study has also shown that, there was statistically significant difference ($p-< 0.05$) observed in both prothrombin time (PT) and activated partial thromboplastin (aPTT) time between bakers and non-bakers' as control individuals. The study further revealed a statistically significant difference ($p \leq 0.05$) PT in bakers compared with non-bakers. This same trend was also recorded for aPTT also shows statistically significant difference in bakers compared with non-bakers ($p \leq 0.05$), respectively.

These findings contrast with the reports of Ikhuenbor *et al.* (2016) who documented prolonged PT and APTT and concluded that heat stress elicited a statistically significant increase in PT and APTT in Nigeria population as temperature increases proportionally with time.

From the forgoing, this study has shown that bakers are exposed to certain occupational hazards and environmental factors (such as flour dust, allergies, chemical exposure, physical/heat stress) that can potentially affect their coagulation profile, leading to reduce in prothrombin time (PT) and activated partial thromboplastin time (APTT) compared to non-bakers.

CONCLUSION

This study revealed insignificant alterations in haematological parameters with significant changes in coagulation parameters on bakers compared with non-bakers. Therefore, the results showed how heat stress impacted on coagulation parameters among occupationally exposed workers in baking industries and this is suggestive that these individuals might be prone to hypercoagulable state and its attending consequences.

Having said this, there is the need for Government to ensure compliance of Occupational Health Monitoring guidelines for bakeries in the Kano state. Personal Protective Equipment should be provided to the bakers to minimize exposure to flour dust and other occupational hazards in bakeries. Safety Measures at workplace such as effective ventilation systems and dust control measures in bakeries should be implemented to reduce airborne irritants level and improve air quality. Health Awareness campaign should be prioritized for bakers to raise awareness on the potential health risks associated with baking industry and consequently promote healthy life style. To this end, the government should support research efforts to explore more areas of occupational hazards in the baking industry.

Conflict of interest: None

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