

EFFECT OF PROLONGED HEAT EXPOSURE ON RED BLOOD CELL INDICES IN-VIVO AMONG LOCAL BREAD BAKERS IN ILORIN METROPOLITAN CITY

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Abstract: Background: Occupational hazards are specific dangers workers are exposed to, at work environments, due to tools, or interactions among co-workers. This is also seen among local bakers exposed to undue heat culminating into several unreported health conditions making the victims to indiscriminately and erroneously take blood supplements as antidotes. This study was conducted to explore the effect of prolonged environmental heat exposure on red blood cells indices in vivo among local bakers in Ilorin metropolitan city. **Methodology:** One hundred office workers and 100 local bread bakers with 5 years and above working exposure to prolonged heat were selected from 10 different local bakeries in Ilorin. Following completion of a questionnaire, blood samples were collected for assessment of red blood cell indices. **Result:** There was significant ($p < 0.05$) increase in levels of haemoglobin, packed cell volume, and mean corpuscular haemoglobin, while there was no significant ($p > 0.05$) change in the levels of RBC, MCV and MCHC, though there was increase. **Conclusion:** In conclusion, the result of this study demonstrated that prolonged heat exposure caused increase in the level of haemoglobin, packed cell volume, and mean corpuscular haemoglobin. However, red blood cell count, mean corpuscular volume, and mean corpuscular haemoglobin concentration of the bakery workers were uneventful compared to that of the control.

Keywords: Prolonged heat, Red blood cell indices, Local bakery, Metropolitan

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Introduction

Occupational hazards are risks and adversities workers are exposed to at work environments, due to tools, or interactions among workers. Haematological studies are of clinical and physiological interests, they are helpful in diagnosis, monitoring of diseases, and investigation of extent of physiological damage of blood components. Paradoxically, blood can be said to be a tool for assessment of health of a subject however, part of the healthiness of blood is a function of red cell indices. Derangement in cellular blood components is a threat to

homeostasis, and makes human to stand at risk of survival.^{1,2} When animals are exposed to elevated temperature, the body temperature rises, this is a result of heat builds up which is a form of energy that is transferable from or to a thermodynamic system. This invariably could affect the core body temperature, and by extension the functionality of organs and tissues. Because Red blood cells are sensitive to environmental temperature, increase in the body temperature may result in affectation of red cell morphology and functions with consequential health

effects such as headache, dizziness, fainting spell or syncopal attack.³

Assessment of red blood cells is part of full blood count investigation, a common medical laboratory test. It measures the size, shape, and physical characteristics of the RBCs. It is a tool that helps in diagnosing the cause of anaemia which is a frequent blood level derangement in which there is too few, misshapen, or poorly functional RBCs. The components incorporate average red blood cell size (MCV), haemoglobin amount per red blood cell (MCH), and the amount of hemoglobin relative to the size of the cell (hemoglobin concentration) per red blood cell (MCHC).

The constituents of blood may be altered at the instance of unfavourable physiological conditions of the body system.⁴ These alterations are of interest in assessing response of animals to various physiological situations.⁵ According to Afolabi *et al* (2010), changes in haematological parameters are often used to determine various status of the body, and to determine stress due to environmental, nutritional and/or pathological factors.⁶ Besides, blood is a vital circulatory tissue that is composed of cells suspended intravascularly in a fluid substance (plasma) with the major function of maintaining homeostasis.⁷ Red blood cells is a carrier of haemoglobin,^{8,9} iron pigment in the blood for the transport of oxygen and carbon dioxide in the body.^{7,10} Hence reduction of red blood cell counts could compromise adequate blood tissue perfusion. This precipitates a state of hypoxia that is consequently accomplished by accumulation of lactic acid, thus subjecting the target tissues to gradual cell death.

Adverse biological effects can occur when the body is subjected to high doses of heat

radiation.¹¹ This can overtime precipitate heat stress which is the total heat load a person is exposed to due to prolonged heat exposure be it at place of work or any other environment. In this instance, large amounts of thermal energy may be absorbed by the body. Heating occurs spontaneously whenever a suitable physical pathway exists between the bodies.¹² The pathway can be direct, as in conduction and radiation, or indirect, as in convective circulation.¹³

Exposure to higher levels of radiation can cause serious deleterious effects, due to the biological constitution of the human body. Heat radiated energy is non-uniformly deposited over the whole-body surface. Some areas on the skin and outer body surface will absorb higher amounts of the radiated energy which are marked by "hot spots" of high temperatures.¹⁴ Heat can cause increased vascular permeability which can lead to significant losses of body fluids and electrolytes. This leads to alteration of blood circulation and other biological functions in the affected area.¹⁵ Generally, breads made with flour, water, and yeast are baked at 400°C to 425°C for 25 to 45 minutes. This prolonged heat exposure over a long span of time constitutes heat stress especially for physiological processes that have very acute temperature reference range. The present heat exposure being considered is different from temperature precipitated by exposure to infectious agents such as bacteria and viruses which invariably by disease process leads to endotoxic shock. The present study was conducted to explore the effect of prolonged heat exposure on red blood cells indices among local bakers in Ilorin metropolitan city as study center.

Materials and Methods

Subjects:

Two hundred male (200) male subjects between the ages of 18 to 45 years were recruited into the study from 10 different local bakeries and offices. The selection criteria included:

- i. Participants were male local bakers between 18 and 45 years with 5 years heat exposure
- ii. Participants were certified physically fit following general physical examination
- iii. Not on any medication associated with red blood cell synthesis or destruction
- iv. Participants must not have received or donated blood in last 6 months
- v. Not on any iron enhancing drug
- vi. No history of chronic illness

Following ethical approval by Kwara State Ministry of Health (MOH/KS/EU/777/339), the subjects were selectively grouped into two: group 1 served as control (non-bakers, n=100) while group 2 served as test group (bakers, n=100). A questionnaire containing various information (which included age, state, family history, social/life style history, medical history, drug history) was given to each participant to fill following informed consents by the participants.

Administrative protocol

The study was carried out on 200 participants divided into two groups of 100 control and 100 test group at 10 different bakeries in Ilorin, Kwara State: Opeloyeru bakery, Oke-Adini; Oremeji bakery, Surulere; Ifedapo bakery, Akerebiata; Temitope bakery, Gerewu; Oyin bakery, Odot; Alafia bakery, Olooje; Tolulope bakery, Ogidi; Olabanji bakery, Offa garage; Iyanu bakery, Ipata market; Bolatito bakery,

Eyenkorin. Subjects were males that have been working in bakeries as bakers for over 5 years with prolonged exposure to direct oven heat. The control group consists of non-bakery workers without prior exposure to prolonged heat.

Experimental procedure

The participants were made to sit comfortably in a relaxed atmosphere following a general physical examination. A tourniquet was then tied around the upper arm to make the veins at the cubital fossa more prominent. The skin was cleansed with spirit-swab and a sterile needle and syringe was carefully to collect blood sample from any of the prominent veins around the cubital fossa. Blood was drawn to reach 3ml mark of the syringe. The tourniquet was released and the needle was removed. A dry cotton wool was then placed on the area of the venopuncture with the elbow in a flexed position. Blood collected from each subject was immediately put in an EDTA bottle and labeled appropriately and then transferred to the laboratory for assessment of red cell indices which include: haemoglobin (Hb), packed cell volume (pcv), red blood cell count (RBC), mean corpuscular volume (MCV), mean corpuscular haemoglobin (MCH), mean corpuscular haemoglobin concentration (MCHC).

Statistical analysis

The frequencies and percentages of the measured variables were determined with SPSS version 20. Comparison was done using Pearson's Chi-Squared test, and level of statistical significance was considered as $p < 0.05$.

Result

Table 1: Showing red blood cell indices of prolonged heat exposed bakery workers and control

Red blood cell indices	MEAN±S.E.M.	
	Control group	Heat exposed group
Hb (g/dl)	15.98±0.28	19.49± 0.22*
PCV (%)	48.13 ±0.70	60.92±1.33*
RBC (million cells/mm ³)	4.96 ± 0.41	6.89±0.11
MCV (fl)	82.13 ±0.73	101.53±1.29
MCH (pg)	27.67 ±0.52	35.20±0.61*
MCHC (g/dl)	34.53 ±0.66	38.07±0.34

Level of statistical significance was considered at $p < 0.05$

A total of 200 male participants were analyzed consisting of 100 control and 100 test subjects. The outcome of analysis of information from test subjects revealed that their age bracket was between 22-55 years with mean value of 32 ± 18.27 . Their academic distribution reflects informal education to be 14 (14%), primary school certificate to be 20 (20%), secondary school certificate to be 58 (58%), tertiary school students to be (6%), and higher institution certificate to be (2%). The distribution of duration of heat exposure reveals 5-10years exposure to be 55 (55%), 10-15years exposure to be 25 (25%), 15-20years to be 10 (10%), over 20years heat exposure to be 10 (10%). The marital status of the participants was distributed as follows: single was 35 (35%), married was 25 (25%), divorced was 10 (10%), separated was 30 (30%). Blood transfusion profile revealed that 27 (27%) of the respondents have donated blood in the past of which 32 (32%) of them voluntarily donated, while 68 (68%) commercialized their blood donation. However, only 5 (5%) of the respondents were blood recipient in the past. There was significant ($p < 0.05$) increase in levels of

haemoglobin, packed cell volume, and mean corpuscular haemoglobin, while there was no significant ($p > 0.05$) change in the levels of RBC, MCV and MCHC, though there was increase.

Discussion

Red blood cell (RBC) indices are part of the full blood count (FBC) test. They reveal information about the content of haemoglobin and size of red blood cell. They are tools used in diagnosing anaemia and the type of anaemia, a condition in which there are too few red blood cells in circulation. In the current study, the increase in haemoglobin observed in the bakery workers may be due to increase in demand for the transportation of oxygen in the body because of increase in metabolism precipitated by long term heat exposure, this also caused the slight increase in the number of red blood cells, though not at significant level. This could be associated with increase in production of erythropoietin that triggers the production of more red blood cells to aid in oxygen delivery to the muscles and vital organs so as to compensate for the decrease in oxygen. This is similar to life at high altitudes which allows body system progressively over time and to produce

extra red blood cells in order to adjust to the oxygen-deprived conditions of high altitudes. The PCV and MCH also showed significant increase which is in support of the increase seen in the haemoglobin levels which is in line with intact physiological compensatory mechanism. Although, there was increase in RBC count, MCV and MCHC but not statistically significant. The observation in this study showed that the changes in the levels of haematological parameters were only selectively affected in the bakery workers compared to the control group. The physiological response to profused internal heat, a common complaint observed in bakers could be due to direct effect of the working environmental heat exposure, thus increasing metabolic rate in a direct relationship, and not as a result of alteration in RBC count. The profuse sweating objectively recorded by the bakers as observed in this study was probably due to heat stress as seen in the work of Wen-Jei Yang (1986).¹⁵

However, the overall unremarkable effect of prolonged heat exposure seen in the study of bakers is seemingly in concordance with the work of Lee and Ducoff (1993) which demonstrated that high temperature up to 50°C has thermoresistance for red cells, although it was an in-vitro study in avians.¹⁶ The building environment of local bakery workers which is often poorly ventilated might have also been responsible for the alterations observed in red blood cell count due to decreased availability of oxygen. In view of the above, it is of pertinent to discourage bakers involved in indiscriminate use of haematinics and blood supplements from such practices.

Conclusion

In conclusion, the result of this study demonstrated that prolonged heat exposure caused increase in the level of haemoglobin, packed cell volume, and mean corpuscular haemoglobin. However, red blood cell count, mean corpuscular volume, and mean corpuscular haemoglobin concentration of the bakery workers were uneventful compared to that of the control.

Conflict of Interest

We, the authors of this manuscript declare no conflict of interest in its preparation and submission for onward publication.

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