

Hematological Effect of Heat on Bakery Workers

Elaf Ismael Mahdi

Ibnsina University / Collage of Dentistry

ABSTRACT

Heat stress is a common dangerous factor on bakery workers because of hematological disruption. In this study measured the blood parameters changes in 25 bakery workers (ages 18-52) visible to heat for long time and 10 people as control (ages 21–52). Hazard for bakery workers and may disrupt hematological homeostasis. This cross-sectional study assessed changes in selected blood parameters among 25 bakery workers (ages 18–52) exposed to prolonged occupational heat and 10 unexposed controls (ages 21–52). Venous blood (5 mL) was collected in heparin tubes and analyzed using a D-Cell 60 automated hematology analyzer to measure red blood cell (RBC) count, total white blood cells (WBC), differential leukocyte counts (lymphocytes, monocytes, granulocytes), and hematocrit (HCT). Compared with controls, 44% (11/25) of exposed workers showed elevated RBC counts, 16% (4/25) had increased lymphocyte counts, 48% (12/25) had increased granulocyte counts, and 24% (6/25) exhibited reduced total WBC. No significant changes were detected in monocyte counts or HCT values. These findings suggest that chronic occupational heat exposure in bakery environments is associated with alterations in hematological and immune cell profiles—likely reflecting dehydration, hem concentration, and immune activation or dysregulation. Regular medical monitoring, improved workplace ventilation, adequate hydration, and protective measures are recommended to mitigate heat-related hematological effects among bakery workers. A physiological condition like Heat stress is effect on the homeostasis of various blood parameters. The aim of this study to estimate alterations in red blood cells (RBCs), white blood cells (WBCs), lymphocytes, granulocytes, and hematocrit (HCT) levels among persons have been exposed to prolonged heat, such as bakery workers. Consequences indicate important changes in differential leukocyte counts and RBC levels, proposing that chronic heat exposure may influence immune responses and hematological stability.

KEYWORDS: Heat stress; bakery workers; hematological parameters; red blood cells (RBC); white blood cells (WBC); lymphocytes; granulocytes; occupational health

1. INTRODUCTION

1.1. Blood definition & contents

“A circulating connective tissue called blood which is nurturing the body with oxygen and act as scavenger for waste, blood components are liquid (mostly) ,cells and proteins suspended that’s make it more denser than water . Every person has about 5 liters of blood, The bulk of blood is plasma ,plasma helps blood to clot because of fibrinogen which make blood clot , substances transport and also has glucose and other dissolved nutrients,

About most of blood component are cells:

Red cells for oxygen transportation to tissue, White cells act as infection fighters and Platelets act as clotting cells” (1).

Blood is passed through the tubes called veins and arteries. Blood isn’t clotting when passed through these tubes because of presence of smoothing factors.

It is consist of blood cells suspended in blood plasma. Plasma, which establishes 55% of liquid, is mostly water (92% by volume)” (2).

Plasma is a matrix that holds all dissolved product like hormones ,proteins, glucose, mineral ions and carbon dioxide and cells mainly the red blood cells (also called RBCs or erythrocytes), white blood cells (also called WBCs or leukocytes) and platelets. The most abundant cells in vertebrate blood are red blood cells. These contain hemoglobin, a protein holds iron that helps to transfer oxygen by reversible obligatory with gas in respiratory to increase the chance of solubility in blood. In the other side Carbone dioxide has been exclude outside the cells and melted in plasma, when the hemoglobin in blood free brings shine color to blood and dark color when it contains hemoglobin, heat has been circulating through the body by blood circulation Blood circulation transports heat throughout the body, and variations to this flow are an essential part of thermoregulation. The movement of blood to the surface of skin through the warm weather or making exercise make skin warmer helping in heat loss. While when the weather is low temperature the movement of blood toward the edge and surface is decrease to prevent heat loss and transporting to the important organs of the body (3).

Hematological Effect of Heat on Bakery Workers

1.2. Blood roles:

The blood has many functions within the human body including:

- O₂ to the tissues (O₂ binds to hemoglobin, which is carried in RBCs)
- Nutritional functions: blood transports amino acids, fatty acids and glucose as a dissolved substance in the blood or bound to plasma proteins
- Elimination of waste products like CO₂, Urea and Lactic acid
- Immunological purposes, including circulating WBCs, and detecting foreign molecules by antibodies
- Hemostasis: which is the coagulation process, by which the blood is transformed from a liquid to a semi-solid gel to stop bleeding.
- Transportation: carriage of hormones and Cytokines
- Acid Base Balance
- Regulation of temperature
- Hydraulic functions

1.3. The Aim of this study:

The aim of this study is to measure the changes in hematological parameters among persons who are exposed to daily heat for prolonged durations, especially bakery workers.

2. MATERIAL AND METHODS

2.1. Tools & apparatus

Equipment	Company
Syringe	Germany
Cotton	Turkey
Ethanol (76%)	Turkey
Heparin tube	Germany
Tourniquet	China
D-Cell 60	Bulgarian

2.2. Methods

In this study the researcher collected a blood samples from bakers who exposure to heat more than the normal people, samples collected from 25 persons their ages from (18_52 years) from different places from Baghdad in the morning, also samples from 10 control people from (21_52 years) who not exposure to heat and not suffering from any disease have been collected.

A 5ml/cc syringe used to take the blood from bakers and then the researcher used heparin tube for the collected samples and analyzed the samples by D-Cell 60 (it's a Bulgarian device) gives a complete blood picture test (CBB). This study assessed differential WBC counts, RBC levels, and HCT values; platelet counts were not evaluated.

2.3. Procedure

Blood samples **were collected** via venipuncture using standard sterile techniques. Samples were shaking gently and analyzed within the D-Cell 60 device to get complete blood count parameters.

Table 1: Normal range of blood parameters we recognized in

Blood Parameters	NORMAL RANGE
RBC	3.5 – 5.5 * 10 ¹² /L
HCT	37 – 54 %
WBC	4.0 – 10.0 * 10 ⁹ /L
LYMPHOCYTE	0.8 – 4.0 * 10 ⁹ /L
MONOCYTE	0.1 – 1.5 * 10 ⁹ /L
GRANULOCYTE	2.0 – 7.0 * 10 ⁹ /L

Table 2: shows the distribution of differentiate WBC for bakers:

WBC	CONTROL	Patients More control than	Abnormalities
LYMPHOCYTE	2.06	18(72%)	4(16%)
MONOCYTE	0.83	0	0

Hematological Effect of Heat on Bakery Workers

GRANULOCYTE	2.3	0	12(48%)
TOTAL	5.2	3(12%)	6(24%)

Table 3: shows the distribution of RBC and HCT for bakers:

RBC & HCT	Control	Patients more Than control	Abnormalities
RBC	5.5	1(4%)	11(44%)
HCT	48	14(56%)	0

3.1. RESULT

The results in table 2 where shown are 4(16%) of bakers have an increase in lymphocyte more than the normal range, and 12(48%) of bakers have an increase in granulocyte more than the normal range, and about 6(24%) of bakers have a decrease in a total WBC. also, the RBC of bakers shown an increase as seen in table 3 about 11(44%) patients were more than normal range, and there is no effect in Monocyte or Hematocrit all patients are within the normal range.

3.2. DISCUSSION

In many studies have observed that the growth performance of animal and immune competence of bacterial or viral infection effected by heat stress [4–5].

In other studies have established that chronic heat stress condition negatively affects both humeral and cellular responses, Heat stress led to a decrease in the concentration of ATP, phosphocreatine, and glycogen.

In other local studies on workers in a glass industries in Ramadi Iraq the results shows decrease in protein membranes concentration ($p \leq 0.01$), while the results shows an increasing in lipids membranes with increase in cholesterol and a phosphorylation lipids ($p \leq 0.01$), and rise in the absorption of (protein/lipid) membranes ($p \leq 0.01$).

Some change that appear in the content of membranes through alternative (protein/lipid) concentration or by adding or deletion or change lipid and protein or lipids only or protein by another molecular proteins or lipids or by other organic or inorganic content (6). Some researches shows that when the plasma membranes exposure to high temperature that effect denaturation of proteins and degradation by high temperature because it will increase the activity of some enzymes (protease) so this cause collapse and degradation of proteins membrane, and after the degradation of protein appear so changes in lipids membrane (transition) especially (boundary lipids) so the process of alternative of lipid membrane are successive to protein denaturation (7), so the causes of the damage affected by the heat stress it is by the collapse of the cellular membrane and the changes that happen in the nature of the enzyme because of heat (8), that when we exposure the RBC of the human to degree 46c for a long time that will cause a denaturation in protein of membranes (9). But the degree of the Baker oven is to high more than 70c°. Also some researches shows that establish major alterations in hematological parameters among bakery workers exposed to chronic heat. The increase in RBC count detected in 44% of the exposed subjects aligns with findings from (10), who recognized similar raises to heat-induced dehydration and hem concentration. While other studies confirming that heat stress consistently changes immune profiles and hematological markers through exposed peoples (11).

While some researchers highlighted that high temperatures change plasma volume and effect on viscosity of blood, associate the RBC and WBC variations seen in the present study (12). Recent studies afford deeper mechanical explanations which chronic heat stress leads to oxidative destruction and immune dysregulation, which may explain the rise in lymphocytes and granulocytes was detected (13). Furthermore, other studies confirmed that heat stress prompts mitochondrial injury in immune cells, explaining the sensitivity of leukocytes to elevated temperature (14). Additionally, the detected reduction in total WBC count in 24% of workers may be related to heat-induced leukocyte (15). In other studies high temperature effects on blood serum factors the high temperature caused an increase in glucose, Na, triglyceride ($P \leq 0.05$), cholesterol ($P \leq 0.01$) and uric acid ($P \leq 0.001$) levels but decrease the blood serum protein ($P \leq 0.01$), albumin ($P \leq 0.001$), P ($P \leq 0.05$), K ($P \leq 0.01$) and ALP ($P \leq 0.05$) levels, meanwhile they observed a the speed of respiration has adverse effect on CO₂ level in blood when the respiration speed increase ,the level of CO₂ decrease . And others when raising the temperature lead to increase PH level in blood and increase free CA amount. Also, there is an increase in differential WBC to the people who exposure to heat stress may contributed to immunity reflex against change in environment condition that may lead to stimulate immunity cells to migrate to blood that will get some changes in blood may occur.

In other hand increased in RBC may lead to supply blood with nutrient and oxygen that increased in highest temperature. High temperature can cause dehydration, heat stroke. The mechanism of the human body that the body's temperature is monitored by the brain, the brain sends impulses to the skin, which has three ways to either increase or decrease heat loss from the body's surface: hairs of the skin trap less warm if they are lying flat, Tiny muscles in the skin can quickly lay them down flat to increase heat loss, if the body is too hot, glands under the skin secrete sweat onto the surface of the skin, to increase heat loss by

Hematological Effect of Heat on Bakery Workers

evaporation, sweat secretion stops when body temperature returns to normal, blood vessels supplying blood to the skin can swell or dilate called vasodilation, this causes more heat to be carried by the blood to the skin, where it can be lost to the air.

CONCLUSION

Heat stress has determinate impacts on blood parameters, especially lymphocytes, granulocytes, and RBCS. Bakers exposed to long period of heat should undergo periodic medical estimate and have good protection measures, including suitable ventilation and hydration strategies.

REFERENCES

- 1) Anitua E, Andia I, Ardanza B, Nurden P, Nurden AT. 2004 Autologous platelets as a source of proteins for healing and tissue regeneration. *Thromb Haemost.* 91:4–15.
- 2) Jump up [^] *The Franklin Institute Inc. "Blood – The Human Heart". Retrieved 19 March 2009.*
- 3) Gerard J. Tortora, Bryan Derrickson. (2012) "The Cardiovascular System: The Blood". *Principles of Anatomy & Physiology*, 13th. John Wiley & Sons, Inc. pp. 729–732. ISBN 978-0470-56510-0.
- 4) M. S. Goligorsky, 2001 "The concept of cellular "fight-or-flight" reaction to stress," *American Journal of Physiology*, vol. 280, no. 4, pp. F551–F561.
- 5) N. E. Odongo, O. Alzahal, M. I. Lindinger et al., 2006 "Effects of mild heat stress and grain challenge on acid-base balance and rumen tissue histology in lambs," *Journal of Animal Science*, vol. 84, no. 2, pp. 447–455.
- 6) Kold threed. (1982) *Ultrastructure of the animal cell.*
- 7) AL-Qysi, H.MA. (1984) *physical properties of mammalian Cell membranes and alteration after hyperthermia.* Ph. D. Thesis. University of Waterloo. Canada.
- 8) Ando, M. Asanuma, Sh. Ushuda, M. Sasaki, K. et al. (1997) Age related effects of heat stress on protective enzymes for peroxidase and micrlosomal monooxygenase in rat liver. *J. Enviro. Health. Prespectevies.* , 105(7), 726733.
- 9) Al-Gailani, BT. (1989) *Deformability of human Red blood cell Ghosts.* PH D thesis. University of Leeds. Canada.
- 10) Bhalakiya, N. et al. (2021). *Effect of heat stress on hematological parameters.*
- 11) 10. Awad, R. (2025). *Heat stress effects: Systematic review.*
- 12) Alberghina, D. et al. (2024). *Impact of Heat Stress on Hematological Balance.*
- 13) Chen, H. et al. (2024). *Chronic Heat Stress Induces Oxidative Stress and Immune Dysregulation.*
- 14) Iba, T. et al. (2025). *Heat stress-induced mitochondrial injury in immune cells.*
- 15) Harrison, M. et al. (2025). *Heat stress alters leukocyte profiles.*