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КАЗУЙ КАПАППІЧІ

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ISSN 1643-0218

10-Февраль национального Казахстана алкоголь-измениллік
The effect of ambient temperature on human blood cells

Introduction

The research aims to investigate the impact of ambient temperature on human blood cells, focusing on the role of various environmental factors. Temperature changes can influence the function and behavior of cells, affecting cellular processes and overall health.

Methods

The study involves controlled experiments where blood cells are exposed to different temperatures to observe their responses. Key parameters include temperature variation, duration of exposure, and cellular responses measured through various biological markers.

Results

Experiments revealed significant changes in cell morphology and function under varying temperature conditions. Higher temperatures were associated with increased metabolic activity, while lower temperatures led to reduced activity and altered cell structure.

Discussion

The findings highlight the importance of ambient temperature in maintaining cellular health and function. Understanding these effects is crucial for developing strategies to protect against temperature-related health issues.

Conclusion

The study underscores the need for further research to explore the complex interactions between ambient temperature and blood cell physiology. This knowledge can be applied in various fields, including medicine and environmental science.
The effect of ambient temperature on the human blood cells

Adaptation and extract the onslaught of external factors, the new environment is an important issue. The response to achieve environmental factors makes changes in the human body. Primarily affects greatly the immune system and the circulatory system. The regulation of body temperature in the heat is critical, because of the great potential for lethal hyperthermia. To study attended 10 local people and 10 people, who came from other regions of Kazakhstan. People create heat stress lasting 1 hour at ambient temperature +42 – 45 °C and 76 – 80% relative humidity once and daily for 14 days. In people of all groups was measured rectal temperature and measured changes in blood cells by method Shilling. Blood for research was taken from the vein. The number of blood cells was determined by the standard technique with using hematology analyzer. The study set that mechanisms of regulation of body temperature on multiple high temperatures correspond to the maximum and minimum periodic rises of the body temperature. Adaptive responses to high ambient temperatures most adaptable people aged 15-18 than in aged 55-60.

Key words: blood, hyperthermia, adaptation, acclimatization, stress, homeostasis.

THE TE/ HL

Святы орта температурасынын адам агаазының жана жасушадарының асерi

Святы ортаның колоши факторларына жауап реакциясы рәссә адам агаазына унеме өзгөртөр орын алып өтәрә. Ол ең алдындың агаазы нерв иммунитет жүргөй мен өз ирмек өзгөрүүсүн жасушаның асерге өтә. Святы ортаның жогорку температуралары жалгызда тышы температурасында башкара молдога сыйнып, себеби өз гипертермияга сәйең бөлүш мүмкүн. Святы ортаның жогорку температураларын адам агаазына өз жашуулыктын асерин аныктау мүмкүн. Зерттөүгө катышкан бүгү төп адаымдар ауа температурасы +42-43°С жана жылыдырык, 76-80% жалгызда үндөлөштүрүү күн аркылы температуралары, стресске үшүнүр. Барысында адамдарга, жүктөөдөрүңүздө өзгөрүүртүгө Шиллингдө айыми аяксыз. Зерттеу жүмүштөр ушул болунча ачык. Қан жасушарының сөзөнен сыйнып келетин биологиялар генетикалык анализатор пайдасында. Зерттеу жүмүштөр жөнөкөөсүн, святы ортаның жогорку температураларын асерилген жана жасушаның каламты мөлшөрөүү орнотулар озгөрүүрү азыктуу болмаса аяксыз. Жылыдырык манымчы, нөлкөөсүн, святы ортаның жогорку температураларын жасушаның физиологиялары, корреспонденти стрессерлер, ауа етепкий байкалады. Солдай-ак, бүгү өзгөрүүртүгө агаазының жылы, жылы жылычы, күрөшөлөктөр, сакалкары дегенде болмаса аяксыз.

Учун сөзөр: бейімделу, адаптация, гомеостаз, гипертермия, жүктөөдөрүңүздө, стресс.

Влияние температуры окружающей среды на клетки крови человека

Адаптация и выдерка натиска внешних факторов новой среды обитания является важной проблемой. Ответная реакция на неблагоприятные факторы внешней среды вносит изменения в организм человека. Она в первую очередь сильно влияет на иммунную систему организма и систему кровообращения. Для изучения влияния теплового стресса на клетки крови люди всех групп подвергались действию теплового стресса продолжительностью 1 час при температуре воздуха +42 – 45 °C и относительной влажности 76 – 80 % однократно и ежедневно в течение 14 дней. У людей всех групп определяли изменения в клетках крови методом Шиллинга. Кровь для исследований брали из вены. Для получения числа клеток крови использовали гематологический анализатор. В результате исследования установлено, что приспособительные реакции к высокой температуре окружающей среды наиболее выражены у людей в возрасте 15-18, чем у людей в возрасте 55-60 лет. У людей развивается лихорадка и экзомена.

Ключевые слова: температура, адаптация, клетки крови, стресс, гомеостаз, адаптация.
Complete heat acclimatization requires up to 14 days, but the systems of the body adapt to heat exposure at varying rates. The early adaptations (initial 1-5 days) involve an improved control of cardiovascular function, including expanded plasma volume, reduced heart rate, and autonomic nervous system habituation which redirects cardiac output to skin capillary beds and active muscle. Plasma volume expansion resulting from increased plasma proteins and increased sodium chloride retention, ranges from +3 to +27%, and is accompanied by a 15-25% decrease in heart rate. This reduction of cardiovascular strain reduces rating of perceived exertion, which is proportional to central cardiorespiratory stress, also decreases during the first five days of exercise-heat exposure. Plasma volume expansion is a temporary phenomenon, which decays during the 8th to 14th days of heat acclimatization (as do fluid-regulatory hormone responses, see below), and then is replaced by a longer-lasting reduction in skin blood flow that serves to increase central blood volume [2].

The regulation of body temperature in the heat is critical, because of the great potential for lethal hyperthermia. Thermoregulatory adaptations (i.e., increased sweat rate, earlier onset of sweat production), coupled with cardiovascular adjustments, result in a decreased central body temperature. This response is maximized after 5 to 8 days of heat acclimatization. However, the adaptations of eccrine sweat glands are different during humid and dry heat exposures. Heat acclimatization performed in a hot-humid condition stimulates a greater sweat rate than heat acclimatization in a hot-dry environment. Also, the absolute rate of sweating influences thermoregulation. If hourly sweat rate is small (<400-600 ml), a peripheral adaptation of whole body sweat rate may not occur.

Humans live their entire lives within a very small, fiercely protected range of internal body temperatures. The maximal tolerance limits for living cells range from about 0°C (ice crystal formation) to about 45°C (thermal coagulation of intracellular proteins); however, humans can tolerate internal temperatures below 35°C or above 41°C for only very brief periods of time. To maintain internal temperature within these limits, people have developed very effective and in some instances specialized physiological responses to acute thermal stress. These responses—designed to facilitate the conservation, production or elimination of body heat—involve the finely controlled coordination of several body systems [3].

By far, the largest source of heat imparted to the body results from metabolic heat production (M). Even at peak mechanical efficiency, 75 to 80% of the energy involved in muscular work is liberated as heat. At rest, a metabolic rate of 300 ml O₂ per minute creates a heat load of approximately 100 Watts. During steady-state work at an oxygen consumption of 1 l/min, approximately 350 W of heat are generated—less any energy associated with external work (W). Even at such a mild to moderate work intensity, body core temperature would rise approximately one degree centigrade every 15 min were it not for an efficient means of heat dissipation. In fact, very fit individuals can produce heat in excess of 1,200 W for 1 to 3 hours without heat injury (Gisolfi and Wenger 1984).

Heat can also be gained from the environment via radiation (R) and convection (C) if the globe temperature (a measure of radiant heat) and air (dry-bulb) temperature, respectively, exceed skin temperature. These avenues of heat gain are typically small relative to M, and actually become avenues of heat loss when the skin-to-air thermal gradient is reversed. The final avenue for heat loss—evaporation (E)—is also typically the most important, since the latent heat of vaporization of sweat is high—approximately 680 W·h/l of sweat evaporated. These relations are discussed elsewhere in this chapter.

In particular, heavy work (high energy expenditure which increases M-W), excessively high air temperatures (which increase R+C), high humidity (which limits E) and the wearing of thick or relatively impermeable clothing (which creates a barrier to effective evacuation of sweat) create such a scenario. Finally, if exercise is prolonged or hydration inadequate, E may be outstripped by the limited ability of the body to secrete sweat (1 to 2 l/h for short periods).

For purposes of describing physiological responses to heat and cold, the body is divided into two components—the core and the osphèl. Core temperature (T_c) represents internal or deep body temperature, and can be measured orally, rectally or, in laboratory settings, in the oesophagus or on the tympanic membrane (cardium). The temperature of the shell is represented by mean skin temperature (T_s). When confronted with challenges to thermal neutrality (heat or cold stresses), the body strives to control T_s through physiological adjustments, and T_c provides the major feedback to the brain to coordinate this control. While the local and mean skin temperature are important for providing sensory input, T_s varies greatly with ambient temperature, averaging about 33°C at thermoneutrality, reaching 36 to 37°C under conditions of heavy work.
rate was determined by the standard technique with using hematology analyzer.

Digital material of results of the study were treated by variational statistics with using Microsoft Excel computer program. The statistical accuracy of the survey results, \( p<0.05 \), \( **p<0.01 \), \( ***p<0.001 \), compared with Student’s t-distribution.

**Results and discussion**

On 7-fold influence of critical temperature the organism of group 1 peoples decrease in quantity of erythrocytes by 13.2% and hemoglobin 12.8% in comparison with control. To 10 – and 15-fold thermal impacts on an organism group 1 peoples led to decrease in maintenance of erythrocytes by 22.6% and 19.2%, and hemoglobin for 25.6% and 13.2%, respectively in comparison with control.

Group 1 peoples on 3- and 7-fold influence of a stressor have answered with decrease in maintenance of erythrocytes to 4.6,0.4,10^9/l (p<0.05) that is 24% lower than value in control. Content of hemoglobin after the 7th influence was 9,8±0.2 g/l (p<0.05) that below control for 13.3% and SSE was 2,3±0.4 mmg/h, above control for 35.3%. During the period with 10th on the 15th influences the maintenance of erythrocytes and hemoglobin was lower 11% and 4.5%, respectively, in comparison with control group. SSE in group 1 was 2.2±0.2 mmg/h, in control 1.8±0.2 mmg/h.

It is established that in response to influence of critical temperature there is a certain reaction of leukocytes. After 3-fold influence the quantity of leukocytes increases by 21.8%, and 7-fold decreases to 5.9±0.2,10^9/l, at norm 6.1±0.5,10^9/l. Reliable decrease in leukocytes to 4.5±0.0,10^9/l (p<0.01) is noted after 14-fold influence (32.8%) and 15-fold thermal impact on 38.7% in comparison with control. Research of maintenance of leukocytes during the post-stressful period has shown that for the 3rd day the quantity of leukocytes in blood of control group has reached values of control group and had no differences during all term of researches.

Important component of blood are leukocytes. All types of leukocytes participate in protective reactions of an organism, each look carries out it in the special way (production of interferon, a lizoxins, propradin, histamine and other biologically active agents, the main role of humoral immunity).

The organism of group 1 people reacted to single thermal influence increase of maintenance of leukocytes to 7.4±0.2,10^9/l (p<0.05) that is 32.1% higher, than in control group. The blood test after 8 hours has shown that the maintenance of leukocytes in group 1 has decreased to 5.4±0.2,10^9/l, and after 24 hours has reached values of control group – 5.6±0.5,10^9/l.

At group 1 people have established reliable increase in young neutrophils up to 1,1±0.1% (p<0.05) and the stab neutrophils to 31,3±2.9% (p<0.05). In group 1 decrease in small lymphocytes to 32.8±0.8%, average to 9,6±0.8% and big to 3.9±0.7%.

After 8 hours from single thermal influence contents young and the segmented neutrophils remained raised – 1.4±0.7% and 24.7±2.6%, respectively, and big lymphocytes were below control group and has made 3.9±0.8%, the maintenance of average lymphocytes has increased to 10.7±0.8%.

Restoration of percentage of neutrophils in blood of group 1 people came within 24 hours after influence. During this period the maintenance of young neutrophils has decreased to 0.5±0.2%, and the stab neutrophils to 19.6±1.3%. Decrease in percent of highly segmented neutrophils to 2.5±2.7% has been noted in both of group.

Single impact of critical temperature on an organism of group 2 people has led to decrease in maintenance of leukocytes to 5.3±0.2,10^9/l that is 20.9% lower than control group. In 8 hours after influence a stress factor observed increase of maintenance of leukocytes up for 14.9% of a reference level. In 24 hours the maintenance of leukocytes in skilled group corresponded to control.

Peoples of control group had an increase of maintenance of leukocytes in blood. So, for the 7th day of researches the quantity of leukocytes in blood has increased by 8.9%, on the 14th – for 19.6%. Authenticly high value 6.8±0.2,10^9/l, (p<0.05), in comparison with initial level, was for the 14th day after the last influence. Leukocytic reactions reflect a condition of an organism more precisely. Proceeding from it we have carried out studying the leukocytic reactions at group 1 peoples(Table 1).

14-fold influence of critical temperature, in comparison with 7-fold, has caused decrease in quantity of the segmented neutrophils to 20.7±1.6%, but exceeding value of control for 3.2% (17.5±1.7%). The quantity of highly segmented neutrophils in comparison has made 3.3±0.7%, in skilled group of 2.4±0.2%.
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Conclusions

1. We regard the changes of indicators of blood established in experiences as responses of an organism to thermal influence. At humans organism of all two skilled groups the quantity of erythrocytes and hemoglobin decreased at once after single thermal influence. In group of 15-18 years old people the maintenance of erythrocytes has gone down for 20.7%, and hemoglobin for 10.4%. In group of 55-60 years old people the maintenance of erythrocytes has decreased 25.5%.

2. In our work we have tracked recovery of the contents of erythrocytes after single influence of high temperature. So, the maintenance of erythrocytes and hemoglobin reached values of control group at 15-18 years old people within 24 hours after thermal influence, in group of 55-60 years old people these indicators came back to norm within 24 hours that is connected with more perfect mechanisms of system of thermal control.

3. The analysis of a leukogramma has shown dynamics of changes in the maintenance of various groups of leukocytes on a thermal stress. Single influence of high temperature caused reliable increase in percent young and the stab neutrophils in all age groups. The increased contents young and the stab neutrophils in group of 15-18 years old people remained till 24 o'clock after single influence. At 55-60 years old people in 8 hours after the 1st influence the maintenance of young neutrophils has gone down to values of control group, and the stab neutrophils in 24 hours. At 55-60 years old people in 24 hours after single influence contents young and the stab neutrophils authentically didn’t differ from values of control group.

4. At humans develops limfopeniya and an eosinopeniya, (development signs a stress reaction). At 15-18 years old people the level of monocytes respectively decreases by 34.7% and 58.4%, at 55-60 years old people the limfopeniya is characterized by relative increase of quantity of small lymphocytes, against decrease in average and big lymphocytes. The system of blood of 55-60 years old people for preservation of a homeostasis reacts increase of level of basophiles in blood.

References

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References
