ISSN: 2309-5288 (Print)
ISSN: 2309-6152 (Online)
CODEN: JCLMC4
Journal of Coastal Life Medicine

Glycemic Responses in the Baby Rabbits in the Age of One Month when Exposed to the Different Modifications of Hypoxia

Received: 24 October 2022, **Revised:** 21 November 2022, **Accepted:** 27 December 2022

Elnara Jabir Mehbaliyeva
Azerbaijan State Pedagogical University, Department of "Physiology" Baku, Azerbaijan
*Corresponding author: Azerbaijan State Pedagogical University, Department of "Physiology",
AZ 1000 Uzeyir Gadzhibekov Street 68 Baku, Azerbaijan Republic,

Key words
blood glucose, hypoxia, stress, starving, physical load.

Abstract. It is known, that factors such as stress, starvation, exercise and some pathological processes cause significant and recorded adaptive or pathological changes in glucose hemostasis. But there is very little information in the literature about the effect of oxygen deficiency on blood glucose levels. It should be noted, that the issues of studying posthypnotic effects at various systemic, organ, and tissue levels occupy a special place in the complex of tasks of complex biomedical research. We believe that the identified posthypnotic changes in blood glucose levels in rabbits at the age of one month are more likely to be associated with the mechanisms of central metabolic regulation.

Introduction

It is known that the overwhelming majority of animals, including the human body, first of all, extract the required energy from the metabolically high mobile energy substrate of glucose entering the cells from the plasma of the circulating capillary blood. The cellular resources of glucose are continuously exposed to catabolism through the anaerobic glycolysis and as a result of oxidation by the molecular oxygen entering the body from the environment (8, 9). In both cases, and especially during the oxidation, at the expense of glucose the cells produce the free energy in the form of high-energy molecular compound of adenosine triphosphoric acid in the required quantities. According to some authors, the content of glucose (or sugar) in the circulating blood and in the animal of human body cells, both from the physiological and biochemical points of view, is one the most significant indicators of homeo- and hemostasis which in timely manner provides the demand of cells and tissues for glucose (15). Blood sugar is also the main source for the synthesis and accumulation of glycogen polysaccharide in a number of tissues (liver, muscles, etc.) – the main internal reserve of the metabolically active glucose (8, 16). In some physiological states it becomes the substrate for re-synthesis of amino and fatty acids as well as the other compounds which actively participate in the energetic and plastic body metabolism (19).

The metabolism of glucose and glycogen, glucose homeostasis and regulation of the glucose level in blood is performed with the involvement of the different and complicated mechanisms of the enzyme, hormone and nervous nature. However, it became known that normally only 15-20% of the produced glucose passes through the circulation (cycle), and the share of glucose involved into the cycle is permanent and does not depend on the hormones or physical loads (14).

According to many investigators, the humoral, neurohormonal and central nervous mechanisms play the major role in the regulation of vegetative functions and visceral processes, including the level of glucose in blood. Due to this fact the changes of their dynamics in the normal physiological conditions are subordinated to the circadian biological rhythms. The normal hypo- and hyperglycemic peaks in the experimental animals are found even in the daily dynamics of the blood glucose. The hypothalamus, pineal gland, pituitary gland and vegetative nervous system as well as some peripheral endocrine and interceptor regulation links occupy the leading place in these mechanisms. It is demonstrated that the vegetative nervous system can have the regulative effect even on the processes of gluconeogenesis in the liver (1, 2, 4, 5, 9, 12).

The content of glucose in blood reacts to the impacts of many factors both in the external and internal environment of the human and animal body. There are many experimental and clinical facts proving that such factors as stress, starving, physical load and some pathologic processes cause the substantive and recordable adaptive or abnormal changes in the glucose hemostasis (1, 5, 9, 13, 16). But the literature contains very few information on the impact of the oxygen insufficiency (hypoxia or oxygen deficit) on the content of glucose in blood. It should be noted that the issues of studying the post-hypoxia effects at the different systemic, organ and tissue levels occupy the special place in the range of problems of the medical and biological complex trials (3,6).

Methods

In this work the experiments with hypoxia were performed on the baby male and female rabbits in the age of one month. Five animals were taken for each experiment; first, the normal content of sugar in blood was determined in the certain periods of time (at 10-11 AM, 1-2 PM and 4-5 PM) in order to find if this indicator changes rhythmically in the baby rabbits in this age.

The hypoxification of the experimental baby rabbits of both sexes was performed in two modifications: The breathing of animals for 30 minutes in the special small-volume chamber which was filled with the mixture of gaseous nitrogen (N_2) and oxygen (O_2) in the (moderate form of hypoxia). In the animals always hypoxified in the morning the blood sugar was determined on the 1 and 3 day at the same time – 1-2 and 4-5 PM when its normal values achieved the peaks of increase and decrease in the control baby rabbits. This allows for more objective judgment on the extent and nature of the impact of hypoxia on the normal dynamics of this indicator in the bodies of experimental animals.

The blood for analysis was taken from auricular vein in the amount of up to 2 ml from each animal in which the quantity of glucose was determined using the express method on the automatic glucometer (Bayer-Holding, USA-Canada). The concentration of glucose was expressed in mg % per 100 ml of blood. The obtained digital data were processed using the parametric method of variational and statistical biometry (7). The changes in the blood sugar concentration are recorded in the form of curves and diagrams.

The results of study demonstrated that in the baby rabbits in the age of one month the content of glucose of blood normally reaches quite high levels (76±3.0 to 98±6.0 mg% in males and 62±2.0 to 106±0.4 mg% in females), and it changes rhythmically in both sexes in the course of the day. It is characteristic that the blood glucose level in the male baby rabbits was lower (statistically credible, $p<0.01$) than in the female baby rabbits, and its change in them was expressed by curves on which the highest peak (hyperglycemia) was detected, as a rule, in the day time (at 1-2 PM) and the lowest (hypoglycemia) – in the evening (at 4-5 PM) (Fig. 1).

The analysis of data obtained when determining the content of sugar in the blood of baby rabbits in the age of one month normally demonstrated the existence of substantial individual homeostatic limits for the variation of this indicator both in the males and females, and such homeostatic and, probably, metabolic status of the blood sugar impacts on the daily rhythm of its changes having the certain frequency ranges already in the early postnatal period of the animal body development.

The experiments with both acute and moderate hypoxia demonstrated the limits for changes of the blood sugar concentrations in the baby rabbits depending on their sex, time of the day and duration of exposure to the hypoxic factor. The breathing of baby rabbits in the chamber with gas mixture of 95% N_2 and 5% O_2 for 30 minutes (acute form of hypoxia) had the quite expressed impact on the glucose homeostasis of blood (Fig. 2).

ISSN: 2309-5288 (Print)
ISSN: 2309-6152 (Online)
CODEN: JCLMC4
Journal of Coastal Life Medicine

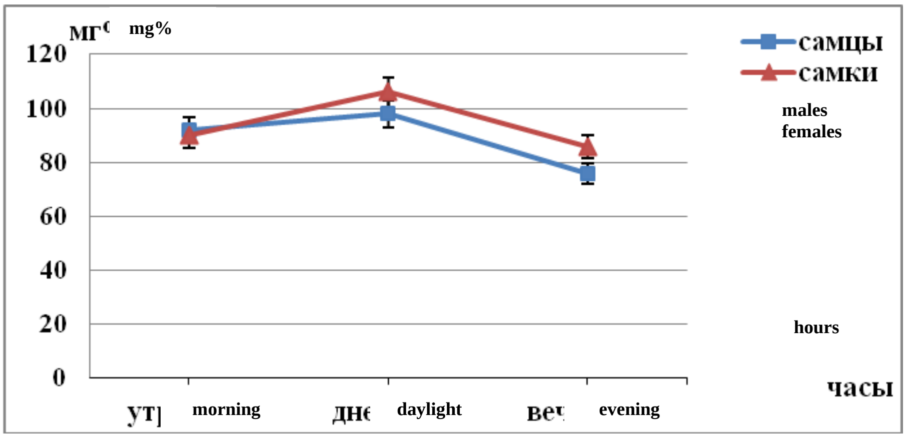

Fig. 1. Curves of the normal daily blood sugar dynamics in the male and female baby rabbits in the age of one month

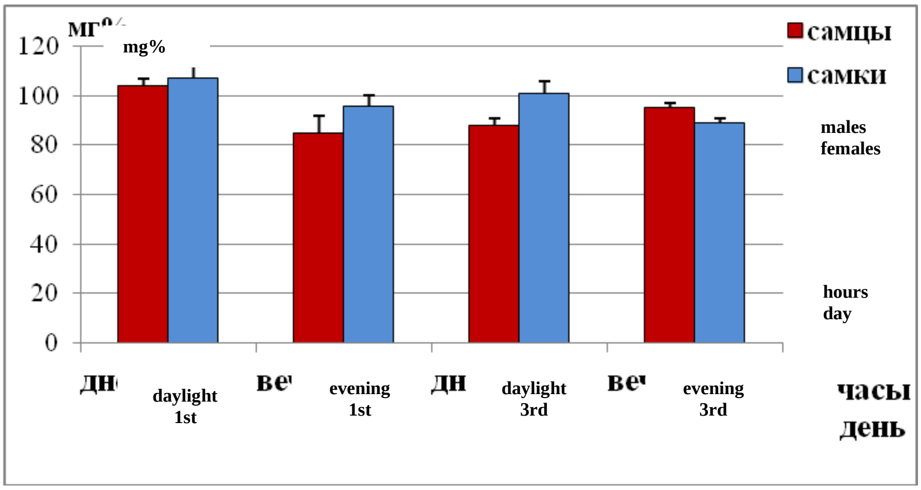

Fig. 2. Blood sugar content in the male and female baby rabbits in the age of one month at the acute hypoxia

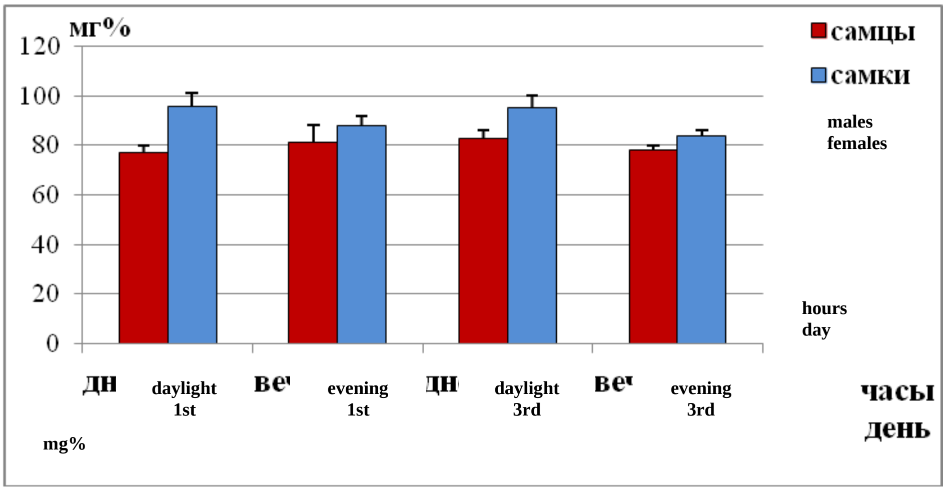

Fig. 3. Blood sugar content in the male and female baby rabbits in the age of one month at the moderate hypoxia

According to the data of this experiment the acute hypoxia in baby rabbits is characterized by the fact that on the first day of hypoxification the daily rhythm of the blood glucose content dynamics is not violated both for males and females. However, the level of glucose in blood for both of them on the 1st day of hypoxia was slightly increased both in the daylight and evening hours in relation to the control values. Thus, for example, if for the control male baby rabbits the content of glucose in blood in the daylight hours (1-2 PM) reached up to 98.0±6.0 and in the evening – up to 76.0±3.0 mg%, for the experimental animals of the same sex at these terms it was expressed as 104.0±3.0 and 85.0±7.0 mg%, respectively. But the differences in the levels of glucose were statistically credible only in the comparatively small values ($P<0.05$). On the 3rd day of acute hypoxia the concentration of glucose in blood differed slightly from the control values, but the daily rhythm specific for it was violated to some extent in the experimental animals of both sexes. Moreover, the level of glucose in blood for the male baby rabbits is higher in the daylight hours than for the male baby rabbits (101.0±5.0 and 88.0±3.0, respectively), and this difference is statistically credible ($P<0.01$). The reverse picture was observed in the evening.

The experiments with moderate hypoxia (staying in the gaseous medium 70% N_2 and 30% O_2) demonstrated that for the male baby rabbits the level on glucose in blood at all the terms of determination was lower than for the females, same as during the acute hypoxification; herewith, the rhythm of its dynamics was preserved more or less intensively only for the last ones.

Therefore, according to our experiments, it can be concluded that in the early postnatal ontogenesis both the acute and moderate oxygen deprivation can affect the glucose homeostasis regardless of the sex of the body, causing initially the hyperglycemic and further the normal or hypoglycemic responses. Such offsets in the glucose homeostasis do not change completely in the ontogenetic manner the rhythmical status of these responses which is formed early in the body.

The glucose homeostasis violation mechanisms and manifestations of the different glycemic responses at hypoxia can be different, but the most probable of them, to our opinion, include the decrease of glucose disposal in tissues at the deficit of oxygen in them. Further, probably, the mechanisms for adaptation of body to the deficit of oxygen are involved, ensuring by it the glucose status supporting in the more or less resistant physiological norms. Some authors emphasize that the hypoxia and especially its acute and serious forms initially activate the functions of vegetative centers (first of all, the hypothalamus and sympathetic-adrenal system), reproducing the rhythms of excitation in the physiological processes of visceral sphere, including the blood system and metabolic regulation of its glucose level (2, 10, 11, 15, 17, 18). We believe that the detected post-hypoxic offsets of the blood glucose level in the baby rabbits in the age of one month, probably, are associated, to a larger extent, with the specified central metabolic control mechanisms.

References

[1] Aliyeva F.A. The role of pineal gland in the neuroendocrine regulation of glycemic responses and circadian rhythm at physical load / Abstract of the All-Russian Neuroendocrinology Conference. Saint-Petersburg, 2003, p. 81-82.

[2] Baturin E.B., Popov A.V. Suprachiasmatic nucleus of hypothalamus as the regulator of circadian system in mammals // Successes of physiological sciences, 1988, vol. 19, No. 3, p. 67-87.

[3] Vataeva L.A., Otellin V.A., Kassil V.G. et al., Hypoxia in the early postnatal ontogenesis of rat: development of brain and behavior // Reports of the Russian Academy of Sciences, 1998, vol. 363, No. 3, p. 409-411.

[4] Gaibov T.D., Guseynov G.A., Aliyev A.G. The role of pineal gland in the regulation of vegetative functions / Materials of XVII congress of the All-Union Physiological Society named after I.P. Pavlov, 1987, vol. 2, p. 315-316.

[5] Karayev A.I., Loginov A.A. Interoceptive metabolic reflexes, Baku, AGU Publishing House, 1960, 340c.

[6] Kolchev A.I., Korovin A.B. Hypoxia of organs and systems / In the book: Hypoxia: adaptation, pathogenesis, clinic. M., Publishing House “Meditsina”, 2000, p. 189-214.

[7] Lakin G.F. Biometry. M.: Publishing House “Vysshaya Shkola”, 1980, p. 97-110.

[8] Lenindzher A.L. The basics of biochemistry. M., Publishing House “Mir”, 645p.

[9] Leibson L.G. Blood sugar. Regulation of the sugar content in blood for animals and humans. M.: Publishing House of the Academy of Sciences of USSR, M-L., 1962.

[10] Lunets E.F., Maslova G.T., Vasilyeva L.P., Polyukovich G.S. The influence of oxygen deprivation on some components of adrenergic and cholinergic systems of brain / In the book:

ISSN: 2309-5288 (Print)
ISSN: 2309-6152 (Online)
CODEN: JCLMC4
Journal of Coastal Life Medicine

The physiology and biochemistry of mediator processes, M., 1980, vol. 2, p. 408, 420, 606.
[11] Soroko S.I., Burykh E.M. Intrasystem and intersystem reconstructions of physiological parameters at the acute experimental hypoxia. // The human physiology, 2004, vol. 30, No. 2, p. 58-66.
[12] Tagiyev Sh.K. Phylogenetic and ontogenetic evolution of the interoceptive impact on the glycemic responses in vertebrate animals / Publishing House “Elm” of the Academy of Sciences of Azerbaijan, 1976, 180 p.
[13] Bunalda B., Nyakas C., Vosselman H., Luiten P. Effects of early postnatal anoxiya on adult learning and emotion in rats // Bchav. Brain Res., 1995, v. 67, p. 85-90.
[14] Burchfild David J., Abrams Robert M., Hutchioson Alastair A. Local cerebral glucose utilization in normocemic and hipercemic newbran lams // Dev. Brain Res., 1990, v.55, № 2, p. 249-253.
[15] Hers N.C. Mechanisms of blood glucose homeostasis // S. Inheret Metab. Diasse, 1990, v. 13, № 4, p. 393-410.
[16] Holness Mark J., Sugden Mary C. Glucose utilization in heart, diaphragm and skeletal muscle during the fed-to starved transition // Biochem J., 1990, v. 270, № 1, p. 145-249.
[17] Lin M.T., Shion L.R. Stimulation of 5-hidroxytriotamine nerve cells in dorsal and median rate nuclei elevates blood glucose in rat // Pfluger Arch., 1991, v. 417, № 5, p. 441.
[18] Pascol Wendy S., Smythe Georgic A., Starllen Leonard H. 2-Deoxy-D glucose-induced hyperglycemia: role for direct sympottaergic nervous system activation of liver glucose output // Brain Res., 1980, v. 505, № 1, p. 25-28.
[19] Wolfe R.R. Resent advances in the use of stable isotopes to stady glucose and fatty acids // New. Eral Global Hormone Nutr. Proc. 14th Int. Congr. Nutr., Seul, 1989, p. 836-838.