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ERYTHROCYTE MEMBRANE MICROVISCOSITY IN THE POPULATION OF SAMBURG VILLAGE

ABSTRACT

We studied the indices of relative microviscosity of the erythrocyte membranes in the two groups of inhabitants of the village Sumburg Yamalo-Nenets Autonomous District: indigenous (tundra and forest Nenets) and non – indigenous arrived from central Russia. We revealed a significant increase in microviscosity of lipid-lipid interactions in the native women aged 46-55 years ($p < 0.05$) compared with the non – indigenous ones. Increased membrane microviscosity may obstruct erythrocytes passage through microcapillary channel and lead to the development of the northern hypoxia.

Keywords: microviscosity of erythrocyte membranes, the indigenous people of the North, the Yamalo-Nenets Autonomous District.

INTRODUCTION

Climate conditions of the North regions impel the human organism to change its level of homeostasis. This affects the biochemical reactions, functioning of cell membranes, and rheological properties of blood. A change in relative microviscosity of membranes can serve as a marker of the metabolic state of cells. It is known from the literature that microviscosity of human membranes increases with age, which is related to an excess of cholesterol [1], accumulation of lipid peroxidation (LPO) products, and changes in the composition of phospholipid bilayer. Therewith, biological membranes become rigid and porous, the cell shape is distorted [1]. The state of erythrocyte membranes changes with alteration of the lipid composition of blood [5] and in type 1 and 2 pancreatic diabetes [9]. These changes show up as a decrease in fluidity (an increase in microviscosity) of membranes, which is attributed to the glycolysis of membrane proteins and to the action of insulin, which is involved in the activation of LPO and facilitates the growth of intracellular calcium level [2].

An increase in erythrocyte membrane microviscosity may be caused by a decreased content of the main antioxidant, tocopherol, and accumulation of lipid peroxidation products (diene conjugates) as well as lysoforms of phospholipids, which can disturb the diffusion of gases (CO_2 , O_2) through erythrocyte membranes [6,8]. Our earlier *in vitro* study demonstrated

and increase in erythrocyte membrane microviscosity with raising the concentration of hormones (cortisol, adrenalin, noradrenalin, androsterone, and testosterone) in the ghost suspension [1]. This is caused by a simultaneous interaction of carbonyl and hydroxo groups of the hormones with CO and NH_2 groups of membrane proteins and phospholipids [11].

The **objective** of the work was to investigate age-related changes in erythrocyte membrane microviscosity in non-indigenous and indigenous population of Sumburg village (YNAO).

MATERIALS AND METHODS

Material for the study was collected during the expeditions to the Yamalo-Nenets Autonomous Okrug in 2012-2014 by researchers from the Laboratory of population ethnogenetics at ICG SB RAS under the supervision of Ph.D. (biol.) Osipova L.P. Blood donations were obtained in compliance with international rules using the informed consent from volunteers who were practically healthy at the time of the study. The study involved indigenous persons and non-indigenous population of Sumburg village (latitude $67^\circ 0'$ north, longitude $78^\circ 25'$ east), Purovsky district, YNAO. Overall 136 inhabitants (60 men and 76 women) 25 – 65 years of age were examined. Among them were 98 representatives of indigenous nation (tundra and wood Nenetses) and 38 – non-indigenous Caucasian inhabitants of Sumburg village.

Blood was taken from the ulnar

vein after 10-12 hours of night fasting. Erythrocyte ghosts were obtained by haemolysis in a hypotonic phosphate buffer (pH 7.35) containing 2.75 mM KH_2PO_4 and 8.5 mM Na_2HPO_4 . Ghosts were sedimented by centrifugation at 5500 g, the supernatant was decanted. Ghosts were obtained and stored at 4°C . Microviscosity of erythrocyte membranes was measured on a RF-5301(PC)SCE (Shimadzu) spectrofluorimeter by a technique reported elsewhere [9,10].

Statistical treatment was carried out with Statistika 9.0 software using nonparametric statistical methods (Mann-Whitney rank sum test). Membrane microviscosity was measured at the Shared Equipment Center of Spectrometric measurements (FSBI Research Institute of Biochemistry (Novosibirsk).

RESULTS AND DISCUSSION

Relative microviscosity of erythrocyte membranes was measured in indigenous and non-indigenous men and women that were divided into four groups according to their age: 25-35, 36-45, 46-55 and 56-65 years. The study showed a significant increase in relative microviscosity of membranes by 26% ($P < 0.05$) in the region of lipid-lipid interaction in indigenous men of age 56-65 as compared to the group of indigenous men of age 25-35. No significant differences were found in other groups.

A significant age-related increase in relative microviscosity of membranes was revealed also in women (Table).

Table

Relative microviscosity (L) of membranes in the region of lipid-lipid and protein-lipid interaction for women

Relative microviscosity (L) of membranes	Lipid-lipid region	p	Protein-lipid region	p
1. Indigenous women of age 25-35 (n = 9)	0.43±0.04		0.44±0.03	
2. Indigenous women of age 36-45 (n = 17)	0.47±0.03	1-3, p < 0.01	0.47±0.03	1-3, p < 0.01
3. Indigenous women of age 46-55 (n = 16)	0.61±0.02	–	0.62±0.02	–
4. Indigenous women of age 56-65 (n = 14)	0.61±0.03	2-4, p < 0.01	0.62±0.02	2-4, p < 0.01
5. Non-indigenous women of age 25-35 (n = 8)	0.44±0.03		0.46±0.02	
6. Non-indigenous women of age 36-45 (n = 4)	0.48±0.06	–	0.50±0.08	–
7. Non-indigenous women of age 46-55 (n = 4)	0.50±0.05	3-7, p < 0.05	0.55±0.05	–
8. Non-indigenous women of age 56-65 (n = 4)	0.57±0.05	–	0.65±0.06	–

Indigenous women of age 56-65 showed a significant increase in relative microviscosity of membranes by 42% in the regions of lipid-lipid and protein-lipid interaction in comparison with the group of indigenous women of age 36-45. A significant increase in relative microviscosity in the region of lipid-lipid interaction was found in the group of indigenous women of age 46-55 as compared to non-indigenous women of the same age (Table). It seems interesting that erythrocyte membrane microviscosity starts to increase earlier in indigenous women (after 46 years of age) as compared to non-indigenous women (after 56).

Under the conditions of Far North, an elevated energy demand of the body requires an intense consumption of fat, so the human organism should move from carbohydrate diet to the lipid one [6]. A growing role of fats in energy metabolism of the body creates an increased oxygen demand of tissues that is needed for intense oxidation processes. An increased microviscosity (rigidity) of erythrocyte membranes hinders the passage of erythrocytes through the capillary bed [4, 5, 7]. Such conditions can induce the development of north tissue hypoxia. Several causes of such hypoxia are reported in the

literature.

The main cause is insufficient oxygen delivery to tissues due to deterioration of rheological properties of blood. Such deterioration can be produced, in particular, by This can result from an increase in the blood concentration of cholesterol, which raises the concentration of cholesterol in erythrocyte membranes. Cholesterol molecules penetrate into lipid bilayer, thus increasing the membrane microviscosity [1].

Conclusion

It was shown that erythrocyte membrane microviscosity in indigenous women of age 46-55 significantly exceeds this parameter in non-indigenous women. This may be related to adaptation of the female organism to conditions of the North.

REFERENCES

1. Panin L.E. Mokrushnikov P.V. Knyazev R.A. [et al.] Gormony stressa i koronarnyjsindromH(jeksperimental'nye issledovaniya) [Stress hormones and coronary syndrome X (experimental studies)]. Atherosclerosis, 2012, V. 8, № 2, P. 5-13.
2. Dobretsov G.E. Fluorescentnye zondy v issledovanii kletok, membran i lipoproteinov [Fluorescent probes

in the study of cells, membranes and lipoproteins]. Moscow: Nauka, 1989, 324 p.

3. Ishutina N.A. Perekisnoe okislenie lipidov i mikrovjazkost' membran jeritrocitov u zhenshhin s obostreniem herpes-virusnoj infekcii [Lipid peroxidation and erythrocyte membrane microviscosity in women with acute herpes virus infection] Dal'nevostochnyj medicinskij zhurnal [Far East Medical Journal], 2012, V. 34, № 1, P. 59-61.

4. Kunitsyn V.G. Mokrushnikov P.V. Panin L.E. Mehanizm mikrocirkuljacii jeritrocita v kapilljarnom rusle pri fiziologicheskom sdvige pH [Mechanism of erythrocyte microcirculation in capillary vessels at physiological changes of pH]. SNMZh, 2007, V. 5, № 127, P. 28 – 32.

5. Mokrushnikov P.V. Vlijanie pH na poverhnostnoe natjazhenie vzvesi jeritrocitov [The influence of pH on surface tension of suspended erythrocytes]. SNMZh, 2010, V.1, № 147, P. 38 – 46.

6. Panin L.E. Gomeostaz i problemy pripoljarnoj mediciny (metodologicheskie aspekty adaptacii) [Homeostasis and problems of circumpolar medicine (methodological aspects of adaptation)], SNMZh, 2010, V. 30, P. 6-11.

7. Panin L. E. Mokrushnikov P.V. Vzaimodejstvie sinteticheskikh proizvodnyh vitamina E na reologicheskie svojstva jeritrocitarnyh membran [Effects of synthetic vitamin E derivatives on the rheological properties of red blood cell membranes] Vestn. Nov. Gosud. Ped. Univ., 2013, V. 5, № 15, P. 101-110.

8. K. Kon, N. Maeda, M. Sekija [et al.] A method for studying oxygen diffusion barrier in erythrocytes: Effects of haemoglobin content and membrane cholesterol. J. Physiol. (Gr. Brit.), 1980, V. 309, P. 569-590.

9. Panin L.E. Mokrushnikov P.V. Kunitsyn V.G. [et al.] The interaction mechanism of cortisol and catecholamines with structural components of erythrocyte membranes/ // Journal of Physical Chemistry B. – 2010. – V. 114. – P. 9462-9473.

10. Panin L.E. Mokrushnikov P.V. Kunitsyn V.G. [et al.] Interaction mechanism of anabolic steroid hormones with structural components of erythrocyte membranes. Journal of Physical Chemistry B, 2011, V. 115, P. 14969-14979.

11. Tsuda K. Insulin and membrane microviscosity of erythrocytes as risk factors for stroke. Stroke, 2003, V. 54, № 3, P. 154-159.

12. Waczulikova I. Sikurova L.

Carsky J. [et al.] Decreased fluidity of isolated erythrocyte membranes in type 1 and type 2 diabetes. The effect of resorcyldene aminoguanidine. Gen. Physiol. Biophys, 2000, V. 19, № 4, P. 381-392.

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FORMATION OF THE PATHOLOGY IN CHILDREN AND ADULT POPULATION OF THE NORTH

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GENDER EDUCATION IN THE PREVENTION OF SUICIDAL BEHAVIOR AMONG THE PEOPLES OF THE ARCTIC ZONE

ABSTRACT

Russia occupies one of the first places in the world by the level of children's and adolescents suicides. In Russia itself, in the number of suicides the northern regions are in the leading position, where mainly small in number people live.

The problem of suicide among indigenous people is typical not only for Russia but also for other countries in the Arctic zone, including highly-developed countries, such as Canada and the United States. Suicide worldwide is predominantly «male» phenomenon. An important reason for suicidal behavior is a weakening of the institution of the family - «paternity crisis.» The lowest suicide rate is observed in the regions of North and South Caucasus countries, due, apparently, to the development of folk pedagogy of the Caucasus, where the fathers mainly bring up boys.

Thus, an important task in the prevention of youth suicide in the Russian Federation is a gender education, which implies the return of interest in the origins of folk pedagogy and strengthening the institution of paternity.

Keywords: suicides, children's and teenage suicides, the high level of suicide among indigenous youth in the Arctic, «paternity crisis,» the father's absence, incomplete family, folk pedagogy of the Caucasus, the prevention of suicidal behavior, gender training.

Suicidal behavior is currently the global socio-psychological problem. Every year more than 800 thousand people commit suicide. Therefore, the World Health Organization (WHO) considers suicide prevention a public health care priority. In 2014 the first WHO report "Preventing suicide: a global imperative" aimed at understanding by the public health care suicide significance was published. In the WHO actions Plan on mental health for 2013-2020 States - WHO members committed themselves to achieving the global target of reducing the suicide rate in countries on 10% by 2020 [14].

Particularly alarming in recent years is the increase of suicides among teenagers. According to WHO, the number of suicides among persons aged 15-24 years has increased in 2 times. In 2012 suicides ranked second as the cause of death of adolescents and adults.

By the level of children's and teenage suicides, Russia ranks one of the first places in the world. In Russia itself, in the number of suicides the northern regions are in the leading position, where mainly indigenous people live.

In the Republic Sakha (Yakutia) the rate of suicide among younger adolescents aged 10-14 years is 13,4 cases of suicide per 100 thousand, while among youth 15 to 19 years reaches to 74,2 per 100 thousand (for comparison: in Moscow region the level of suicide in this age group is 4,4 per 100 thousand) [14]. Among the indigenous population of Yakutia, the rate of suicide is in 4 times higher than that recorded among the non-indigenous population. This indicates the decrease in the level of resilience of the titular nations and is a consequence of the negative social processes occurring in the Arctic regions.

As the world practice shows, the

problem of suicide among indigenous peoples of the North are characteristic not only for Russia but for other countries of the Arctic zone, including highly developed, such as Canada and the USA. In the US the rate of suicide among the indigenous population of Alaska (Inuits, Aleuts, Tabaski, Haida, Tlingit) in 3.3 times exceeds the average for the country [9]. The highest rate of suicide is among aboriginal youth aged 20 to 29 years [10].

Due to "Strategy for the circumpolar Inuit health in 2010 – 2014" data in Canada the frequency of suicide among the Inuits is in 6-11 times higher than the average figure for the rest of the population [12]. Moreover, the frequency of suicides in the regions inhabited by the Inuits, over the past 15 years increases. Of particular concern is the fact that 51% of the suicide rate in Inuit regions of Canada fall to the share of men younger