

Eastern region. *Modern issues of pediatrics. Collection of scientific papers of the III Congress of Pediatricians of the Far Eastern Federal District, the II Congress of Pediatric Doctors of the Republic of Sakha (Yakutia)*. North-Eastern Federal University named after M. K. Ammosov, 2014; 459-465.

9. D Wang, X Cheng, S Yu et al]. Data mining: Seasonal and temperature fluctuations in

thyroid-stimulating hormone. *Clin Biochem*. 2018. Sep. 60:59-63. doi: 10.1016/j.clinbiochem.2018.08.008.

10. Cepon TJ, Snodgrass JJ, Leonard WR et al. Circumpolar adaptation, social change, and the development of autoimmune thyroid disorders among the Yakut (Sakha) of Siberia. *Am J Hum Biol*. 2011 Sep-Oct.;23(5):703-9. doi: 10.1002/ajhb.21200.

11. Leonard WR, Levy SB, Tarskaia LA et al. Seasonal variation in basal metabolic rates among the Yakut (Sakha) of Northeastern Siberia. *American Journal of Human Biology*. 2014; 26 (4): 437-445.

12. D. Santi, G. Spaggiari, G. Brigante et al. Semi-annual seasonal pattern of serum thyrotropin in adults. *Scientific report*. 2019.-9:10786 | <https://doi.org/10.1038/s41598-019-47349-4>

I.V. Averyanova, S.I. Vdovenko

MORPHOLOGICAL AND FUNCTIONAL FEATURES OF THE MICROCIRCULATION STATE IN CAPILLARY BED AND THERMAL IMAGING OF THE BODY OF YOUNG MALE NORTHERNERS RESIDING DIFFERENT CLIMATIC AND GEOGRAPHICAL ZONES OF MAGADAN REGION

DOI 10.25789/YMJ.2021.74.24

The research involved 364 young men aged 17-21, permanently residing in the coastal (the city of Magadan, n = 217) and continental (the settlement of Susuman, n = 47) climatic zones of Magadan region. Morphofunctional parameters of the microcirculatory bed vessels, as well as thermographic characteristics of different parts of the body were studied. It was found that the residents of Susuman were characterized by smaller arterial diameter and bigger diameters of the venous and transitional sections of the capillaries as compared with those from Magadan. At the same time, significantly higher average temperatures were observed in Magadan subjects through all the analyzed areas of the thermographic picture than it could be seen with examinees from Susuman.

Keywords: young men, North-East, microcirculation, thermography.

Capillaroscopy is a method of non-invasive investigation of the microcirculatory blood flow [1]. It is created to diagnose functioning of human cardiovascular system in its peripheral parts, the skin and mucous membranes. Capillaroscopy provides the most useful way to promptly visualize the skin capillary blood circulation, and assess density and blood flow rate in capillaries, which gives reliable information about the structural and functional parameters of the capillaries in real time and under real physiological conditions [16]. The most important link in the bloodstream is the capillary system, which provides organs and tissues with

all vital substances. Large vessels deliver these substances. They come into tissues through capillaries with simultaneous extraction of metabolic products from the tissues and transferring them to the bloodstream [1]. Microcirculation blood flow maintains health of tissues and organs by delivering oxygen and nutrients [17]. In addition, it regulates blood pressure and tissue perfusion, as well as the body thermal state [18]. Microcirculatory vessels also support functioning and homeostasis in cells. It should be noted that average values for some microcirculation parameters, in particular those characterizing adaptation to the North extremes, remain unclear, which suggests the need for more detailed study of the microcirculatory bed.

Another interesting and easy-to-use method for assessing peripheral blood circulation is thermography [6]. It helps to study skin temperatures, which describe intensity of metabolic processes, since any changes in metabolism or blood circulation affect skin temperatures, and therefore can be seen in the thermogram [2]. Maintaining skin temperature and, consequently, heat balance is represented there as heat production equal to heat loss. Based on this, infrared imaging is of great importance when studying physio-

logical adaptation of the body. This method has proven to be useful for thermal imaging of the body (skin) surface, as well as for monitoring of the body thermoregulation response under different conditions [18].

The body microcirculation system and thermal imaging map formation under the chronic influence of the cold factor is undoubtedly a problem for the modern science that studies adaptation processes. In this regard, visualization and objective assessment of capillary blood flow with both video capillaroscopy and thermography may be useful for the North residents in prognostic and diagnostic terms.

Based on the above, the objects of this work was studying functional state of microvessels and thermal images of the body in the North inhabitants under different environmental extremes of coastal or continental climatic zones in order to identify and justify the use of these assessment methods in providing mechanisms for adaptive changes.

Materials and methods. A random sample was made up of 364 males aged 17-21 permanently residing in coastal (Magadan, n=217) and continental (Susuman, n=47) climatic zones of Magadan region. The structure of capillaries and microcirculation was studied in the epon-

AVERYANOVA Inessa Vladislavovna - Leading Researcher, Laboratory for Physiology of Extreme States, Scientific Research Center "Arktika", Far Eastern Branch of the Russian Academy of Sciences (SRC "Arktika" FEB RAS), Ph. D. (Biology), <http://orcid.org/0000-0002-4511-6782>, Inessa1382@mail.ru, tel.: +7 (924) 691-11-46; **VDOVENKO Sergei Igorevich** - Senior Researcher, Laboratory for Physiology of Extreme States, Scientific Research Center "Arktika", Far Eastern Branch of the Russian Academy of Sciences (SRC "Arktika" FEB RAS), <http://orcid.org/0000-0003-4761-5144>, Vdovenko.sergei@yandex.ru, tel. +7 (924) 856-55-50.

ychium of the nail bed since this area is easily accessible for research, and the main axis of the capillaries there is parallel to the skin surface while in other areas it is visualized as perpendicular [14]. The study was conducted using a drop of immersion oil to maximize the transparency of the keratin layer on the fourth and fifth fingers of the left hand due to the high light transmission of the skin in these areas [19]. A video capillaroscope of Capillaroscan-1 (New Energy Technologies, Skolkovo) equipped with an optical probe was used within the study course. A 15 minute rest session preceded the recordings which were made at a comfortable ambient temperature of 22-25°C, before afternoon, with the hands at the heart level position [19]. None of the participants had frostbites, hand injuries or vascular pathologies that could affect their microcirculation. In addition, the criterion for inclusion in the research was medical examination as an admission to PE classes within the framework of the educational program.

Microcirculation morphometric characteristics were registered, and vascular density was evaluated in the mode of constructing a panoramic static image of the first-line capillary net with an optical 200-fold magnification. It was necessary that characteristic (contrasting) capillaries could be seen throughout the field of vision. A more detailed analysis was performed using a 10-second video recording with a 400 optical magnification of a specific skin area followed by automatic calculation of the observed capillaries. That made it possible to assess all visually observed processes and anatomical structures, and obtain an average value of morphometric indicators and the speed of red blood cell movement in the specifically studied capillaries [20].

The paper analyzes the following morphofunctional parameters of microcirculatory vessels: the diameter of the arterial, venous, and transitional sections of the capillary (mcm), which refers to the area of the vessel filled with visible red blood cells (the vessel walls are hardly distinguishable by light microscopy); capillary length (mcm); capillary net density (arb. units) indicating the number of observed capillary loops of the first echelon; the amount of the perivascular zone (mcm) namely its linear size from the most remote point of this zone to the nearest point of the transition section of the capillary; the speed in the arterial, venous and transitional sections (mcm/s), which suggests the speed of the red blood cell movement in the capillary; and the deformation coefficient (arb. units), which

shows the number of strongly wound and damaged capillaries [12].

Thermography was performed in a sitting position, using a thermal imaging camera (FLIR SC620 Thermal Imager, FLIR Systems, Sweden), which provides long-wave (7.5–13 mcm) imaging with a thermal sensitivity of 0.1 °C. The spatial resolution was 640 x 480 pixels. The study was conducted in accordance with the standards set by the European Thermographic Association [13]. Quantitative analysis of thermal images was performed for 7 front and back zones of the body, in the sitting position (Fig. 1): C_1 – average temperature of the left subclavian region (°C), C_2 – average temperature of the right subclavian region (°C), C_3 – average temperature of the forehead (°C), C_4 – average temperature of the chest (°C), C_5 – average temperature of the abdominal surface (°C), C_6 – average temperature of the upper back (°C), C_7 – average temperature in the area of the shoulder blades (°C). For each selected area, the average surface temperature was obtained, which was more representative of this area than the minimum or maximum values. The advantage of infrared systems in comparison with other methods of temperature measurement is the possibility of simultaneous analyzing a large number of image elements (pixels) in a short period of time followed by real time image processing [15].

Prior to the examination, all participants acclimated for more than 10 minutes, which is the optimal time to get used to the ambient temperature [8]. It was necessary that the subjects reported no chronic diseases in the acute stage or complaints about the health state. The study was carried out in accordance with the principles of the Helsinki Declaration. The study Protocol was approved By the Commission on Bioethics of the Federal State Institution of IBPN, FEB RAS (Protocol No. 1 dated March 25, 2019). Prior to the study, all volunteers gave their written informed consent. The obtained material was processed using the Statistica 7.0 application package. The average values of indicators (M) and errors of averages (m) were calculated. The statistical significance of the differences was ascertained using the t-test by Student at normal distribution, which was determined using the Kolmogorov-Smirnov test. The significance level criterion (p) was assumed to be ≤ 0.05 .

Research results. Table 1 shows the main morphological and functional indicators of capillary microcirculation in young men residing in different climatic zones of Magadan region. Examples of

capillaroscopic patterns of young male residents of the coastal and continental zones are presented in Figure 1. The data from Table 1 suggest significantly smaller diameter of arterial section typical for young males of the continental area with bigger diameters in venous and transition sections, and longer capillaries. No difference in density of the capillary net as compared to the subjects of the coastal zone was found though. The velocity rate characteristics in the arterial, venous, or transitional sections of the capillary bed did not differ through the examined groups either. A significant growth was observed in size of perivascular area and coefficient of deformation in the group of young men from Susuman. A higher number of slugs in the group of coastal residence subjects could be seen.

Table 2 shows thermal imaging patterns observed with young male northerners residing in different climatic zones of Magadan region. Examples of thermograms recorded in subjects from coastal and continental zones can be seen in Figure 2. The data show significantly higher average temperatures demonstrated by coastal examinees through all analyzed areas of the heat picture. We analyzed average values of the thermal imaging patterns through the two groups. The abdomen (C_5) area proved to have the lowest temperature with significantly higher average temperatures observed in the chest (C_4), forehead (C_3), upper back (C_6), and subclavian areas (C_1 , C_2). That is associated with the temperature of internal organs that emit heat as a result of their normal metabolic processes, as well as with a low thickness of subcutaneous fat [22].

Discussion of results. It is known that the capillary diameter is the structural parameter that determines the volume of blood flow passing through the entire length of microcirculatory bed [3]. In this case, the capillary diameter refers to the area of the vessel filled with visible red blood cells, while the capillary walls are hardly distinguishable under light microscopy. [3]. Young men of the continental zone of residence were characterized by significantly lower values of the arterial capillary diameter as compared to the subjects of the coastal area, with this indicator located at the lower limit of the standard range (from 7 to 17 microns; on average 11.91 ± 1.87 microns) [11], which could be better seen in the group of Susuman examinees.

The venous capillary diameter indicator normally ranges from 11 to 20.6 microns (on average 15 ± 2.42 mcm) [11]. In our research, subjects from Susuman

were significantly higher in this parameter with the average value reaching the upper limit of the standard, while the group of Magadan proved to be close to the lower limit. The loop diameter of the capillary tip (the transitional section of the capillary) was bigger in subjects of the continental area of residence (normally it varies from 8 to 21 mcm; on average, 17.17 ± 2.12 mcm) [11]. Examinees from the coastal territory demonstrated this indicator within the presented range, and those from Susuman significantly exceeded it.

When we were comparing the results obtained in our study with those cited in foreign references, (from 92 to 295 mcm; on average 240 ± 38.3 mcm) for the capillary length [20], we found that the examined males from both coastal and continental areas were higher in their values vs. the standards with the longest capillary length observed in young men living in more extreme climatic conditions (continental zone). It is known that longer capillaries may be associated with the arterial hypertension [21], which is fully consistent with the earlier results where higher indicators of both systolic (133 ± 1.6 mmHg) and diastolic (75 ± 1.2 mmHg) blood pressure were observed in young men in Susuman while the group from Magadan demonstrated the following values: 125 ± 0.9 mm Hg and 73 ± 0.7 mm Hg, respectively [5].

The next indicator is the value of the perivascular zone. This indicator is a relatively new parameter used to study microcirculation and reflect the degree of the interstitial hydration, which makes it possible to assess the effectiveness of metabolism in the aspect of its filtration-reabsorption mechanisms [12]. This indicator can be also used to estimate the number of functioning (i.e. open) capillaries at the moment of the study. Of note that, in a normal state, not all micro vessels are open at the same time. In general, the state of the perivascular zone characterizes the barrier function of micro vessels, i.e. the permeability of the vessel wall, and its size proportionally depends on the degree of edema. Normally perivascular zone in healthy individual's nail area is 93.6 ± 9.0 mcm [4], which fully corresponds to indicators observed with subjects from the city of Magadan, and is much lower than shown by the examinees from Susuman who were on average 29% higher in the perivascular zone than the standard rate. We found no intergroup differences regarding the density of the capillary net. With this factor, the rise of the perivascular zone typical for the residents of the continental zone

Table 1

Microhemocirculation indicators in young men of coastal (Magadan) and continental (Susuman) climatic

Indicators	Indicators		Significance Level for Differences
	Continental Climatic Zone (Susuman)	Coastal Climatic Zone (Magadan)	
Diameter of Arterial Section. mcm	7.8 ± 0.2	8.5 ± 0.1	$p=0.011$
Diameter of Venous Section. mcm	18.3 ± 0.3	12.1 ± 0.2	$p=0.008$
Diameter of Transition Section. mcm	28.7 ± 0.6	16.8 ± 0.2	$p=0.004$
Capillary Length. mcm	368.1 ± 8.8	317.35 ± 6.1	$p=0.005$
Amount of Perivascular Zone. mcm	120.4 ± 2.5	91.28 ± 1.5	$p=0.004$
Density of Capillary Net. arb. units	0.039 ± 0.001	0.040 ± 0.001	-
Velocity in Arterial Section. mcm/s	209.0 ± 10.2	214.08 ± 8.4	-
Velocity in Venous Section. mcm/s	153.2 ± 5.2	154.39 ± 6.2	-
Velocity in Transitional Section. mcm/s	186.2 ± 12.3	183.82 ± 7.4	-
Slugs. n p s	2.43 ± 0.3	3.27 ± 0.1	$p=0.009$
Coefficient of Deformation. arb. units	0.37 ± 0.01	0.32 ± 0.01	$p=0.008$



Fig. 1. Examples of microcirculatory bed images in young male residents of the continental (A) and coastal (B) climatic zones of Magadan region

Table 2

Temperature indicators of different zones of the body in male northerners inhabiting coastal (Magadan) and continental (Susuman) climatic zones of Magadan region

Indicators	Examined Cohorts		Significance Level for Differences
	Continental Climatic Zone (Susuman)	Coastal Climatic Zone (Magadan)	
C_1	35.20 ± 0.07	35.57 ± 0.11	$p=0.016$
C_2	35.37 ± 0.08	35.68 ± 0.12	$p=0.038$
C_3	33.95 ± 0.08	35.14 ± 0.13	$p=0.012$
C_4	33.95 ± 0.09	34.62 ± 0.14	$p=0.013$
C_5	33.42 ± 0.15	33.88 ± 0.16	$p=0.005$
C_6	34.03 ± 0.11	35.39 ± 0.11	$p=0.011$
C_7	33.58 ± 0.11	35.03 ± 0.12	$p=0.008$

Note. See the symbols C1-C7 in the text.

testifies to the growth of the interstitial hydration, apparently, due to the chronic and more pronounced impact of the cold factor. In our opinion, that may be caused by a bigger diameter of the venous section, a larger size of the transition section, and 53% lengthening of the capillary.

After V. I. Kozlov, the velocity rate of erythrocytes in capillaries varies with-

in the range of 400-800 mcm/s, and on average is 617 ± 0.72 mcm/s in healthy men at rest. That is much higher than we could observe in our studies [4]. It is necessary to specify that such changes in structural and functional characteristics of the capillary bed could be seen on the background of significantly high values of the coefficient of deformation

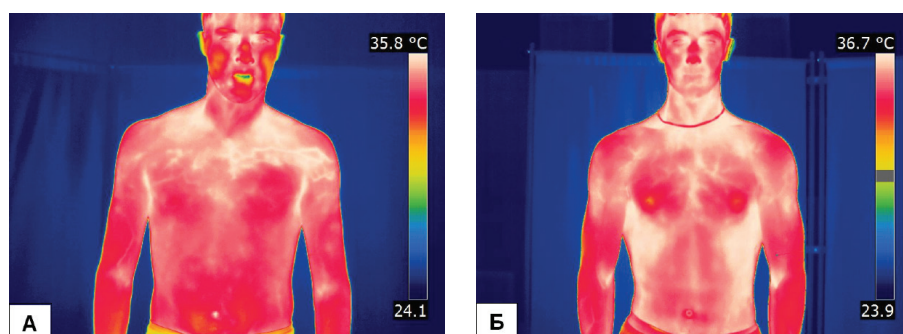


Fig. 2. Examples of thermal images in young male residents of the continental (A) and coastal (B) climatic zones of Magadan region

in male residents of the continental zone.

Changes in skin surface temperature occur primarily due to the changes in peripheral blood flow. The blood acts as a conductor of heat exchange between the internal and external environment. It is also the influence of the tonic state of surface vessels [7]. On the whole, significantly lower values of the temperature pattern were typical for the young men of the continental zone. The lowest temperatures were found in the abdominal area for both groups since this is a poorly vascularized area with adipose tissue [9]. The highest temperatures in examinees of the two groups were recorded in the chest, forehead, upper back, and subclavian zones, which is associated with the temperature of internal organs that emit heat as a result of their normal metabolic processes, as well as with quite thin subcutaneous fatty layer [10].

Conclusion. It should be noted that young male northerners were similar in the microcirculation morphological characteristics: they demonstrated constriction in arterial diameter, lengthening in capillaries, and reduced blood flow rate through all parts of the capillary bed. Along with the above capillary profiles, subjects of the continental zone had such changes in the functionality of the capillary blood flow as more pronounced growth of the perivascular zone, which indicates a higher degree of interstitial hydration due to chronic and more extreme impact of the cold factor, and also due to the bigger diameter of the venous section, significantly larger transition section, and 53% lengthening of the capillary together with higher values of the deformation coefficient. Such changes in the capillary bed are considered to be early signs of microcirculation disorders, which usually begin with a weaker blood refill in the microcirculatory bed and lead to outflow violation accompanied by venous stagnation and further bad disorders of capillary blood flow [3]. In general, the analysis of temperature patterns has re-

vealed significantly lower values through all the studied body areas with representatives of the continental zone of residence. The observed differences could be seen in compensatory and adaptive rearrangements of the microcirculatory bed, and the body thermal image of the young men residing in different natural and climatic territories. We have found the relationship between changes in the architectonics and the capillary bed functionality, as well as between the body temperature picture and the degree of severity of climatic extremes in different areas of residence. Our research has shown the importance of ascertaining the structural and functional parameters of microcirculation and temperature pattern to understand how the environmental extremes affect the body cardiovascular system. In addition, we have revealed that morphofunctional changes in microcirculation and thermal imaging can serve as integral and informative markers, as well as determining criteria of the degree of human adaptation to the North conditions and its severe impact.

Литература

1. Аракчеев А.Г., Гурфинкель Ю.И., Певгов В.Г. Компьютерный капилляроскоп для неинвазивных исследований параметров циркулирующей крови. *Московский хирургический журнал (Московский хирургический журнал)*. 2010; 5:27-30. [Arakcheev AG, Gurfinkel JI, Pevgov VG. Computer capillaroscope for non-invasive studies of circulating blood parameters. *Moscow Surgeon Journal*. 2010; 5:27-30. (In Russ.)] <https://www.elibrary.ru/item.asp?id=16402912>
2. Иванецкий Г.Р., Хижняк Е.П., Деев А.А. Биофизические основы медицинского тепловидения. *Биофизика*. 2012; 57(1):130-139. [Ivanickiy GR, Hizhnyak EP, Deev AA. Biophysical foundations of medical thermal imaging. *Biophysics*. 2012; 57(1):130-139. (In Russ.)] <https://www.elibrary.ru/item.asp?id=17681763>
3. Козлов В.И. Гистофизиология системы микроциркуляции. *Регионарное кровообращение и микроциркуляция*. 2003; 2(3):79-85. [Kozlov VI. Histophysiology of the microcirculation system. *Regionarnoe krovoobrashchenie i mikrocirkulyaciya (Regional Blood Circulation and Microcirculation)*. 2003; 2(3):79-85. (In Russ.)]

<https://www.elibrary.ru/item.asp?id=13074553>

4. Козлов В.И. Система микроциркуляции крови: клинко-морфологические аспекты. *Регионарное кровообращение и микроциркуляция*. 2006; 5(1):84-101. [Kozlov VI. The system of blood microcirculation: clinical and morphological aspects. *Regionarnoe krovoobrashchenie i mikrocirkulyaciya (Regional Blood Circulation and Microcirculation)*. 2006; 5(1):84-101. (In Russ.)] <https://www.elibrary.ru/item.asp?id=11715571>

5. Максимов А.Л., Суханова И.В., Вдовенко С.И. Функциональные особенности организма юношей и девушек, жителей различных климатогеографических зон магаданской области. *Российский физиологический журнал им. И.М. Сеченова*. 2012; 98(1):48-56. [Maksimov AL, Suhanova IV, Vdovenko SI. Functional profiles typical of the male and female residents in different climatic-geographical areas of Magadan region. (*Rossiyskiy fiziologicheskij zhurnal im. I.M. Sechenova*) *Russian Journal of Physiology*. 2012; 98(1):48-56. (In Russ.)] <https://elibrary.ru/item.asp?id=17697768>

6. Яровенко Г.В., Новожилов А.В. Термографическое обследование пациентов с патологией артерий верхних конечностей. *Регионарное кровообращение и микроциркуляция*. 2018; 17(4):46-50. [Jarovenko GV, Novozhilov AV. Thermographic examination of patients with pathology of upper limb arteries. *Regional Blood Circulation and Microcirculation*. 2018; 17(4):46-50. (In Russ.)] <https://www.elibrary.ru/item.asp?id=36995305>

7. Arens E, Zhang H. The skin's role in human thermoregulation and comfort. *Thermal and Moisture Transport in Fibrous Materials* / under N. Pan, P. Gibson ed. Woodhead Publishing. 2006:560-602. <https://doi.org/10.1533/9781845692261.3.560>

8. Bouzas Marins C, Moreira GD, Piñonosa Cano S, Sillero Quintana M, Dias Soares D, Andrade Fernandes A de, Sousa da Silva F, Magno Amaral Costa C, Roberto dos Santos Amorim P. Time required to stabilize thermographic images at rest. *Infrared Phys. & Technol.* 2014; 65:30-35. <https://doi.org/10.1016/j.infrared.2014.02.008>

9. Chesterton LS, Foster NF, Ross L. Skin temperature response to cryotherapy. *Arch. Phys. Med. Rehabil.* 2002; 83(4):543-549. <https://doi.org/10.1053/apmr.2002.30926>

10. Dębiec-Bąk A, Skrzek A. The comparison of surface body temperature distribution between men and women by means of thermovision. *Inz. Biomed.* 2012; 18(1):25-29.

11. Etehad Tavakol M, Fatemi A, Karbalaie A, Emrani Z, Eerlandsson BE. Nailfold capillaroscopy in rheumatic diseases: Which parameters should be evaluated? *Biomed Res. Int.* 2015; 2015:1-17. <https://doi.org/10.1155/2015/974530>

12. Fedorovich AA. Capillary hemodynamics in the eponychia of the upper limb. *Regional Blood Circulation and Microcirculation*. 2006; 5(1):20-29.

13. Fujimasa I. Pathological expression and analysis of far infrared thermal images. *IEEE Engineering in Medicine and Biology Magazine*. 1998; 17(4):34-42. <https://doi.org/10.1109/51.687961>

14. Grassi W, Del Medico P. Atlas of Capillaroscopy. *Edra Medical Publishing and New Media*. Milan. 2004.

15. Heuvel CJ van den, Ferguson SA, Dawson D, Gilbert SS. Comparison of digital infrared thermal imaging (DITI) with contact thermometry: pilot data from a sleep research laboratory. *Physiol. Meas.* 2003; 24(3):717-725 <https://doi.org/10.1088/0967-3334/24/3/308>

16. Hosking SPM, Bhatia R, Crock PA, Wright I, Squance ML, Reeves G. Non-invasive detection of microvascular changes in a paediatric and

adolescent population with type 1 diabetes: a pilot cross-sectional study. *BMC Endocr. Disord.* 2013; 13:1-9. <https://doi.org/10.1186/1472-6823-13-41>

17. Jeong JH, Sugii Y, Minamiyama M, Okamoto K. Measurement of RBC deformation and velocity in capillaries in vivo. *Microvasc. Res.* 2006; 71(3):212-217. <https://doi.org/10.1016/j.mvr.2006.02.006>

18. Lal C, Leahy M. An Updated Review of Methods and Advancements in Microvascular

Blood Flow Imaging. *Microcirculation.* 2016; 23(5):345-363 <https://doi.org/10.1111/micc.12284>

19. Lambova SN, Müller-Ladner U. Nail-fold Capillaroscopy of the Toes in Healthy Subjects. *Annals of the Rheumatic Diseases.* 2015; 74(2):1264-1264. <https://doi.org/10.1136/annrheumdis-2015-eular.5709>

20. Lambova SN. The role of capillaroscopy in rheumatology: Ph.D. thesis. Giessen. 2011. 195 p.

21. Lo LC, Lin KC, Hsu YN, Chen TP, Chiange JY, Chen YF, Liu YT. Pseudo three-dimensional

vision-based nail-fold morphological and hemodynamic analysis. *Comput. Biol. Med.* 2012; 42(9):873-884. <https://doi.org/10.1016/j.compbiomed.2012.06.001>

22. Oerlemans HM, Graff Maud JL, Dijkstra-Hekkink JBG, Boo T de, Goris RJA, Oostendorp RAB. Reliability and normal values for measuring the skin temperature of the hand with an infrared tympanic thermometer: a pilot study. *Journal of Hand Ther.* 1999; 12(4):284-290. [https://doi.org/10.1016/s0894-1130\(99\)80065-9](https://doi.org/10.1016/s0894-1130(99)80065-9)

S.I. Sofronova, T.M. Klimova, V.M. Nikolaev, A.N. Romanova, I.V. Kononova

ASSESSMENT OF RENAL FUNCTION IN THE INDIGENOUS PEOPLES OF YAKUTIA WITH ARTERIAL HYPERTENSION

DOI 10.25789/YMJ.2021.74.25

The aim of the study was to assess the functional state of the kidneys in the group of people with arterial hypertension (n=159), representatives of the indigenous population of the Republic of Sakha (Yakutia). The average age of the subjects was 60.6 years. 78% of the examined individuals have signs of decreased renal function. Most number of participants, along with existing hypertension, have additional risk factors that contribute to the development of renal dysfunction. The surveyed women are characterized by a more unfavorable profile of risk factors for chronic non-communicable diseases, which probably accounts for a higher proportion of women with signs of chronic kidney diseases.

Keywords: arterial hypertension, renal function, glomerular filtration rate, risk factors, indigenous population, Arctic.

Diseases of the circulatory system remain the leading cause of death in the world. In the Russian Federation, according to data from 2019, these diseases attributed to 46.8% of all deaths [2]. Arterial hypertension (AH) and chronic kidney disease (CKD) are considered as independent risk factors for the development of cardiovascular diseases and their complications, simultaneously, each of these conditions can be the cause of the other. Thus, a decrease in renal function leads to an increase in blood pressure, and long-term hypertension affects the glomerular filtration rate, leading to renal failure [9, 10, 12, 14].

Chronic kidney disease is a term that encompasses all degrees of decline in kidney function. Moreover, all its stages are associated with an increased risk of cardiovascular diseases, premature mortality and a decrease in the quality of life [5]. Currently, the glomerular filtration rate (GFR) and the level of albuminuria

are used for: determining the stage of CKD, risk stratification, and prognosis [1, 11]. Due to the fact that GFR is difficult to measure directly, various equations are used that take into account serum creatinine level, age, race, sex and body surface area [4, 6, 7].

The aim of the study: assessment of renal function in the indigenous peoples of Yakutia with arterial hypertension.

Materials and methods. A group of people with arterial hypertension was formed during an epidemiological study among the populations of the Tomtor village of Oymyakonskiy district and the city of Srednekolymsk of Srednekolymskiy district in expeditionary conditions. Inclusion criteria were: ages 20 and older, belonging to an indigenous ethnic group by self-identification, presence of an elevated blood pressure when measured (according to ESH/ESC criteria, 2013), taking antihypertensive drugs during the examination period or less than 2 weeks before the examination, regardless of the measured blood pressure level. The Yakuts and representatives of the indigenous small-numbered peoples of the North were attributed to the indigenous peoples of Yakutia. The analysis included data from 159 people, including 58 men and 101 women. The average age of men was 59.3 ± 2.36 years, women 61.4 ± 1.36 years ($p = 0.347$). All participants were representatives of the indigenous ethnic groups of Yakutia (Yakuts, Evens, Evenks, Chukchi, Yukagirs).

Research program included the following sections: a questionnaire for objective assessment of state; informed consent of the respondent to conduct research and donate blood (according to the protocol of the Ethics committee of YSC CMP); anthropometric examination with measurement of height and weight with calculation of body mass index, waist and hips measurements; blood sampling from the cubital vein in the morning on an empty stomach with 12-hour abstinence from food. After centrifugation, blood serum was stored in a freezer (-70°C) until analysis.

For further analysis, the traditional indicator was used - body mass index (BMI) or Quetelet index, which was calculated by the following formula: $BMI (kg / m^2) = \text{body weight (kg)} / \text{height (m}^2\text{)}$. Overweight was considered to be a $BMI \geq 25$ and $<30 kg/m^2$, obesity was determined at a $BMI \geq 30 kg/m^2$ [according to European recommendations of the III revision, 2003]. The abdominal obesity (AO) is exposed to the value of the waist measurement (WM) ≥ 80 cm on women, ≥ 94 cm on (VNOK, 2009).

Blood pressure (BP) was measured twice with an OMRON M2 Basic automatic tonometer (Japan) in a sitting position with calculation of average blood pressure with a margin of permissible measurement error of ± 3 mm Hg. (ESH/ESC, 2013) according to the instructions for the correct measurement of blood pressure, outlined in the European clinical guidelines for the diagnosis and treatment of

Yakut Scientific Centre of Complex Medical Problems: **SOFRONOVA Sargylana Ivanovna** - PHD, researcher, ORCID: 0000-0003-0010-9850, sara2208@mail.ru; **NIKOLAEV Vyacheslav Mikhailovich** - PHD, researcher, nikolaev1126@mail.ru; **ROMANOVA Anna Nikolaevna** - MD, director, ORCID: 0000-0002-4817-5315; **KONONOVA Irina Vasilievna** - PHD, researcher, irinakon.07@mail.ru; **KLIMOVA Tatyana Mikhailovna** - PHD, researcher of YSC CMP, assistant professor of Institute of Medicine at M.K. Ammosov NEFU