25. Solodovnikova E.N., Zherdev K.V. Taktika operativnogo lecheniya pacientov s nesovershennym osteogenezom I i III tipov. [Tactics of surgical treatment of patients with osteogenesis imperfecta types I and III]. Rossijskij pediatricheskij zhurnal [Russian Pediatric Journal. 2023; 26: 56 (In Russ.).]

26. Wagner V.D., Konev V.P., Korshunov A.S., et al. Sravnitel'naya ocenka skorosti i kachestva sozrevaniya mineral'nogo komponenta emali zubov cheloveka pri displazii soedinitel'noj tkani v pozdnem postnatal'nom periode ontogeneza [Comparative assessment of the rate and quality of maturation of the mineral component of human tooth enamel in connective tissue dysplasia in the late postnatal period of ontogenesis]. Institut stomatologii [Institute of Dentistry. 2020; 89 (4): 72-73 (In Russ.).]

27.Fokina N.M., Santrosyan A.A., Popova I.V. Celesoobraznost' mezhdisciplinarnogo podhoda k vedeniyu pacientov s nedifferencirovannoj displaziej soedinitel'noj tkani v stomatologii [Feasibility of an interdisciplinary approach to the management of patients with undifferentiated connective tissue dysplasia in dentistry]. Effektivnaya farmakoterapiya [Effective pharmacotherapy. 2023; 24 (19): 38-44 (In Russ.).] DOI 10.33978/2307-3586-2023-19-24-38-44

28. Belenova I.A., Mitronin A.V., Sushchenko A.V., et al. Formirovanie prognosticheskih kriteriev vyyavleniya kariesvospriimchivogo kontingenta kak etap predikcii i profilaktiki patologii tverdyh tkanej zubov [Formation of prognostic criteria for identifying a caries-susceptible contingent as a stage of prediction and prevention of pathology of hard dental tissues]. Kafedra. Stomatologicheskoe obrazovanie [Cathedra . Department. Dental education. 2018; 63: 42-47 (In Russ.).]

29. Dombrovskaya Yu.A., Kravets O.N., Nikolaeva A.V., et al. Evolyucionnye tendencii izmeneniya mikroelementnogo sostava emali, poverhnostnyh sloev dentina, cementa zubov cheloveka v Severo-Zapadnom regione Sibiri v norme i pri patologii v X-XX vekah [Evolutionary trends in changes in the microelement composition of enamel, surface layers of dentin, and cementum of human teeth in the North-West region of Siberia under normal and pathological conditions in the 10th-20th centuries]. Stomatologiya [Dentistry. 2025; 104 (1): 5-8 (In Russ.).]

30. Wagner V.D., Konev V.P., Korshunov A.S., et al. Ekspress-sposoby vysokotochnoj diagnostiki displazii soedinitel'noj tkani na stomatologicheskom prieme i ocenki kachestva tverdyh tkanej zubov cheloveka [Express methods for high-precision diagnostics of connective tissue dysplasia at a dental appointment and assessment of the quality of hard tissues of human teeth]. Institut stomatologii [Institute of Dentistry. 2021; 91(2): 111-113 (In Russ.).]

31. Castori M, Tinkle V, Levy N, et al. A framework for the classification of joint hypermobility and related conditions. Am. J. Med.Genet. C.Semin.Med.Genet.2017;175(1):148-157.

31. Bascom R., Schubart J.R., Mills S. et al. Heritable disorders of connective tissue: description of a data repository and initial cohort characterization. American journal of medical genetics part A. 2019;179(4):552-560. https://doi.org/10.1002/ajmg.a.61054

32. Syx D, De Wandele I, Rombaut L, et al. Hypermobility, the Ehlers-Danlos syndromes and chronic pain. Clin Exp Rheumatol. 2017;35(suppl. 107)(5):116-122.

33. Gensemer C, Burks R, Kautz S, et al. Hypermobile Ehlers-Danlos syndromes: complex phenotypes, challenging diagnoses, and poorly understood causes. Developmental dynamics. 2021; 250 (3): 318-344.

34. Dinulescu A, Pasarica A.S., Carp M., et al. New Perspectives of Therapies in Bone theogenesis imperfecta - A Literature Review. J. Clin. Med. 2024; 13 (4): 1065. DOI: 10.3390/jcm13041065

35. Song Y.L, Bian Z. Recognition on dentin dysplasia type II. Zhonghua Kou Qiang Yi XueZaZhi. 2023; 58 (8): 766–771. DOI: 10.3760/cma.j.cn112144-20230410-00148

36. Rapoport M, Bober M.B., Raggio C, et al. The patient clinical jour ney and socioeconomic impact of osteogenesis imper fecta: a systematic scoping review. Orphanet J. Rare Dis. 2023;18(1):34 doi: 10.1186/s13023-023-02627-3

37.Koldehoff J, Swain M.V., Schneider G.A. The geometrical structure of interfaces in dental enamel: A FIB-STEM investigation. Acta Biomater. – 2020; 104: 17—27. PMID: 31917293.

38. Tinkle B.T. Symptomatic joint hypermobility. Best Practice and research clinical rheumatology. 2020; 34(3):101508.

POINT OF VIEW

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THE RELATIONSHIP BETWEEN MARKERS OF METABOLIC SYNDROME AND LEVELS OF SPECIFIC IgG TO FOOD PRODUCTS IN HEALTHY PEOPLE AND WITH METABOLIC SYNDROME

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Due to the steady increase in the incidence of metabolic syndrome (MetS), studying the ways to reduce the risk of its occurrence is an important task for modern medicine. The aim of the study is to identify the relationship of MetS markers with the levels of specific IgG to various products, as well as to assess the relationship of the content of proinflammatory cytokines and C-reactive protein with MetS. It is shown that for the examined individuals with MetS, more direct correlations are recorded and most often - with the glucose level. Many products can provoke postprandial hyperglycemia, which in a practically healthy person will not cause significant disturbances, but with MetS, a failure of glucose and lipid homeostasis in combination with insulin resistance does not allow effective correction of blood glucose levels. Thus, when introducing elimination diets for MetS, it is necessary to take into account the possibility of postprandial hyperglycemia in this group of people, monitor glucose and insulin levels to prevent the development of insulin resistance.

Keywords: food antigens, metabolic syndrome, specific IgG, correlation relationships.

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Introduction. MetS is a set of pathological conditions including visceral obesity, insulin resistance, hyperglycemia and lipid metabolism disorders. This symptom complex increases the risk of developing other diseases, such as cardiovascular, neurodegenerative, oncological diseases and the development of type 2 diabetes mellitus [5, 22, 26]. It is known that inflammatory processes are involved in the pathogenesis of many diseases. The inflammatory response, as a protective mechanism, is based on the permeability of the intestinal epithelium for food antigens and impaired immune regulation. In obesity, the inflammatory process is localized in adipose tissue, liver, muscles and pancreas. These tissues are infiltrated with macrophages and other immune cells that produce proinflammatory cytokines that act in an autocrine and paracrine manner to interfere with insulin signaling in peripheral tissues or cause β-cell dysfunction and subsequent insulin deficiency [16, 19, 25]. Studies show that food antigens can affect the barrier functions of the intestinal wall, facilitating the penetration of harmful substances into the blood, thereby initiating inflammation. Once in the blood, food antigens cause an increase in the concentration of specific IgG [1, 3]. In patients with MetS, 88.5% of cases show an increase in immunoglobulin IgG, which is involved in autoimmune processes [6]. An unbalanced diet with a predominance of fats, circadian rhythm disorders, and stress play a key role in the development of MetS [23]. In turn, MetS increases the risk of anxiety due to an increase in the level of chronic inflammation [9]. Thus, studying the underlying mechanisms of MetS development and associated inflammation may be useful for the treatment, diagnosis and prevention of associated diseases.

The **aim** is to establish the presence of correlations between MetS markers and levels of specific IgG to food antigens, as well as to analyze the relationship between MetS and the content of proinflammatory cytokines and C-reactive protein.

Materials and methods. According to the classification of the International Diabetes Federation (IDF, 2005), the main sign of MetS is the presence of visceral obesity, for women the abdominal circumference should be equal to or more than 80 cm, for men more than 94 cm, as well as any two of the following four factors: elevated triglyceride levels (more than 1.7 mmol / l), decreased high-density lipoprotein levels (less than 1.03 mmol / l in men and less than 1.29 mmol / l in women), elevated blood pressure (systolic more than 130 or diastolic more than 85 mm Hg), elevated fasting plasma glucose (more than 5.6 mmol / l). Laboratory and anthropometric data of 230 people were analyzed. The group with MetS included 110 people, including 71 women and 39 men, the average age was 33.92 ± 1.09 years. The inclusion criterion for patients was the presence of clinical signs of MetS according to the classification of the International Diabetes Federation (IDF, 2005). The diagnosis was confirmed by the results of laboratory tests. The examined individuals with MetS did not have a confirmed diagnosis of diabetes mellitus and, therefore, did not take insulin drugs to regulate blood sugar levels. The control group included 120 practically healthy people, including 100 women and 20 men, the average age was 41.90 ± 1.12 years. According to the questionnaire, none of the examined people had any allergies to any food products. The examination was carried out with the written consent of the volunteers, in compliance with the norms and rules of biomedical ethics approved by the Helsinki Declaration of the World Medical Association on Ethical Principles for Medical Research (2013). The study was approved by the Ethics Committee of the Institute of Physiology of Natural Adaptations of the Federal Research Center for Animal Health, Ural Branch of the Russian Academy of Sciences (Protocol No. 3 dated December 20, 2024). Abdominal circumference was assessed in all patients. The concentration of low-density lipoproteins, high-density lipoproteins, total cholesterol, triglycerides and glucose was determined in blood serum using spectrophotometry kits (Vector-Best, Russia) on a UV-1800 spectrophotometer (Shimadzu, Japan). The enzyme immunoassay method was used to determine the content of C-reactive protein (AccuBind, USA), cytokines IL-6, IL-10, IL-1β and TNFα (RayBiotech, USA), c-peptide (Monobind Inc., USA), specific IgG antibodies to 90 food allergens (Biomerica, USA) in the blood serum, with the result being assessed on a Multiskan FC enzyme immunoassay analyzer (Thermo Fisher Scientific, USA). Statistical data processing was performed using the Statistica 6 program (StatSoft, USA). Correlation analysis was performed using Pearson's analysis. The normality of distribution of quantitative indicators was checked using the Shapiro-Wilk criterion. The description of the obtained data was carried out using the mean value and standard deviation, median, lower and upper quartiles. Statistically significant differences between groups were identified using the parametric Student t-test

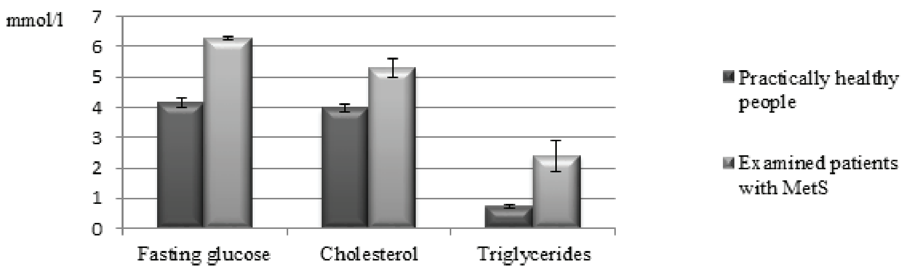

Fig. 1. Concentrations of glucose, total cholesterol and triglycerides (M ± m). ***p < 0.001 is the significance of the differences

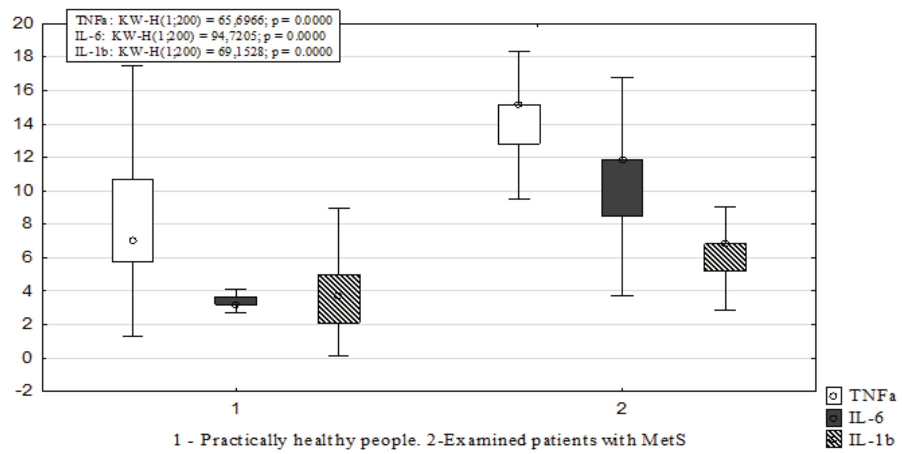

Fig. 2. . Concentrations of pro-inflammatory cytokines TNFa, IL-6, IL-1b

for independent samples and the non-parametric Kruskal-Wallis test. The significance of differences was considered at p <0.05.

Results of the study and their discussion. The results of the examination showed that in the MetS group, the abdominal circumference in women averaged 98.53 ± 2.56 cm, while in men it was 106.71 ± 1.82 cm. In the comparison group, the abdominal circumference in women was 68.96 ± 1.46 cm (p < 0.001), while in men it was 79.50 ± 1.50 cm (p < 0.001). The group of volunteers with MetS was characterized by higher levels of glucose, cholesterol, and triglycerides in the blood serum. The comparison data are presented in Figure 1. The groups were assessed for the level of general inflammation. MetS is characterized by the presence of chronic sluggish inflammation, which is confirmed by higher levels of proinflammatory cytokines IL-1β, IL-6, and TNFα in the examined individuals with MetS (Figure 2).

The concentration of C-reactive protein, a marker of general inflammation, was determined. It was found that in practically healthy volunteers its content was 1.31 (0.75-2.06) mg/l with elevated

Table 1

Correlations of levels of specific IgG to fish and seafood antigens with markers of metabolic syndrome, r

		Abdominal circumference	Triglycerides	HDL	LDL	Glucose
Turbot	Practically healthy	-0.17	0.28	0.37	0.08	-0.13
	MetS	0.14	-0.09	0.08	-0.07	0.43*
Flounder	Practically healthy	-0.09	0.43*	0.41*	0.25	0.34
	MetS	0.13	-0.15	0.08	-0.15	0.44*
Cod	Practically healthy	-0.30	0.34	0.34	0.12	0.28
	MetS	0.42*	-0.14	-0.13	-0.08	0.05
The crab	Practically healthy	-0.10	0.57**	0.49**	0.02	0.37
	MetS	0.34	-0.16	-0.13	-0.17	-0.08
Tuna	Practically healthy	-0.09	0.19	0.40*	-0.07	-0.22
	MetS	0.43*	-0.09	-0.14	-0.05	-0.01
Shrimp	Practically healthy	0.19	0.15	0.54**	0.11	0.28
	MetS	-0.20	0.15	0.25	0.24	0.37*
Trout	Practically healthy	-0.29	0.41*	0.51**	0.32	0.40*
	MetS	0.49**	-0.17	0.08	0.02	-0.16
Hake	Practically healthy	-0.36	0.34	0.38	0.16	0.40*
	MetS	0.26	-0.15	-0.06	-0.04	0.16
Salmon	Practically healthy	-0.17	0.26	0.46*	0.18	0.30
	MetS	0.14	-0.18	0.10	-0.13	0.27

Note. In table 1-6 * - p<0.05. ** - p<0.01. *** - p <0.001.

Table 2

Correlations of levels of specific IgG to fruit antigens with markers of metabolic syndrome, r

		Abdominal circumference	Triglycerides	HDL	LDL	Glucose
Avocado	Practically healthy	-0.14	0.02	0.38*	0.28	0.02
	MetS	-0.07	-0.06	0.13	-0.12	0.42*
Orange	Practically healthy	-0.29	-0.11	0.21	0.15	0.31
	MetS	-0.15	-0.04	0.17	-0.08	0.48**
Banana	Practically healthy	-0.20	0.20	0.14	0.07	-0.01
	MetS	-0.01	-0.04	0.10	-0.24	0.50**
The grapes are white	Practically healthy	-0.47**	0.04	0.05	0.04	-0.31
	MetS	-0.02	-0.06	0.17	-0.13	0.44*
Peach	Practically healthy	-0.14	-0.19	0.35	0.43*	0.10
	MetS	-0.16	-0.16	0.28	-0.08	0.41*
Plum	Practically healthy	0.02	0.04	0.30	0.23	0.22
	MetS	-0.14	-0.10	0.29	-0.06	0.47**
Lemon	Practically healthy	-0.11	-0.06	0.27	0.30	0.31
	MetS	-0.11	-0.09	0.19	-0.03	0.41*

Table 3

Correlations of levels of specific IgG in vegetables with markers of metabolic syndrome, r

		Abdominal circumference	Triglycerides	HDL	LDL	Glucose
Carrot	Practically healthy	-0.16	-0.013	-0.1	0.07	0.08
	MetS	-0.1	-0.06	0.21	0.0004	0.42*
Eggplant	Practically healthy	-0.22	-0.15	0.28	0.4	0.26
	MetS	-0.28	-0.05	0.32	-0.02	0.39*
Punch	Practically healthy	-0.2	-0.08	0.19	0.26	0.05
	MetS	-0.12	-0.09	0.21	-0.16	0.49**
Green peas	Practically healthy	-0.01	-0.12	0.58**	0.46*	0.1
	MetS	0.12	-0.07	0.32	0.001	0.45**
Green sweet pepper	Practically healthy	-0.12	-0.07	0.24	0.12	0.38*
	MetS	-0.08	-0.1	0.29	-0.12	0.55*
Celery	Practically healthy	-0.22	-0.12	0.32	0.33	0.15
	MetS	0.06	-0.08	0.21	-0.07	0.37*
Cabbage	Practically healthy	-0.23	-0.04	0.01	-0.01	-0.07
	MetS	0.03	-0.06	0.13	-0.08	0.4*
Tomatoes	Practically healthy	0.04	-0.13	0.26	0.35	0.4*
	MetS	-0.13	-0.14	0.07	-0.12	0.44**
Pumpkin	Practically healthy	-0.1	-0.24	0.2	0.19	0.04
	MetS	-0.1	-0.08	0.34	-0.02	0.51*
Corn	Practically healthy	-0.04	0.15	0.09	0.004	-0.07
	MetS	-0.2	0.41*	0.05	0.38*	0.24
Garlic	Practically healthy	-0.05	-0.15	0.5**	0.43*	0.28
	MetS	-0.21	-0.12	0.23	-0.13	0.48**
Onion	Practically healthy	0.04	-0.01	0.2	0.35	0.24
	MetS	-0.22	-0.08	0.12	-0.08	0.37*

Table 4

Correlations of levels of specific IgG to dairy antigens with markers of metabolic syndrome, r

		Abdominal circumference	Triglycerides	HDL	LDL	Glucose
Soft cheese	Practically healthy	-0.01	-0.07	0.31	0.19	0.52**
	MetS	0.07	0.02	-0.08	0.07	0.76*
Yogurt	Practically healthy	0.05	0.1	0.41*	0.18	0.5**
	MetS	0.15	-0.03	-0.02	0.09	0.15
Casein	Practically healthy	0.13	-0.12	0.34	0.25	0.41*
	MetS	0.25	-0.04	-0.14	0.13	0.12
Cheddar cheese	Practically healthy	0.01	-0.09	0.54*	0.26	0.29
	MetS	-0.1	0.12	0.14	-0.11	0.66**
Swiss cheese	Practically healthy	0.03	-0.16	0.5**	0.28	0.13
	MetS	-0.09	0.15	-0.08	-0.05	0.72
Butter	Practically healthy	0.1	0.2	0.22	0.05	0.49**
	MetS	0.07	0.002	-0.05	0.19	0.16
Goat's milk	Practically healthy	-0.03	-0.06	0.61***	0.36	0.22
	MetS	0.01	-0.1	-0.06	0.13	0.12

concentrations (over 5 mg/l) recorded in 6.81±0.15% of those examined. In the group of those examined with MetS, the content of C-reactive protein was 2.86 (2.28 – 3.87) mg/l, elevated levels were found in 20.34±1.32% of cases. An increase in the level of inflammation markers increases the risk of vascular endothelial dysfunction, increased insulin resistance, lipid peroxidation and oxidative stress. As a result of chronic sluggish inflammation and impaired immune control, a change in the regulation of food antigen transport occurs through weakening of tight junctions of the epithelium and

Table 5

Correlations of levels of specific IgG to meat antigens with markers of metabolic syndrome, r

		Abdominal circumference	Triglycerides	HDL	LDL	Glucose
Sheepmeat	Practically healthy	-0.21	0.03	0.26	0.18	0.09
	MetS	-0.02	-0.09	0.14	-0.15	0.39*
Beef	Practically healthy	-0.44*	-0.36	0.16	0.14	-0.11
	MetS	-0.07	0.13	0.34	-0.16	0.33
Turkey	Practically healthy	-0.09	0.11	0.45*	0.31	0.38*
	MetS	0.44*	-0.16	-0.12	-0.1	0.07
Chicken	Practically healthy	0.02	0.14	0.26	0.28	0.35
	MetS	0.4*	-0.11	-0.11	-0.05	-0.03

Table 6

Correlations of levels of specific IgG to antigens of products with markers of metabolic syndrome, r

		Abdominal circumference	Triglycerides	HDL	LDL	Glucose
Black pepper	Practically healthy	0.05	0.04	0.42*	0.49**	0.23
	MetS	0.25	-0.09	-0.02	-0.16	0.18
Mushrooms	Practically healthy	-0.01	0.11	0.34	0.18	0.39*
	MetS	0.22	-0.06	0.04	-0.08	0.14
Beer yeast	Practically healthy	0.23	0.41	0.21	-0.27	0.39*
	MetS	0.11	-0.09	0.09	-0.09	0.36
Chocolate	Practically healthy	-0.08	0.2	0.46*	0.29	0.33
	MetS	0.4*	-0.08	-0.03	-0.01	0.04
Honey	Practically healthy	-0.28	0.16	0.18	-0.002	-0.1
	MetS	0.09	-0.11	0.14	-0.22	0.41*

dysfunction of M-cells, which increases the permeability of the intestinal epithelium for food antigens. We have previously shown that individuals with MetS have higher levels of IgG to food antigens and their elevated concentrations are more often detected [4].

A correlation analysis of the levels of specific IgG to antigens of products with MetS markers was performed in groups with metabolic syndrome and in practically healthy individuals. Antigens were divided into groups: dairy products, meat, fish and seafood, cereals and nuts, fruits, vegetables.

Regular fish consumption has a positive effect on thyroid homeostasis and improves glucose homeostasis, helping to prevent diabetes and MetS [21, 28]. Analysis of the relationships between IgG to fish and seafood and MetS markers showed that practically healthy volunteers more often show significant positive correlations between IgG to fish and seafood antigens and HDL and triglycerides, and with MetS – with glucose levels (Table 1).

Plant products contain numerous biologically active substances (polyphenols, flavonoids, etc.) and fiber, which have a positive effect on MetS markers, reducing their levels and also regulating the normal functioning of the intestinal microflora [14, 15, 17, 24]. In MetS, statistically significant positive correlations were found between glucose levels and specific IgG to fruits with a high glycemic index - avocado, orange, banana, grapes, peach, plum and lemon (Table 2), which can be explained by metabolic disturbances in glucose absorption.

Analysis of correlations between specific IgG to vegetable antigens and MetS markers showed that in both groups a direct significant relationship between IgG levels to tomatoes and glucose concentration was recorded (Table 3). A relationship was found between IgG to green peas and HDL and LDL in practically healthy subjects. In individuals with MetS, IgG to green peas had a highly significant relationship with glucose levels. Legume fibers, resistant starch, and oligosaccharides can reduce glucose and lipid levels and have a probiotic effect. In addition, they have a number of other health benefits, such as anti-inflammatory and antitumor effects [10].

Dairy products have different effects on the body when consumed. Cheese does not have a strong effect on blood cholesterol levels, like butter [7]. Casein micelles in the cheese structure can affect the ability of lipases to break down fat. In addition, cheese contains phosphorus, which promotes the formation of insoluble compounds during digestion, which reduces the absorption of fats [12]. The literature describes the beneficial effects of milk proteins on hypertension, dyslipidemia, and hyperglycemia [11]. In both groups of subjects, a highly significant relationship was found between the levels of specific IgG to soft cheese and glucose levels. In individuals with MetS, this relationship was more pronounced (r = 0.7555, p = .034) than in practically healthy volunteers (r = 0.5230, p = .004). In individuals with MetS, there are also high significant associations of specific antibodies to Cheddar and Swiss cheeses with glucose levels (r=0.6618, p=0.014 and r=0.7168, p=0.010, respectively). In practically healthy volunteers, there is a significant correlation between Cheddar cheese consumption and HDL levels (R=0.5386, p=.003) and cholesterol (r=0.4176, p=0.027). There is also a high correlation between antibodies to Swiss cheese, yogurt and HDL (r=0.4992, p=0.007 and r=0.4090, p=0.031, respectively) in practically healthy people (Table 4).

According to the literature, red meat consumption is associated with a higher risk of MetS, while poultry consumption is associated with a lower risk [8, 20]. A small number of significant relationships are recorded for meat and poultry antigens, so no reliable correlations were found between the levels of IgG to rabbit and pork with MetS markers in either group. For the examined individuals with MetS, a positive significant correlation was found between IgG to turkey and HDL (r=0.45, p=0.02), glucose (r=0.38, p=.05), total cholesterol (r=0.49, p=0.01); IgG to chicken - with total cholesterol (r=0.41, p=0.03) and a negative relationship between IgG to beef antigens and abdominal circumference (r=-0.44, p=0.02). In practically healthy volunteers, abdominal circumference has a direct significant relationship with IgG to turkey (r=0.44, p=0.02) and chicken (r=0.40, p=0.03), and IgG to lamb antigens with glucose levels (r=0.40, p=0.03) (Table 5).

In our study, immunoglobulins G to black pepper have a direct significant correlation with LDL and HDL levels in the group of practically healthy people, and in the group with MetS these indicators have an inverse relationship (Table 6). Black pepper contains a substance - piperine, which has a hypoglycemic effect, and also reduces the level of lipids and cholesterol [2].

Some sources claim that dark chocolate/cocoa products have a beneficial effect on total and LDL cholesterol [27]. According to other sources, cocoa polyphenols contained in chocolate can increase HDL cholesterol concentrations, while chocolate fatty acids can change the fatty acid composition of LDL and make it more resistant to oxidative damage [12]. In our study, a significant association of immunoglobulins G to chocolate with abdominal circumference was observed in individuals with MetS (Table 6).

Conclusion. The examined patients with MetS are characterized by a higher content of proinflammatory cytokines and C-reactive protein, which may be due to the presence of chronic sluggish inflammation associated with the risk of developing chronic non-infectious diseases, including MetS. It has been shown that with MetS, the range of food antigens to which correlations with markers of MetS and general inflammation are established is wider. Most often, direct significant relationships with glucose levels are recorded. The examined individuals with MetS did not have a confirmed diagnosis of diabetes mellitus and, therefore, did not take insulin drugs to regulate blood sugar levels. Thus, when introducing elimination diets, it is necessary to take into account the possibility of postprandial hyperglycemia in this group of individuals, and monitor insulin levels to prevent the development of insulin resistance.

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The authors declare no conflict of interest.

References

1. Novikov P.S., et al. Giperchuvstvitel'nost' k pishchevym antigenam kak prediktor razvitiya metabolicheskogo sindroma [Hypersensitivity to food antigens as a predictor of the development of metabolic syndrome]. Citokiny i vospalenie [Cytokines and inflammation. 2016; 3-4(15): 280-284 (In Russ.).]

2. Karomatov I.D., Abdullaeva D.A. Chernyj perec i metabolicheskij sindrom [Black pepper and metabolic syndrome]. Biologiya i integrativnaya medicina [Biology and integrative medicine. 2019; (34): 4-11 (In Russ.).]

3. Novikov P.S. Rol' giperreaktivnostosti k pishchevym antigenam v razvitii metabolicheskogo sindroma: Avtoref. dis. ... kand. med. nauk [The role of hyperreactivity to food antigens in the development of metabolic syndrome: Abstract of the dissertation of the Candidate of Medical Sciences. M. 2024 (In Russ.).]

4. Patrakeeva V.P., et al. Ocenka soderzhaniya specificheskih IgG k pishchevym antigenam u pacientov s metabolicheskim sindromom [Assessment of the content of specific IgG to food antigens in patients with metabolic syndrome]. Voprosy pitaniya [Nutrition issues. 2023; 92 (6): 98-106 (In Russ.).] DOI: 10.33029/0042-8833-2023-92-6-98-10

5. Patrakeeva V.P., Shtaborov V.A. Rol' pitaniya i sostoyaniya mikroflory kishechnika v formirovanii metabolicheskogo sindroma [The role of nutrition and intestinal microflora in the formation of metabolic syndrome]. Ozhirenie i metabolism [Obesity and metabolism. 2022; 3(19): 292-299 (In Russ.).] DOI: 10.14341/omet12893.

6. Tanchenko O.A., Naryshkina S.V., Reshetnikova L.K. Osobennosti immunnogo statusa u bol'nyh s metabolicheskim sindromom [Features of the immune status in patients with metabolic syndrome]. Dal'nevostochnyj medicinskij zhurnal [Far Eastern Medical Journal. 2014; 2: 20-23 (In Russ.).]

7. Biong A.S., et al. A comparison of the effects of cheese and butter on serum lipids, haemostatic variables and homocysteine. Br J Nutr. 2004; 92(5): 791-7. DOI: 10.1079/bjn20041257.

8. Guo H, et al. Association of Red Meat and Poultry Consumption With the Risk of Metabolic Syndrome: A Meta-Analysis of Prospective Cohort Studies. Front Nutr. 2021. 8:8:691848. DOI: 10.3389/fnut.2021.691848.

9. Cen M., et al. Associations between metabolic syndrome and anxiety, and the mediating role of inflammation: Findings from the UK Biobank. Brain Behav Immun. 2024; 116: 1-9. DOI: 10.1016/j.bbi.2023.11.019.

10. Singh B., et al. Bioactive constituents in pulses and their health benefits. J Food Sci Technol. 2017; 54(4): 858-870. DOI: 10.1007/s13197-016-2391-9.

11. Bjørnshave A., Hermansen K. Effects of dairy protein and fat on the metabolic syndrome and type 2 diabetes. Rev Diabet Stud. 2014. Vol. 11(2). P. 153-66. DOI: 10.1900/RDS.2014.11.153.

12. Timon C.M., et al. Dairy Consumption and Metabolic Health. Nutrients. 2020; 12(10):3040. DOI: 10.3390/nu12103040.

13. Mursu J, et al. Dark chocolate consumption increases HDL cholesterol concentration and chocolate fatty acids may inhibit lipid peroxidation in healthy humans. Free Radic Biol Med. 2004; 37(9):1351-9. DOI: 10.1016/j.freeradbiomed.2004.06.002.

14. Ren Y, et al. Effect of fruit on glucose control in diabetes mellitus: a meta-analysis of nineteen randomized controlled trials. Front. Endocrinol. 2023; 14. DOI: 10.3389/fendo.2023.1174545.

15. Du H., et al. Fresh Fruit Consumption and Major Cardiovascular Disease in China. N Engl J Med. 2016; 374(14):1332-43. DOI: 10.1056/NEJMoa1501451.

16. Grandl G., Wolfrum C. Hemostasis, endothelial stress, inflammation, and the metabolic syndrome. Semin Immunopathol. 2018. Vol. 40(2). P.215-224. DOI: 10.1007/s00281-017-0666-5.

17. Grath L., Fernandez M-L. Plant-based diets and metabolic syndrome: Evaluating the influence of diet quality. Journal of Agriculture and Food Research. 2022. 9:100322. https://doi.org/10.1016/j.jafr.2022.100322.

18. Hallfrisch J., Behall K.M. Mechanisms of the effects of grains on insulin and glucose responses. J Am Coll Nutr. 2000. Vol. 19(3). P. 320-325. DOI: 10.1080/07315724.2000.10718967.

19. Esser N., et al. Inflammation as a link between obesity, metabolic syndrome and type 2 diabetes. Diabetes Res Clin Pract. 2014; 105(2): 141-50. DOI: 10.1016/j.diabres.2014.04.006.

20. Kim Y., Je Y. Meat Consumption and Risk of Metabolic Syndrome: Results from the Korean Population and a Meta-Analysis of Observational Studies. Nutrients. 2018; 10(4):390. DOI: 10.3390/nu10040390.

21. Mendivil C.O. Fish Consumption: A Review of Its Effects on Metabolic and Hormonal Health. Nutr Metab Insights. 2021. 3:14:11786388211022378. eCollection 2021. DOI: 10.1177/11786388211022378.

22. Ford E. S., et al. Metabolic syndrome and risk of incident diabetes: findings from the European Prospective Investigation into Cancer and Nutrition-Potsdam Study. Cardiovascular Diabetology. 2008; l (7) : 35. https://doi.org/10.1186/1475-2840-7-35.

23. Monteiro R., Azevedo I. Chronic inflammation in obesity and the metabolic syndrome. Mediators Inflamm. 2010:2010:289645. DOI: 10.1155/2010/289645.

24. Kim H., et al. Plant-based diets and incident metabolic syndrome: Results from a South Korean prospective cohort study. PLOS Med. 2020; 17(11):e1003371. DOI: https://

doi.org/10.1371/journal.pmed.1003371.

25. Saltiel A.R., Olefsky J.M. Inflammatory mechanisms linking obesity and metabolic disease. Invest. 2017; 127(1): 1-4. DOI: 10.1172/JCI92035.

26. Lorenzo C., Williams K., Hunt K. J., Haffner S. M. The National Cholesterol Education Program - Adult Treatment Panel III, International Diabetes Federation, and World Health Organization Definitions of the Metabolic Syndrome as Predictors of Incident Cardiovascular Disease and Diabetes. Diabetes Care. 2007; 30(1): 8-13

27. Tokede O.A., Gaziano J.M., Djouss L. Effects of cocoa products/dark chocolate on serum lipids: a meta-analysis. Eur J Clin Nutr. 2011; 65(8): 879-86. DOI: 10.1038/ejcn.2011.64

28. Tørris C., Cvancarova S.M., Molin M. Nutrients in Fish and Possible Associations with Cardiovascular Disease Risk Factors in Metabolic Syndrome. Nutrients. 2018; 10(7):952. DOI: 10.3390/nu10070952.

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PROSPECTS FOR THE USE OF REMOTE BLOOD PRESSURE MONITORING AT THE PRIMARY HEALTHCARE LEVEL

To study the effectiveness and prospects of using telemedicine technologies for monitoring blood pressure (BP) in patients with arterial hypertension (AH) at the primary care level, remote BP monitoring was carried out using a digital platform. The study included 146 patients with uncontrolled BP, who measured BP at least twice a day using automatic monitors with Bluetooth data transfer. Measurement data were received by the remote monitoring system, where they were automatically processed and transmitted to the attending physician's personal account.

During the 10-month follow-up of patients with AH, target BP values below 135/85 mmHg were achieved in 83% of cases. During remote monitoring, therapy adjustments were observed: the number of patients on monotherapy decreased from 22.4% to 8% ($p<0.05$).

Keywords: arterial hypertension, blood pressure, telemedicine, remote blood pressure monitoring.

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Introduction. Modern medicine at the primary care level faces a number of challenges associated with the diagnosis and treatment of chronic noncommunicable diseases, among which arterial hypertension (AH) holds one of the leading places. Its high prevalence, associated complications, and significant share of mortality due to cardiovascular disease make blood pressure (BP) control a priority in healthcare. It is important to note that uncontrolled hypertension is directly associated with the development of cardiovascular catastrophes such as stroke, myocardial infarction, and sudden cardiac death [5].

According to the Ministry of Health of the Republic of Sakha (Yakutia), the main causes of mortality in 2023 were circulatory system diseases (42.4% vs. 38% in 2021), cancer (16.5% vs. 11.8% in 2021), and external factors (16.6% vs. 10.4% in 2021). Among cardiovascular diseases, coronary heart disease (46.3%, including myocardial infarctions 14.9%) and cerebrovascular diseases (22.2%, including strokes 48.0%) are most common [8]. The increase in mortality from cardiovascular disease is associated with a rise in the number of conditions among the population, particularly those accompanied by elevated blood pressure.

Extensive studies show that lowering blood pressure can significantly reduce the risk of serious cardiovascular diseases, coronary artery disease, heart failure, and death, with the same proportional reduction across different population subgroups [14]. One of the main forms of preventive work with patients with elevated BP is timely enrollment in dispensary observation, with adherence to the required frequency of check-ups [8, 4].

Studies over the past decade confirm that home (ambulatory) blood pressure measurements outperform standard in-clinic measurements for predicting both overall and cardiovascular mortality [6]. However, traditional approaches to BP monitoring, based on keeping self-control diaries and periodic patient visits to the physician, do not always provide timely and sufficient data for effective disease control.

According to the observational study ESSE RF-2, only 49.7% of patients diagnosed with hypertension and receiving antihypertensive therapy achieved target indicators. Meanwhile, only 24.9% of the general population with hypertension maintained BP control after achieving target results [10].

The use of active remote observation of patients with hypertension receiving antihypertensive therapy (both in Russian and international practice) contributes to achieving target BP values, subsequent monitoring of health indicators, and timely provision of medical assistance [11].

In this regard, remote blood pressure monitoring (RBPM), using modern telemedicine technologies, represents a promising direction that can improve the quality of medical care and reduce the workload on primary healthcare. Integration of RBPM into primary care practice allows not only continuous monitoring of patient status and achievement of targets, but also increases adherence and involvement in the treatment process — especially important for chronic noncommunicable diseases requiring long-term follow-up.

The aim of our study was to evaluate the effectiveness of RBPM in outpatients to improve control of arterial hypertension.

Materials and Methods. The depart-

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