ревматоидного артрита в России (по данным эпидемиологического исследования). Тера-певтический архив. 2010;5:9-14. [Myasoedova SE, Lesnyak OM, Men'shikova LV. [et al.] Prevalence of rheumatoid arthritis in Russia (according to the epidemiological study). Terapevticheskij arhiv. 2010; 5:9-14. (In Russ.).]

4. Macovei L, Ancuta C, Belibou C, Chirieac R. Bone mineral density in patients with rheumatoid arthritis. Rev Med Chir Soc Med Nat Iasi. 115 (2011):723-730.

5. Leslie W.D., Lix L.M., Wu X. [et al.] Compet-

ing mortality and fracture risk assessment. Osteoporos Int 2013; 24:681–8.

6. Crane M.M., Juneja M., Allen J. [et al.] Epidemiology and treatment of New-Onset and Established Rheumatoid Arthritis in an Insured US Population. Arthritis Care Res (Hoboken). 2015; 67:1646–55.

7. Leslie W.D., Lix L.M., Johansson H. [et al.] Manitoba Bone Density Program. Does osteoporosis therapy invalidate FRAX for fracture prediction? J Bone Miner Res. 2012; 27:1243–51.

8. Murariu R.V., Macovei L.A. , Brujbu I.C. Os-

teoporosis in rheumatoid arthritis. Rev Med Chir Soc Med Nat Iasi. 117 (2013):394-403.

9. Fadda S., Hamdy A., Abulkhair E., Elsify H.M., Mostafa A. Serum levels of osteoprotegerin and RANKL in patients with rheumatoid arthritis and their relation to bone mineral density and disease activity. Egypt Rheumatol. 37 (1) (2015):1-6.

10. Marques A., Ferreira R.J., Santos E. [et al.] The accuracy of osteoporotic fracture risk prediction tools: a systematic review and meta-analysis. Ann Rheum Dis. 2015; 74:1958–67.

P.M. Kosenko, S.A. Vavrinchuk, A.I. Popov, N.V. Tashkinov, N.I. Bojarincev, G.D. Sunozova

METHOD OF DETERMINING THE DEGREE OF IMPAIRMENT OF THE GASTRIC EVACUATION FUNCTION IN PATIENTS WITH CICATRICIAL-ULCERATIVE STENOSIS OF THE DUODENUM

Aim. To develop the method of determining the degree of impairment of gastric evacuation function in patients with cicatricial-ulcerative stenosis of the duodenum based on the data of standard daily pH-monitoring.

Materials and methods. There were examined 45 patients with with cicatricial-ulcerative stenosis of the duodenum. All patients underwent a comprehensive endoscopic and X-ray examination of the gastric evacuation function. Gastric secretory function was assessed by intragastric daily pH monitoring.

Results. A method for determining the degree of impaired gastric evacuation function is proposed, including intragastric pH monitoring, which determines the number of duodenogastric refluxes and the values of the parameters: "ratio of pH in the body of the stomach to the pH in the antrum of the stomach," "pH range in the cardiac part of the stomach."

Using the obtained data, the formulas are used to determine values of prognostic coefficients d1, d2 и d3, compare their numerical characteristics, which are what is used to evaluate degree of disorder of gastric evacuation function. With the value of d1 is greater than d2 and d3, the I degree is established, with d2 is greater than d1 and d3 - II degree and with d3 greater than d1 and d2, the III degree of impaired gastric evacuation functionis established.

Conclusion. The proposed method allows establishing the degree of impaired gastric evacuation function during standard intragastric pH monitoring.

The proposed method can be used for automated computerized, remote, screening diagnostics according to the values of daily intragastric pH monitoring.

Keywords: duodenal ulcerative stenosis, evacuation function of the stomach, intragastric pH monitoring.

KOSENKO Pavel Mihajlovich – Candidate of Medical Science, Associate Professor at the Department of general and clinical surgery, Far Eastern State Medical University, e-mail: kosenko@inbox.ru, phone +7 (962) 502-52-06, (responsible for contacts with editor); **VAVRINCHUK Sergey Andreevich** – Doctor of Medical Science, professor, of the Department of general and clinical surgery of the Far Eastern State Medical University; **POPOV Aleksandr Igorevich** – Candidate of Technical Science, Associate Professor of the Department of Applied Informatics, Institute of Mathematics, Information and Space Technologies, Northern (Arctic) Federal University named after M.V. Lomonosov, Arkhangelsk; **TASHKINOV Nikolai Vladimirovich** – Doctor of Medical Science, professor, head of the Department of general and clinical surgery of the Far Eastern State Medical University; **BOIARINTSEV Nikolai Ivanovich** – Doctor of Medical Science, professor of the Department of additional professional education of the Institute of continuous professional education and accreditation of the Far Eastern State Medical University; **SUNOZOVA Galina Dmitrievna** – assistant of the department of general and clinical surgery, Far Eastern State Medical University.

Introduction. Intragastric pH monitoring is a widely accepted standard method for the study of acid and reflux values of the stomach in acid-related diseases, one of which is duodenal (DD) ulcer (UD) [1, 2, 5, 7].

It is known that cicatricial-ulcerative stenosis (CUS) of the duodenum is one of the most frequent complications of ulcer and occurs in 10.0–56.3% of patients [1, 3, 6, 8]. Its main manifestation is a impairment of the gastric evacuation function (GEF), the assessment of the degree of which is crucial for determining indications for surgical treatment, the nature and extent of preoperative preparation [3, 6, 7].

A method has already been proposed for determining GEF impairment according to intragastric pH monitoring after various surgeries for duodenal ulcer [2]. However, a prerequisite for the use of this method is to restore the patency of the pylorus section of the stomach.

Authors performed a postoperative indirect comparative assessment of the evacuation time from the stomach to restore the initial indices of intragastric pH during evacuation to the duodenum of mixed standard food load. In this case, the degree of its preoperative disorder was not assessed using the claimed method.

The disadvantages of this method are the need to use a mixed standard food load, the patient must be in an upright position for 1.5 hours. In the absence of restoration of the initial value of intragastric pH, the need arises to conduct a repeated study.

The objective of our study was to develop the method of determining the degree of violation of the evacuation function of the stomach in patients with

cicatricial-ulcerative stenosis of the duodenum based on the data of standard daily pH-monitoring.

Technical result of the claimed method is the increased precision and simplification of degree of GEF impairment in patients with duodenal CUS.

Materials and methods. There were examined 45 patients with with cicatricial-ulcerative stenosis of the duodenum. They included 36 men and 9 women. Mean age of patients was 50.5±19.1 years.

All patients underwent endoscopic examination, intragastric pH monitoring (Table 1) and X-ray examination of GEF with determination of the extent of its impairment using classification by M.I. Kuzin et al. (1985) [3].

Radiographically, a first-degree GEF impairment was detected in 24 (53.3%) patients, II degree in 13 (28.9%) patients, and III degree in 8 (17.8) patients.

by stepwise incorporation of signs into the model with a final assessment of the contribution of each indicator to the probability share correct classification. DA was performed by the method of step-by-step inclusion of values of daily intragastric pH monitoring into the model according to Tolerance criteria and F-statistics [4]. The grouping parameter was the degree of GEF impairment.

Results. When comparing the values of intragastric pH in patients with the CUS of the duodenum, a relationship was found between the degree of GEF impairment and the intragastric pH values (Table 2).

Taking into account the obtained data, we created a mathematical model for predicting the degree of GEF impairment based on intragastric pH data in patients with duodenal CUS with a patient distribution accuracy of 92 and 100%, which was determined by the number

subjected to standard daily intragastric pH monitoring with a 3-channel pH-metric probe with sensors located in the cardia section, stomach body and antral sections of the stomach.

The use of 3-channel pH-metric probe and the location of the sensors in the sections of the stomach due to the need for simultaneous recording of the pH values of all parts of the stomach and DGR values.

After the end of study in order to determine the degree of GEF impairment with 92% precision, three parameters are evaluated: number of duodenogastric refluxes, "ratio of pH in the body of the stomach to the pH in the antrum of the stomach," "pH range in the cardiac part of the stomach."

Using the resulting numerical values of said pH-monitoring parameters, there are calculated prognostic coefficients d1, d2 and d3 using the formulas:

Values of intragastric daily pH monitoring in patients with duodenal CUS

pH metry indicators		Healthy people (n=22)	Patients with ulcerative stenosis				p1	p2
			degree GEF impairment					
			I (n=24)	II (n=13)	p1	III (n=8)		
Aggres-sion index (pH)	Antrum	5.1±0.9	3.46±0.55*	2.32±0.75*	p<0.05	2.8±1.18*	p<0.05	p>0.05
	Body	2.13±0.28	3.68±1.44*	3.2±0.81*	p>0.05	4.1±0.92*	p<0.05	p<0.05
	Cardial part	4.38±0.51	3.54±1.5*	3.6±1.34*	p>0.05	4.0±1.64*	p<0.05	p>0.05
% of time with pH <2 in the antrum		17.16±2.13	38.7±11.7*	54.1±12.5*	p<0.05	66.7±31.2*	p<0.05	p<0.05
Duodenogastric reflux		47.4±9.5	8.3±2.21*	3.6±2.1*	p<0.05	0	p>0.05	p>0.05
The number of gastroesophageal reflux duration more than 5 min.		2.5±1.5	11.3±6.1*	16.1±2.7*	p<0.05	21.4±2.7*	p<0.05	p<0.05

To compare the values of daily intragastric pH monitoring, we determined the arithmetic average value (M) and standard deviation (s). To assess the normality of the distribution Shapiro-Wilk criterion was used. Comparison of groups by quantitative characteristics was performed using the Mann-Whitney test [4].

To create mathematical models of motor-evacuation disorders in patients with duodenal CUS, we used the discriminant analysis method (DA) based on the values of daily intragastric pH monitoring, which was carried out

of intragastral pH monitoring values included in the model (Table 3).

In clinical practice, the most convenient is the use of a smaller number of values taken into account with an accuracy of 92%. For scientific research, it is recommended to use a mathematical model with a predictive accuracy of 100% with an increased number of intragastric pH monitoring values taken into account (Table 3).

In accordance with our proposed method for indirect determination of the degree of GEF impairment according to intragastric pH monitoring, patients are

$d1 = -24.1293 + 1.4127 \times A1 + 4.0021 \times A2 + 6.3209 \times A3;$

$d2 = -7.78924 + 0.51564 \times A1 + 4.42335 \times A2 + 4.25367 \times A3;$

$d3 = -11.0768 + 0.0464 \times A1 + 7.8569 \times A2 + 5.3359 \times A3,,$

where:

"-24.1293"; "-7.78924"; "-11.0768" - constants;

"1.4127", "4.0021", "6.3209" - values of the coefficients of the discriminant function for d1;

"0.51564", "4.42335", "4.25367" - values of the coefficients of the discriminant function for d2;

"0.0464", "7.8569", "5.3359" - values of the coefficients of the discriminant function for d3;

A1, 2, 3 - numerical values of paramerers of intragastric pH-monitoring:

A1 – "number ofduodenogastral refluxes";

A2 – "ratio of pH in gastric body to pH in antral section of the stomach";

A3 – "range of pH in cardia section of stomach".

The correlation coefficients (R) indices of intragastric pH and the degree of GEF impairment in patients with the duodenal CUS

Indicator	pH Antrum	% of time with pH <2 in the antrum	pH Cardial part	The number of duodeno-gastric reflux	The number of gastroesophageal reflux
Degree of GEF	-0.76 (p<0.05)	0.83 (p<0.05)	0.42 (p<0.05)	-0.83 (p<0.05)	0.36 (p<0.05)

The list of discriminating signs and the values of the coefficient "b" to determine the degree of GEF impairment in patients with the duodenal CUS

Mathematical Model Accuracy (%)	Discriminating Indicators	Coefficient values «b» Degree of GEF		
		I	II	III
92	The number of duodeno-gastric reflux	1.4127	0.51564	0.0464
	body/antrum ratio	4.0021	4.42335	7.8569
	pH range in cardiac	6.3209	4.25367	5.3359
	Constant (a)	-24.1293	-7.78924	-11.0768
100	Max pH in the antrum	-2.6941	9.6565	16.237
	pH in the antrum	21.3092	-3.6820	-23.712
	% of time with pH <2 in the antrum	0.5422	1.1849	1.612
	The number of duodeno-gastric reflux	-0.6771	1.6063	4.081
	Max pH in the body	7.9097	-4.5311	-14.416
	pH in the body	1.8949	-37.6802	-72.754
	pH range in the body of the stomach	-27.9093	34.5131	86.754
	body/antrum ratio	12.5848	-26.0493	-58.277
	Min pH in cardial part	-19.4664	23.3211	58.401
	cardia/body ratio	7.5721	-3.3728	-11.221
	Constant (a)	-66.1773	-81.3965	-126.543

With the value of d1 is greater than d2 and d3, the I degree is established, with d2 is greater than d1 and d3 - II degree and with d3 greater than d1 and d2, the III degree of impaired evacuation function of the stomach is established.

Discussion The use of the proposed method, in comparison with the analogue [2], is much simpler, due to the absence of the need to use a standard food load and the possibility of arbitrary patient behavior. In particular, it is possible to use it in weakened, bedridden patients.

With an increase in the number of discriminatory indicators included in the mathematical model, up to 10, the predictive accuracy of the proposed method for determining the degree of impairment of evacuation function of the stomach reaches 100%.

To simplify the implementation of calculations by the proposed method, we, together with the laboratory of informatization of applied research of NArFU n.a. M.V. Lomonosov (head. Ph.D. Tech, associate professor Popov A.I.) developed a computer program DiaSten-pH, which presents the results of automatic calculation in numerical and graphical form (Figure 1).

Fig. 1. An example of using the program DiaSten-pH to determine the degree of impairment of evacuation function of the stomach in a patient with cicatrical-ulcerative stenosis of duodenum.

When performing intragastric pH monitoring with the Gastroskan-GEM machine, the DiaSten-pH computer program can be considered an addition to it.

DiaSten software is lightweight and cross-platform. It was tested on Windows 7 and Ubuntu 14.04 operating systems. Only free tools were used for software development.

Conclusions. A correlation was established between the degree of impairment of evacuation function of the stomach and the values of acid and reflux indices of intragastric pH monitoring.

On the basis of discriminant analysis of intragastric pH monitoring indicators, mathematical models were created that allow determining the degree of EFS impairment with an accuracy of 92% and 100%.

The use of the computer program DiaSten-pH greatly simplifies the determination of the degree of EFS impairment in patients with duodenal CUS, allows to expand the diagnostic capabilities of intragastric pH-monitoring, and carry out the remote diagnostics of patients.

An example of using the program DiaSten-pH to determine the degree of impairment of evacuation function of the stomach in a patient with cicatrical-ulcerative stenosis of duodenum.

References

1. Ивашкин В.Т., Шептулин А.А., Маев И.В., Баранская Е.К., Трухманов А.С., Лапина Т.Л., Бурков С.Г., Калинин А.В., Ткачев А.В. Клинические рекомендации Российской гастроэнтерологической ассоциации по диагностике и лечению язвенной болезни. РЖГГК. 2016; 26(6):40–54. [Ivashkin VT, Sheptulin AA, Maev IV, Baranskaya EK, Truhmanov AS, Lapina TL, Burkov SG, Kalinin AV, Tkachev AV. Clinical recommendations of the Russian Gastroenterological Association for the diagnosis and treatment of peptic ulcer. RZHGGK. 2016; 26(6):40–54. (In Russ.).]

2. Дурлештер В.М. М.Т. Дидигов, С.В. Авакимян, Е.С. Бабенко Комплексное лечение декомпенсированного руб¬цово-язвенного стеноза двенадцатиперстной кишки. Медицинский вестник Юга России. 2016;3:54-58. [Durleshter VM, Didigov MT, Avakimyan SV, Babenko ES. Comprehensive treatment decompensated duodenal peptic stenosis. Medical Herald of the South of Russia. 2016;(3):54-58. (In Russ.).]

3. Кропачева Е.И., Воробьев М.В., Рудик А.А. Комплексная оценка моторно-эвакуаторной функции желудка после функциональных операций при язвенной болезни 12-перстной кишки. Дальневосточный медицинский журнал. 2002;2:59-64. [Kropacheva EI, Vorob'ev MV, Rudik AA. Comprehensive assessment of motor-evacuation function of the stomach after functional operations in duodenal ulcer. Dal'nevostochnyj medicinskij zhurnal. 2002;2:59-64. (In Russ.).]

4. Кузин Н.М., Окоемов М.Н. Майорова Ю.Б. Хирургическое лечение больных с язвенными пилородуоденальными стенозами. М.: ОАО "Издательство "Медицина", 2007:160. [Kuzin NM, Okoemov MN, Majorova JB. Surgical treatment of patients with ulcerative pyloroduodenal stenoses. M.: ОАО "Izdatel'stvo "Medicina", 2007:160. (In Russ.).]

5. Ланг Т.А., Сесик М. Как описывать статистику в медицине. Аннотированное руководство для авторов, редакторов и рецензентов. М.: Практическая медицина, 2010:480. [Lang TA, Sesik M. How to describe the statistics in medicine. An annotated guide for authors, editors and reviewers. M.: Prakticheskaya medicina, 2010:480. (In Russ.).]

6. Рапопорт С.И., А.А. Лакшин, Ракитин Б.В., М.М. Трифонов рН-метрия пищевода и желудка при заболеваниях верхних отделов пищеварительного тракта. М.:ИД Медпрактика-М, 2005:208. [Rapoport SI, Lakshin AA, Rakitin BV, Trifonov MM. pH-metry of the esophagus and stomach in diseases of the upper digestive tract. M .:Medpraktik-M. 2005:208. (In Russ.).]
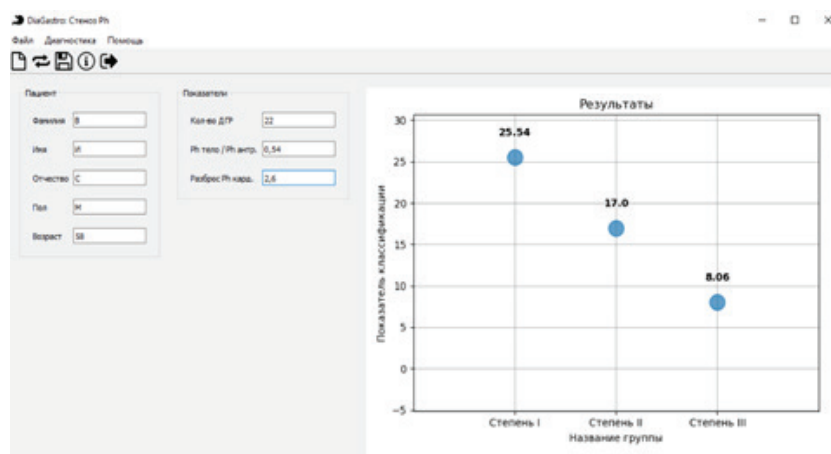
7. Рухляда Н.В., Назаров В.Е., Ермолаев И.А. Диагностика и лечение язвенной болезни, осложнённой стенозом. СПб. ДЕАН. 2006:240. [Ruhljada NV, Nazarov VE, Ermolaev IA. Diagnosis and treatment of peptic ulcer complicated by stenosis. SPb. DEAN. 2006:240. (In Russ.).]

8. Черноусов А.Ф., Хоробрых Т.В., Ветшев Ф.П. Повторные антирефлюксные операции. Вестник хирургической гастроэнтеро-

логии. 2011;3:4-5. [Chernousov AF, Horobryh TV, Vetshev FP. Repeated antireflux operations. Vestnik hirurgicheskoj gastroenterologii. 2011; 3:4-5. (In Russ.).]

9. Яковлев Г.А., Кайбышева В.О., Никонов Е.Л., Мишулин Л.Е., Федоров Е.Д., Шаповальянц С.Г. Суточная ph-метрия пищевода и желудка: ошибки интерпретации данных и их клиническое значение. Доказательная гастроэнтерология. 2018; 3(7): 11-17.

[Jakovlev GA, Kajbysheva VO, Nikonov EL, Mishulin LE, Fedorov ED, Shapoval'janc SG. 24-hour esophageal and gastric pH monitoring: interpretation errors and their clinical significance. Dokazatel'naja gastrojenterologija. 2018; 3 (7):11-17. (In Russ.).]

10. Satoh K, Yoshino J, Akamatsu T. Evidence-based clinical practice guidelines for peptic ulcer disease 2015. J Gastroenterol. 2016; 51:177. DOI: 10.1007/s00535-016-1166-4.

R.N. Zakharova, S.S. Shadrina, T.M. Klimova, E.P. Ammosova, A.I. Fedorov, M.E. Baltakhinova

EPIDEMIOLOGY OF KNEE OSTEOARTHRITIS AMONG RURAL RESIDENTS OF YAKUTIA

Knee osteoarthritis is one of the most common rheumatologic problems. A population study was performed to study the epidemiology of osteoarthritis of the knee joints (gonarthrosis) among the rural indigenous people of Yakutia.

Material and methods: we performed a population study of the adult indigenous population (Yakuts) of 7 villages in central Yakutia. A total of 3.401 people took part in the screening study. The diagnosis of gonarthrosis was made using Altman et al. criteria (1991).

Results: the prevalence of gonarthrosis among the rural population of Yakutia was 12.8% (95% CI: 11.7-14.0) and depended on the age of the examined. Knee osteoarthritis was 2 times more often observed in women. Prevalence rates were 16.9% (95% CI: 15.3-18.7) in women and 7.8% (95% CI: 6.6-9.3) in men, respectively. The mean age of patients with gonarthrosis among the rural population was 56 years. Mechanical overload of the joint in the cold was proved to be the main risk factor for knee osteoarthritis for the rural population.

Conclusions: the high prevalence of gonarthrosis among the indigenous rural residents of Yakutia is due to the features of the population life in the region with extreme climate.

Keywords: epidemiology, gonarthrosis, Yakuts, rural population, Sakha (Yakutia) Republic.

ZAKHAROVA Raisa Nikolaevna – Ph.D (Medicine), senior researcher, Research Center of the Medical Institute of the Northeast Federal University named after M.K. Ammosov, 677000, Yakutsk, ul. Oyunskii, 27, Russia. E-mail: prn.inst@mail.ru, ORCID: 0000-0002-1395-8256; **SHADRINA Svetlana Semenovna** – Senior Researcher, MI NEFU named after M.K. Ammosov, 677000, Yakutsk, ul. Oyunskii, 27, Russia. E-mail: svetlana.maksimo@mail.ru; **KLIMOVA Tatyana Mikhailovna** – Ph.D (Economics), Associate Professor, Chair of Pharmacology and Pharmacy, Medical Institute, Northeastern Federal University named after M.K. Ammosov, Senior Researcher, Department of Epidemiology of Chronic Noncommunicable Diseases, Yakut Science Centre of Complex Medical Problems, Yakutsk, Russia, e-mail: biomedykt@mail.ru. ORCID: 0000-0003-2746-0608; **AMMOSOVA Elena Petrovna** – Ph.D (Medicine), senior researcher, Research Center of the Medical Institute of the North-Eastern Federal University named after M.K. Ammosov, 677000, Yakutsk, ul. Oyunskii, 27, Russia. E-mail: ammosovael@mail.ru, ORCID: 0000-0002-7973-6103. **FEDOROV Afanasy Ivanovich** – Ph.D (Biology), senior researcher, Research Center of the Medical Institute of the Northeast Federal University named after M.K. Ammosov, 677000, Yakutsk, ul. Oyunskii, 27, Russia. E-mail: fedorow@yandex.ru, ORCID: 0000-0002-7973-6103. **BALTAKHINOVA Marina Egorovna** – researcher, Medical Institute of the North-Eastern Federal University named after M.K. Ammosov, 677000, Yakutsk, ul. Oyunskii, 27. E-mail: bmeg@rambler.ru. ORCID: 0000-0003-0986-7754.

Introduction. Osteoarthritis (OA) is one of the most common chronic diseases, reducing the life quality of patients. The disease occupies a leading position in the structure of rheumatic diseases (RD). These diseases often lead to physical disability, and their treatment is the most expensive in the world. Analysis of statistical indicators for Russia in 2015-2016 showed that the main share among the class of diseases of the musculoskeletal system (MSSD) is made up of degenerative joint diseases (the incidence of OA is 4 350 465 cases in 2015; with a slight decrease in 2016 to 4 285 464 cases). Annually in the Russian Federation more than 600 OA new cases are recorded per 100 000 adults. More complete information on the prevalence of chronic RD in the population can be obtained in the course of large-scale epidemiological studies. The first studies of the RD epidemiology were conducted in the early 70s and 80s and differed in approaches to diagnosing the disease, and therefore, the prevalence rate varied widely from 4 to 64% [2, 7, 8, 9]. Epidemiological studies using common methods and diagnostic criteria began to be carried out only in the 90s. These researches indicate the OA widespread prevalence among workers in industrial enterprises and agriculture and range from 18 to 41% depending on the region [2, 8, 9]. The last large-scale

study was initiated by the Institute of Rheumatology of the Russian Academy of Medical Sciences in the mid-2000s as part of the World Decade of Bones and Joints [3, 4]. The research program developed by the Institute of Rheumatology of the Russian Academy of Medical Sciences together with the Association of Rheumatologists of Russia included the study of the epidemiology and economic burden of rheumatic diseases in various regions of the country among different social groups. The project was implemented in 15 regions of the Russian Federation, including the Sakha (Yakutia) Republic.

The Sakha (Yakutia) Republic is located in the permafrost zone, 40% of the republic's territory lies beyond the Arctic Circle. The region is characterized by a long period of below zero temperatures, the absolute value of the minimum temperature and a significant difference in temperatures in the cold and warm periods of the year. As of January 1, 2018 964.3 thousand people live in the Republic (population density - 0.31 people / km2), including the rural population - 331.5 thousand (34.4%), urban - 632.9 (65.6%). According to 2010 census, the national composition of the population is represented by Yakuts (45.5%), Russians (41.2%), Ukrainians (3.6%), Evenks (1.9%), Evens (1.2%), and other nationalities (6.6%). The territory of the