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Artificial intelligence in cardiology

Markers of visceral obesity dysfunction and association with cardiovascular risk

Challenges of early diagnosis and prevention of cardiovascular disease in Sub-Saharan Africa

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CONTACT DETAILS:
Cardioprogress Foundation and Editorial Office:
Room 213, Building 2, Prospect Gostinichny 6, Moscow 127106, Russia
Editorial Office tel.: (+7) 965 236 1600
Official website: http://www.heart-vdj.com

Editorial correspondence should be sent to:
Mekhman Mamedov, Editor-in-Chief,
editor.ihvdj@gmail.com
Articles for publication should be sent to:
Anna Arteyeva, Associate Editor,
submissions.ihvdj@gmail.com

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International Heart and Vascular Disease Journal

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Contents

Editor's Welcome

Dear colleagues!

We present to your attention the next, forty-third issue of the International Heart and Vascular Disease Journal that includes the leading, original, review articles.

The "Leading Article" section begins with an overview of the application of artificial intelligence (AI) in cardiology. In particular, it can be used to assess the results of diagnostic procedures and predict the risk of complications. In the future, AI may be used to select therapeutic tactics. The strengths and weaknesses of AI need to be assessed in order for cardiologists to use this technology effectively.

Four papers are presented in the "Original Articles" section. The first article analyzes arrhythmias and heart rate variability indices in the presence and absence of silent myocardial ischemia. Patients with silent ischemia were found to have normal autonomic innervation of the heart, which may be an additional reason for less severe arrhythmias. In addition, ventricular extrasystoles and tachycardias are less frequent in this case according to the Holter monitoring, indicating a milder course of coronary heart disease. The second article focuses on the determination of some parameters of physical activity and their associations with disease prevention among men engaged in mobile work in the Arctic zone of Russia, depending on the length of service as an expeditionary shift worker. The sample consisted of 750 men aged 25-54 years, with a response rate of 82.4%. Regardless of the length of service in the expeditionary shift work, the lowest level of responsibility for their health was found in the groups with low physical activity.

Two other original articles focused on metabolic disorders. One examined cardiometabolic risk and body composition characteristics in women with rheumatoid arthritis (RA). Patients with RA are characterized by a predisposition for overweight/obesity and high cardiometabolic risk. The authors found that with decreasing BMI, there is a tendency to develop sarcopenia/sarcopenic obesity, which is associated with greater pain intensity on a visual analog scale. Another article evaluated the association of apelin-12 with other indeces of visceral obesity in obese patients. The study included 167 patients aged 40-70 years without cardiovascular disease (CVD). All were assessed for cardiovascular risk (CVR) using the SCORE-2 scale. The results indicate that apelin-12 can be used in the diagnostic protocols of patients with visceral obesity and high CVR.

The "Review Articles" section presentes the work devoted to analyzing the problems of early diagnosis and prevention of CVDs in the countries of Sub-Saharan Africa. CVDs contribute to about 13% of all-cause mortality and to 38% of all deaths due to non-communicable diseases in the countries of the region. CVD risk factors are often more prevalent in areas of uncontrolled urbanization and among people with low income and education levels. Early diagnosis and prevention are limited by resource constraints, socio-economic inequalities and healthcare system problems.

We invite everybody to collaborate with the journal. We are waiting for your original papers, review articles, discussions, and opinions about problems, treatment and prophylaxis recommendations

Mekhman N. Mamedov
Editor-in-Chief
President of the "Cardioprogress" Foundation

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International medical review

Researchers evaluated the effect of sodium intake on the risk of atrial fibrillation (AF) in people with cardiovascular diseases (CVD) or diabetes. Reducing sodium intake may be an effective prevention strategy for patients.

The analysis showed that there was a J-shaped relationship between sodium intake and the risk of AF. Consumption of 8 g or more of sodium per day was associated with a 32% increased risk of AF compared with sodium intake of 4 to 5.99 g/day.

The authors concluded that reducing sodium intake may be the best strategy for preventing AF in people with CVD and diabetes.

According to the JAMA

Researchers have reported the ability of protein "signatures" to predict the onset of 67 diseases. These included multiple myeloma, non-Hodgkin's lymphoma, motor neuron disease, pulmonary fibrosis and dilated cardiomyopathy.

The analysis showed that the determination of 5 protein concentrations without additional information for the prognosis of 163 diseases is equivalent to clinical models and significantly outperforms them for the prognosis of 30 pathologies.

This method offers new predicting possibilities for a variety of diseases, including rare pathologies.

According to the Nature journal

Scientists at the Texas Heart Institute (THI) have implanted the first titanium BIVACOR *total artificial heart* in a human. Eight days later, the patient was successfully transplanted with a donor heart.

The experts believe that such device can be used in people with severe biventricular heart failure or unilateral dysfunction for whom the use of a left ventricular assist device is not recommended.

According to the THI press office

Researchers evaluated the effect of antihypertensive therapy on target organ damage in patients with latent hypertension.

Data from 320 patients with latent hypertension who were not previously treated were analyzed. They were randomized 1:1 into active treatment (antihypertensive therapy) and placebo groups. The effect on target organ damage, defined as normalization of brachial-ankle pulse wave velocity and albumin-to-creatinine ratio, was assessed.

The authors concluded that antihypertensive therapy reduced mean daily BP and target organ damage in patients with latent hypertension.

According to The Lancet journal

Experts evaluated the association between tooth loss and cardiovascular disease (CVD) mortality.

The initial analysis showed that losing all teeth or having fewer than ten teeth was associated with CVD mortality, with a risk ratio of 1.66, meaning that people with tooth loss were more than 66% more likely to die from heart disease than the general population. Further analysis revealed significant heterogeneity in the results of the studies analyzed among participants with 10 or fewer teeth. Those with all teeth missing had a higher risk and no heterogeneity of results was observed.

The authors concluded that missing teeth or having fewer than 10 teeth can be considered a prognostic factor for CVD mortality.

According to the JOE

American scientists were able to predict 30-year cardiovascular risk in women using a blood test. The analysis showed that women with the highest levels of low-density lipoprotein cholesterol had a 36% higher risk of cardiovascular events than participants with the lowest levels. Women with the highest levels of lipoprotein(a) had a 33% increased risk, and those with high levels of C-reactive protein had a 79% increased risk. Data from 27,939 healthy women with an average age of 54.7 years were analyzed. During 30 years of follow-up, 3,662 cardiovascular events were registred.

According to the NEJM Journal

Researchers from Sweden analyzed the relationship between the level of antibodies to phosphorylcholine and the development of cardiovascular diseases (CVD) in elderly women.

The analysis showed that women with the highest levels of antibodies to phosphorylcholine (161 U/mL) had a 60% lower risk of developing CVD than patients with the lowest levels (20 U/mL).

Data from 932 women with a mean age of 66 years were examined. The levels of antibodies to phosphorylcholine were determined in the serum of the participants using enzyme immunoassay. The average follow-up time was 16 years. During this period, 113 women developed CVD.

The authors concluded that antibodies to phosphorylcholine can be used as a risk marker for CVD.

According to the JACC journal

Artificial intelligence in cardiology

Mamedov M.N., Savchuk E.A., Karimov A.K.

National Medical Research Center for Therapy and Preventive Medicine, Moscow, Russia

AUTHORS

Mekhman N. Mamedov, MD, PhD, Professor, Head of the Secondary Prevention of Noncommunicable Diseases Department, National Medical Research Center for Therapy and Preventive Medicine, Moscow, Russia. ORCID: 0000-0001-7131-8049

Elizaveta A. Savchuk, Research Laboratory Assistant of the Secondary Prevention of Noncommunicable Diseases Department, National Medical Research Center for Therapy and Preventive Medicine, Moscow, Russia. ORCID: 0000-0001-7634-0448

Azamat K. Karimov, Junior Researcher of the Secondary Prevention of Noncommunicable Diseases Department, National Medical Research Center for Therapy and Preventive Medicine, Moscow, Russia. ORCID: 0000-0003-1255-0416

Artificial intelligence (AI) holds great promise in cardiology for evaluating the results of diagnostic procedures, including X-ray imaging, electrocardiography, echocardiography, computed tomography, and magnetic resonance imaging. It can reveal abnormalities that were previously difficult for cardiologists to detect. In addition, AI can be used to predict the risk of complications. In the future, various types of medical AI will be used to treat cardiovascular diseases; however, AI itself will not be able to replace the physicians. Reports of randomized controlled trials confirming the benefits of cardiovascular AI are emerging. The strengths and weaknesses of medical AI need to be evaluated so that cardiologists can effectively use this technology to improve patient care.

Keywords: artificial intelligence, diagnostics, cardiology.

Conflict of interests: none declared.

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Introduction

The World Health Organization's Global Strategy for Digital Health 2020-2025 states that technological healthcare should be accessible to patients. The security and confidentiality of information, transparency of data processing, and strengthening trust in e-services are identified as priorities [1]. In Russia, more than 60 billion rubles have been invested for the federal project "Development of a network of national medical research centers and introduction of innovative medical technologies" for the period of 2019-2024 [2].

Innovative technologies in healthcare include artificial intelligence (AI), medical robotics, wearable

* Corresponding author. Тел./Tel. +7 (926) 228-3309. E-mail: mmamedov@mail.ru

devices for health monitoring, genome analysis and editing, virtual and augmented reality technologies, implantable devices and prostheses, drug delivery systems, bioprinting, and telemedicine.

AI is the imitation by a computer of human logic and thought processes to solve various tasks. Machine learning is one of the branches of AI and involves processes by which a computer acquires and recognizes data. The machine then makes assumptions based on the identified relationships.

AI is an assistant to scientists and doctors in various medical fields, including

- Electronic medical record management;
- Disease diagnosis;
- Pharmacological and surgical treatment planning;
- Personalized medical care;
- Health monitoring;
- Drug development;
- Conducting virtual consultations [3].

The first application of AI in medicine was described in 1976; it was the development of a computer algorithm to identify the causes of acute abdominal pain [4]. Since then, the range of AI applications has expanded considerably. The technology has also facilitated the early detection of conditions such as skin cancer and diabetic retinopathy, as well as image interpretation in the field of radiology. In addition to diagnostic imaging, data have been published on the application of AI in the manufacture of neuroprostheses for stroke patients using a brain-computer interface.

Cardiovascular diseases (CVD) are the subject of numerous studies using AI [5]. Several types of AI are being developed for various instrumental studies such as X-ray, electrocardiography (EKG), echocardiography (EchoCG), computed tomography (CT), and magnetic resonance imaging (MRI). It is expected that the use of AI in cardiology will be recommended in clinical practice as soon as substantial evidence is available [6].

The following is a brief review of published studies on the use of AI in the diagnosis of CVD.

Studies of artificial intelligence use in X-ray imaging

In the field of cardiology, the use of chest X-ray imaging is a fundamental tool in the process of differential diagnosis. Toba et al. developed an AI model that assumed hemodynamics based on chest radiography data using the scans of 657 patients with congenital heart disease [7].

A high correlation coefficient was observed between the ratio of pulmonary to systemic blood flow measured through the catheter and that obtained by AI from radiographic data. Matsumoto et al. developed an AI system for the differentiation of heart failure (HF) from normal findings using the chest X-ray scans [8].

By leveraging the transfer learning with the VGG16 model obtained from ImageNet, an AI was developed to differentiate between HF and the norm on 638 chest radiographs, achieving an accuracy of 82%. The sensitivity and specificity were 75% and 94%, respectively.

EKG AI research

The automatic interpretation of electrocardiograms (EKG) is a widely utilized clinical practice, enabling the identification of arrhythmias and ST segment alterations. EKG AI is capable of identifying abnormalities that were previously challenging to discern with automated devices. Attia et al. state that the application of AI in EKG is capable of anticipating the emergence of atrial fibrillation (AF) during sinus rhythm [9]. Following the publication of a study in which the onset of AF was predicted by EKG-based AI in 180,922 cases (sensitivity 79%, specificity 79.5%), clinicians expressed interest in this method.

In a randomized controlled trial (RCT), Yao et al. evaluated the efficacy of EKG AI in detecting a decrease in ejection fraction (EF) [10]. A total of 22,641 cases were randomly in two groups (with and without EKG AI) to facilitate a comparison of the diagnostic rate for detecting reduced EF. In the cohort utilizing EKG AI, the incidence of identifying diminished EF rose by approximately 30%.

Other authors developed AI for diagnosing cardiac amyloidosis [11]. The model worked successfully in 3191 cases. The researchers also got better results when they combined this method with EchoCG.

Sawano et al. developed an AI using EKG data of 29,859 cases and found aortic regurgitation with a high area under the ROC-curve (AUC) of 0.80 [12]. In general, the development of EKG AI has progressed rapidly in recent years.

Echocardiographic studies using artificial intelligence

In recent years, automatic measurement of cardiac function, disease diagnosis and evaluating the prognosis with EchoCG AI are being developed. EchoNet-Dynamic is an automated AI for EchoCG [13].

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Using three-dimensional (3D) CNN and semantic segmentation based on 10,030 EchoCG videos for training, an AI was developed that can be used to automatically measure the value of EF. The correlation coefficient between the EF value inferred by the AI and the value determined by EchoCG experts reached 0.9, corresponding to an AUC of 0.97.

Salte et al. developed an AI that measures global longitudinal strain using EchoCG video [14]. The correlation coefficient between the actual measured global longitudinal strain and the estimated global longitudinal strain of the AI reached 0.93, suggesting that the AI can reduce the examination time for EchoCG.

Ulloa Cerna et al. developed a highly accurate AI for predicting one-year prognosis (AUC 0.83) based on EchoCG video of 32,362 individuals [15]. Cardiologists using this model significantly improved predictive sensitivity by 13% in predicting one-year survival based on EchoCG video.

Shad et al. developed an AI that predicts postoperative right ventricular failure from preoperative EchoCG video recording, and its predictive performance showed an AUC of 0.73, which was higher than that of a group of clinical experts with an AUC of 0.58 [16].

Studies of artificial intelligence use in CT imaging

Coronary arteries (CA) CT is used to evaluate the status of the CA without invasive intervention. Many types of CT AI have been developed using analysis techniques such as 3D CNN.

Martin et al. reported that CT fractional flow reserve (FFR) was useful in predicting revascularization and major adverse cardiac events (MACE) [17]. In 159 cases, CT FFR could predict the occurrence of revascularization and MACE at one year with higher accuracy than conventional coronary CT angiography (odds ratio = 3.4).

Zeleznik et al. developed an AI to assess the rate of CA calcification from conventional CT data and predict cardiovascular events [18]. The AI assessed the rate of CA calcification from conventional (non-contrast) CT data in 20,084 cases. The Spearman correlation coefficient between the specialists' measurements and the estimated significance of the AI was 0.92. In addition, the AI-based calcification score was useful for predicting cardiovascular events (hazard ratio = 4.3).

Kumamaru et al. developed an AI that calculates fractional flow reserve from coronary CT data [19]. They used the CA CT scans from 921 cases. Automatic assessment of fractional blood flow reserve by CT AI can detect abnormal fractional blood flow reserve with an AUC of 0.78, sensitivity of 84.6% and a specificity of 62.6%.

MRI AI research

AI is used in the interpretation of cardiac MRI results.

Knott et al. reported on the prediction of cardiovascular events using AI that automatically assesses myocardial perfusion [20]. Myocardial perfusion reserve was assessed by using cardiac MRI scans in 1049 cases, indicating the importance of MRI AI in predicting cardiovascular events.

Zhang et al. developed a model to detect past myocardial infarction (MI) with a non-contrast MRI [21]. The MI was detected with a high accuracy of 99%.

Piccini et al. developed an AI to simulate expert assessment of cardiac MRI image quality using the scans of 424 cases [22]. The results of the regression analysis, assessing the performance of this AI, agreed very well with the conclusions of the experts.

Cardiovascular AI with GAN use

GAN is a fake image generation method that uses learned data to generate non-existent images [23].

GAN consists of two networks: a generator (generation network) and a discriminator (discrimination network), and the quality of images can be improved by competing these networks with each other. In recent years, GAN has been used in the development of cardiovascular AI. Miyoshi et al. developed an AI that interprets the degree of neointima coverage and the degree of yellow color on angioscopic images of 47 cases [24]. The reading accuracy of the AI improved from an AUC of 0.77 to 0.81 when vascular endoscopy data were supplemented with GAN.

Diller et al. used GAN to generate 100,000 cardiac MRI images from 303 cases of congenital heart disease [25]. GAN may be useful for imaging rare diseases.

The ethics of medical AI

There are several examples of potential misuse of AI, such as the collection of information for commercial purposes or the monitoring of personal behavior without consent. It has been noted that even in the absence of negative intent, the use of limited, poor quality, and unrepresentative data to analyze AI can lead to deepening biases and inequalities. Ethics are important in the development of medical AI. In other words, ensuring transparency, fairness, non-harm, accountability, and confidentiality are important in the ethics of medical AI [26].

The World Health Organization has identified the following ethical principles for AI:

- Protection of human autonomy;
- Supporting human welfare, safety, and the public interest;
- Ensuring transparency, clarity and understandability;
- Promoting responsibility and accountability;
- Ensuring inclusiveness and fairness;
- Promoting flexible and sustainable AI [27].

Rogers et al. reported on the need to familiarize patients and the public with the perspectives of medical AI [28].

It is also necessary to consider how medical AI will affect the doctor-patient relationship.

Will the AI replace the medical staff in cardiology practice?

AI for diagnostics (including wearable devices) in cardiology is expected to develop in the future. Although various types of medical AI have been developed for the treatment of CVD, they will never eliminate the need for physicians to be present. In Japan, the physician is primarily responsible for patient care, so the role of medical AI is still to assist the physician.

To date, several types of medical AI have been developed for diagnosis, while the development of AI for treatment is limited. RCTs, but not the AI predictions, are the gold standard for determining the best treatment protocols for specific conditions. Physicians will continue to play an important role in determining the best treatment for each patient. On the one hand, physicians should use AI to improve and verify diagnosis. On the other hand, physicians using AI should be aware that AI is vulnerable to some unrecognized data. If physicians fully understand the weaknesses of AI and use AI judiciously, we can expect an improvement in diagnostic accuracy. In a study based on a questionnaire survey of 1041 radiologists and residents, limited knowledge of AI was associated with fear of replacement, whereas intermediate to advanced knowledge of AI was associated with positive attitudes toward AI [29].

As cardiologists become more knowledgeable about AI, they will become more supportive of the use of AI and will be able to use AI more effectively in clinical practice.

Conclusion

Medical AI is developing rapidly, and the technologies developed have great prospects in cardiology practice. AI can be used in cardiology primarily for diagnostic purposes in the interpretation of techniques such as X-ray, EKG, EchoCG, CT and MRI. At the same time, limited AI developments are available for selected CVD treatments. Physicians will continue to play an important role in determining the optimal treatment for each patient. Overall, medical AI will not be able to replace the work of physicians. With a better understanding of the effectiveness of medical AI, cardiologists will be able to use it to improve the care of patients with various CVD.

Conflict of interests: none declared.

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Analysis of arrhythmias and heart rate variability according to Holter monitoring in patients with silent myocardial ischemia

Abdrakhmanova A.I.[1,2], Tsibulkin N.A.[3], Amirov N.B.[4,5]

[1] Kazan Federal University, Kazan, Russia.
[2] Interregional Clinical Diagnostic Center, Kazan, Russia.
[3] Branch Campus of the Russian Medical Academy of Continuous Professional Education, Kazan, Russia.
[4] Kazan Medical State University, Kazan, Russia.
[5] Medical and Sanitary Unit of the Ministry of Internal Affairs of the Russian Federation for the Republic of Tatarstan, Kazan.

AUTHORS

Alsu I. Abdrakhmanova*, MD, PhD, Associate Professor, Department of Internal Diseases, Institute of Fundamental Medicine and Biology, Kazan Federal University, Kazan, Russia; Doctor at Cardiology Department, Interregional Clinical Diagnostic Center, Kazan, Russia, Kazan, Russia, ORCID: 0000-0003-0769-3682

Nikolay A. Tsibulkin, MD, PhD, Associate Professor, Department of Cardiology, X-ray Endovascular and Cardiovascular Surgery, Branch Campus of the Russian Medical Academy of Continuous Professional Education, Kazan, Russia. ORCID: 0000-0002-1343-0478

Nail B. Amirov, MD, PhD, Professor, Department of Polyclinic Therapy and General Medical Practice, Kazan Medical State University, Kazan, Russia; Deputy Head of the Science Department, Medical and Sanitary Unit of the Ministry of Internal Affairs of the Russian Federation for the Republic of Tatarstan, Kazan, Russia. ORCID: 0000-0003-0009-9103

The aim of the study was to analyze arrhythmias and heart rate variability parameters in the presence and absence of silent myocardial ischemia (SMI).

Methods. The results of Holter monitoring (HM) of 288 patients (mean age — 63.2±10.7 years), were analyzed. The following parameters were studied: ECG rhythm; heart rate (HR); ventricular extrasystoles (VE); ventricular tachycardia (VT); QT interval; ST segment displacement; T-wave; heart rate variability (HRV), standard deviation of NN interval (SDNN); root mean square of the differences in successive R-R interval (rMSSD), circadian index (CI), and circadian profile (CP).

Results. Patients with SMI more often ($p<0.00005$) had permanent atrial fibrillation (AF), while it is not a complication of myocardial infarction. The SMI group has higher mean daytime HR ($p<0.05$) and maximum HR ($p<0.00001$)

* Corresponding author. Tel.: +7 (917) 922-6629. E-mail: alsuchaa@mail.ru

compared to the control group (CG). SMI patients had lower minimum HR (p<0.05) and difference between maximum and minimum HR compared to CG (p<0.0000005). In the SMI group of patients with VE (p<0.005), the number of VE per day (p<0.001), the mean number of VT episodes (p<0.05) per day were significantly lower compared to CG patients. In SMI, the episodes of ST-segment depression (p<0.05) and negative T-waves (p<0.005) were significantly more frequent, and these changes were more often associated with physical activity (PA) compared to CG (p<0.05). Diurnal SDNN was significantly higher in the SMI group compared to CG (p<0.0005). Decreased CI (p<0.000005) and rigid CP (p<0.005) were less frequent in SMI patients compared to CG patients.

Conclusion. VE and VT were less frequently detected during HM in patients with SMI, indicating a milder course of coronary heart disease (CHD), where ventricular arrhythmias (VA) are one of the indicators. In patients with SMI, HRV data show normal autonomic innervation of the heart, which may be an additional reason for less severe VA along with a milder course of CHD.

Keywords: silent myocardial ischemia, heart rate variability, coronary heart disease, Holter monitoring, electrocardiography.

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Introduction

Silent myocardial ischemia (SMI) is a transient disturbance of myocardial perfusion, metabolism, function, or electrical activity that is not accompanied by angina pectoris or its equivalent [1]. The pathogenesis of SMI is thought to involve alterations in the autonomic regulation of cardiac activity accompanied by cardiac rhythm disturbances [2]. Holter monitoring (HM) allows detecting myocardial ischemia, the presence of arrhythmias and analyzing the state of autonomic regulation of the heart [3, 4]. Analysis of heart rate variability (HRV) allows to evaluate the state of autonomic regulatory influences [5]. Firstly, the activation of the sympathoadrenal system and the decrease of the parasympathetic activity raise the probability of myocardial electrical instability and fatal arrhythmias; secondly, most episodes of myocardial ischemia are accompanied by changes in the state of autonomic nervous system [6, 7]. The aim of the study was to evaluate the arrhythmias and HRV parameters in the presence and absence of SMI. The analysis of HM was aimed at clarifying the course and pathogenesis of SMI, which can be manifested not only by ST-segment dynamic changes, but also by ventricular arrhythmias (VA).

Methods

The study was retrospective, observational, analytical. The subject of the study were medical records of inpatients treated in the cardiology department of Interregional Clinical Diagnostic Center (Kazan). The medical records of 288 patients, mean age 63.2±10.7 years, were analyzed.

Inclusion criteria in the SMI group were following: patients discharged from hospital with the diagnosis of CHD, SMI confirmed during hospitalization (a combination of painless and painful myocardial ischemia was allowed); presence of VA according to HM. The control group (CG) consisted of patients discharged from hospital with the following diagnosis: CHD: angina pectoris; absence of SMI according to the HM and exercise testing; with VA according to HM. Exclusion criteria were: acute coronary syndrome; acute cerebral circulatory failure or transient ischemic attack within 3 months before the study; functional class III-IV heart failure; cardiomyopathies; inflammatory diseases of myocardium, endocardium, pericardium; heart defects; severe liver and kidney pathology; severe anemia; decompensated diabetes mellitus.

The following HM parameters were analyzed: baseline rhythm; heart rate (HR) (mean diurnal HR, mean daytime HR, mean nocturnal HR); maximum HR (relation to PA, relation to complaints); minimum HR; ventricular extrasystoles (VE) (number per day, number per hour, relation to PA), VE pairs (number per day), VE groups (number per day); ventricular tachycardia (VT) (number per day), maximum HR of VT (beats per min), maximum duration of VT; corrected QT interval (ms); ST segment displacement (number of episodes, total duration, maximum depression, minimum threshold HR, relationship to exertion); T-wave (negative, recovery to positive, at isoline, relationship to exertion); rhythm variability: standard deviation of NN interval (SDNN) diurnal (ms), SDNN daytime (ms), SDNN nocturnal (ms), root mean square of the differences in successive R-R interval (rMSSD) diurnal (ms), rMSSD daytime (ms), rMSSD nighttime (ms); circadian index (CI); circadian profile (CP) [8, 9].

Statistical analysis

The results of the study were processed using methods of parametric and non-parametric analysis using the program STATISTICA 12.0 (StatSoft). Quantitative indicators were evaluated for conformity to normal distribution using Shapiro-Wilk and Kolmogorov-Smirnov tests. For quantitative indicators with normal distribution, arithmetic mean (M) and standard deviation (SD) were calculated. For quantitative indicators with non-normal distribution, median (Me) and interquartile range (Q1-Q3) were calculated. For values in normally distributed populations, Student's t-test was used. In cases of non-normal distribution, the Mann-Whitney U-test was used. Differences were considered statistically significant at a significance level of $p<0.05$.

Results

The clinical characteristics of the patients included in the study are shown in Table 1. Patients in the SMI group were significantly older (p=0.0001) compared to CG patients. Females were significantly (p=0.04) more common in the SMI group. Myocardial infarction (MI) was detected 43% less frequently in the SMI group than in the CG (p=0.00001), silent MI was detected 15.2% more frequently in the SMI group than in the CG group (p=0.04). Coronary artery bypass grafting (CABG) (p<0.005) and coronary stenting (CS) were performed 3 times less frequently in SMI patients (p<0.00001) than in CG.

Table 2 shows the characterization of HM parameters in SMI and CG groups. Permanent atrial fibrillation (PAF) was found in 23.2% of patients in SMI and in 0.7% of cases in CG. AF occurred 33 times more frequently in SMI patients compared to CG (p=0.00001), and AF was not a complication of MI (only 6 of 35 (17.1%) patients with AF were found to have a confirmed history of MI). The SMI group had higher mean daytime HR (p=0.01) and maximum HR (p=0.000005) compared to CG patients. CG patients more often had a higher maximum HR associated with discomfort compared to SMI patients (p=0.0001). SMI patients had a lower minimum HR compared to CG (p=0.03) and a lower difference between maximum and minimum HR compared to CG (p=0.0000002).

SMI group had higher achieved maximum HR (p=0.000005) and mean daytime HR (p=0.01) compared to CG according to HM results. The SMI group also had less frequent VE (p=0.001), lower number of VE (per day) (p=0.0006), mean number of VT episodes (p=0.03) compared to CG. Patients with SMI had significantly more episodes of the diurnal ST-segment depression (p=0.03) and the negative T-wave (p=0.002); these changes were less frequently associated with VE compared to CG (p=0.04).

Diurnal SDNN was significantly higher in the SMI group compared to CG (p=0.001). When HRV parameters in SMI and CG groups were examined in patients with sinus rhythm, daily SDNN (p=0.001) was significantly higher in patients with SMI. In the SMI group, decreased CI was found less often compared to CG (p=0.00004), circadian HR profile was normal more often (p=0.001).

Table 1. **Characteristics of patients with VA according to the HM data (n=288)**

Characteristics		SMI (n=151)	CG (n=137)	p
Age, Me [IQR; 25%–75%]		66.0 [59–73]	60.0 [55–67]	0.0001
Gender	male. n (%)	106 (70.2 %)	118 (86.1 %)	0.04
	female. n (%)	45 (29.8%)	19 (13.9 %)	
Postinfarction cardiosclerosis, n (%)		49 (32.4 %)	92 (67.1 %)	0.00001
Confirmed silent MI, n (%)		16 (32.6 %)	16 (17.4 %)	0.04
CABG, n (%)		5 (3.3 %)	17 (12.4 %)	0.004
CS, n (%)		19 (12.6 %)	56 (40.9 %)	0.00001
Arterial hypertension, n (%)		126 (83.4 %)	120 (87.6 %)	0.3
Diabetes mellitus, n (%)		31 (20.5 %)	30 (21.9 %)	0.8

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Table 2. **Characteristics of HM parameters in SMI and control groups with VA (n=288)**

Characteristics		SMI (n=151)	CG (n=137)	p
Baseline rhythm	Sinus, n (%)	116 (76.8 %)	136 (99.3 %)	0.00001
	AF, n (%)	35 (23.2 %)	1 (0.7 %)	
Mean daytime HR (beats per minute), Me [IQR; 25%–75%]		78 [67–87]	72 [65–78]	0.01
Max. HR (beats per minute), Me [IQR; 25%–75%]		120 [106–142]	108 [99–123]	0.000005
Max. HR, symptomatic, n (%)		0 (0 %)	14 (10.2 %)	0.0001
Difference between max. and min. HR (beats per minute), Me [IQR; 25%–75%]		72 [57–93]	59.5 [46–72]	0.0000002
Amount of VE (per day), Me [IQR; 25–75%]		12,5 [1–81]	38 [6–268]	0.0006
VE presence, n (%)		138 (91,4 %)	135 (98.5 %)	0.001
VT (average number per day), Me [IQR; 25–75%]		1 [1–1]	1 [1–2]	0.03
Number of ST-segment depression episodes per day, Me [IQR; 25–75%]		2 [1–3]	1 [1–1]	0.03
Relationship of ST-segment depression to exercise, n (%)		67 (44,4 %)	9 (75 %)	0.04
Negative T-wave, n (%)		15 (10 %)	2 (1.5 %)	0.002
Diurnal SDNN (ms), Me [IQR; 25%–75%]		125,0 [101-148]	105.5 [79–134]	0.001
Daytime SDNN (ms), Me [IQR; 25–75%]		100,0 [91-117] n=23	85 [66.5–109.5] n=45	0.06
Nocturnal SDNN (ms), Me [IQR; 25–75%]		83,0 [64,5–106] n=23	94 [66–115] n=45	0.5
CI, Me [IQR; 25–75%]		1,19 [1,16–1,25]	1.15 [1.1- 1.21]	0.000004
Circadian profile of HR	normal, n (%)	39 (52.7 %)	37 (29.6 %)	0.001
	rigid, n (%)	35 (47.3 %)	88 (70.4 %)	

Discussion

Patients in the SMI group were older than those in the CG group. This was probably because VA occur at an earlier age in CG than in SMI. Presumably, the myocardium in SMI has a lower predisposition for this type of arrhythmia and SMI is a condition that occurs at an older age, which is supported by the literature [10]. Females were more common in the SMI group, which may be due to decreased estrogen levels, changes in levels of other hormones including increased levels of follicle-stimulating hormone, low estrogen and progesterone levels. That, among other factors, may contribute to the development or worsen the course of SMI [11].

The SMI group had a lower incidence of MI compared to CG, but silent MI was more often identified retrospectively in this group, which is due to the fact that more cases of MI are asymptomatic in SMI [12]. CABG and CS were performed less frequently in patients with SMI than in CG. This may be due to the fact that SMI patients were not admitted to the hospital with acute coronary syndrome, hemodynamic disturbances due to the absence of pain syndrome, and therefore CS and CABG were performed less frequently. PAF without MI was detected 33 times more often in patients with SMI than in CG. Myocardial ischemia, especially painless, is an independent risk factor for the development of AF, which is associated with the specific characteristics of the myocardium in such patients.

The SMI group had higher mean daytime and maximum HR compared to CG patients, which was due to the fact that SMI patients did not have clinical manifestations in the background of HR increase, which may limit its level. In CG patients, maximum HR was more often associated with discomfort, which was due to the fact that patients with SMI did not have clinical manifestations. In patients with SMI the minimum HR and the difference between maximum and minimum HR was lower compared to CG. It can be assumed that in SMI the range of sinus node capabilities is wider.

In the SMI group, HM showed higher achieved maximum HR and average daytime HR compared to CG, which was associated with the fact that SMI patients have a higher tolerance to PA, as the level of exercise is not limited by the occurrence of clinical manifestations. At the same time, AF was detected significantly more often in the SMI group. There may be a relationship between high HR and the frequency of AF detection in the SMI group, these phenomena are related to the myocardial structure in these patients. The SMI group had less frequent VE, lower number of VE (per day) and average number of VT attacks compared to CG. It is possible that the myocardial structure itself is unique in SMI, resulting in a lower predisposition to VA, ultimately indicating a more favorable prognosis in such patients. Patients with SMI were significantly more likely to have daytime episodes of ST-segment depression and negative T-wave. Patients with SMI are ECG reactive patients with unique characteristics of myocardial functional state; they have different responses to ischemia and PA.

Diurnal SDNN was significantly higher in the SMI group compared to CG. SDNN is an integral general assessment indicator of the sinus rhythm wave structure presence; its increase usually indicates a decrease in the number of monotype intervals in the intervalogram, i.e. weakening of sympathetic activity and increase of vagal effects and central regulation activity. In patients with SMI, PAF was registered more often, which means that in these patients this index does not show an obvious vegetative dependence, but determines a high adaptive corridor of rhythm fluctuations. Inverse dependence was found in the SMI and CG groups by the level of the SDNN at night and during the daytime. Daytime SDNN shows predominantly sympathetic effects, while nighttime SDNN — the parasympathetic effects. These functions are not only different, but they are opposite in 2 groups. Perhaps the balance of the autonomic nervous system is altered in SMI. In the SMI group, a decrease in CI was found less often compared to CG, and a normal CP — more often. This indicates that the total effect of autonomic regulation of blood circulation is high in SMI and its increase is associated with increased vagal activity. It means that there are no disturbances of central and autonomic connection of heart rhythm regulation, better prognosis and lower risk of fatal arrhythmias in SMI compared to CG. CG shows a certain impairment of the central and autonomic link of heart rhythm regulation and is associated with poor prognosis and high risk of sudden cardiac death. In rigid rhythm, which is significantly more common in CG, parasympathetic control of cardiac activity is reduced, and rigid rhythm is a precursor of fatal arrhythmias.

Conclusion

In patients with SMI, VE and VT are detected less frequently during the HM, indicating a milder course of CHD, where the ventricular arrhythmias are one of the indicators of its severity. In patients with SMI, HRV data show normal autonomic innervation of the heart, which may be an additional reason for the lower severity of ventricular arrhythmias along with a milder course of CHD.

Conflict of interests: none declared.

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Physical activity and attitude towards disease prevention among men engaged in mobile labor in the Arctic zone of Russia

Akimova E.V.[1], Gafarov V.V.[2], Kayumova A.R.[3]

[1] Tyumen Cardiology Research Center, Tomsk National Research Medical Center of the Russian Academy of Sciences, Tomsk, Russia.
[2] Institute of Therapy and Preventive Medicine — Branch of the Institute of Cytology and Genetics, Siberian Branch of Russian Academy of Sciences, Novosibirsk, Russia.
[3] Ural Federal University, named after the first President of Russia, Boris Yeltsin, Yekaterinburg, Russia.

AUTHORS

Ekaterina V. Akimova*, MD, PhD, Head of the Laboratory of Epidemiology and Prevention of Cardiovascular Diseases, Tyumen Cardiology Research Center, Tomsk National Research Medical Center of the Russian Academy of Sciences, Tomsk, Russia. ORCID: 0000-0002-9961-5616

Valery V. Gafarov, Doctor of Medical Sciences, Professor, Head of the Laboratory of Psychological and Sociological Problems of Internal Diseases, Institute of Therapy and Preventive Medicine — Branch of the Institute of Cytology and Genetics, Siberian Branch of Russian Academy of Sciences, Novosibirsk, Russia. ORCID: 0000-0001-5701-7856

Alina R. Kayumova, student of the Institute of Natural Sciences and Mathematics, Ural Federal University, named after the first President of Russia, Boris Yeltsin, Yekaterinburg, Russia. ORCID: 0009-0000-0803-166X

The aim of the study was to determine the associations of some parameters of physical activity and disease prevention among men engaged in mobile work in the Arctic zone of Russia depending on the length of expeditionary shift work.

Methods. The object of the study was a "random" representative sample of male workers engaged in expeditionary shift work at the industrial enterprise EURACORE in the Arctic latitudes of the Tyumen region. The sample consisted of 750 men aged 25–54, and the response rate was 82.4%. The length of work in the Arctic was assessed according to three parameters: 1) 3 years or less; 2) 4–9 years; 3) 10 years or more. Attitudes towards physical activity, health and disease prevention were assessed using the standard WHO MONICA-MOPSY questionnaire.

Results. Regardless of the years of expedition shift work in the Arctic zone of Russia, the lowest level of responsibility for their health was observed in the groups with low physical activity. Low awareness of the risks of non-communicable diseases was observed in the groups with low

* Corresponding author. Tel. +7 (912) 920-60-43. E-mail: akimovaev@infarkta.net

physical activity at the minimum duration of expeditionary shift work experience, and the most positive attitude to disease prevention was observed in the groups with the maximum duration of expeditionary shift work experience and the absence of low physical activity.
Conclusion. Thus, the results of determining the associations of low physical activity and the parameters of attitudes to disease prevention in the organized population of oil and gas extraction workers, depending on the length of work in the expeditionary shift method, should be used as an important part of a comprehensive preventive program at industrial enterprises in the Arctic region.
Keywords: organized population, mobile work, physical activity, attitude towards disease prevention, Arctic.

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Introduction

The health of men working in the Arctic on a rotating basis is determined by many factors: the natural conditions of this region (the severity of the climate includes not only extreme temperatures, but also the aerodynamic regime, electromagnetic factors, photoperiodicity, etc.); constant rhythmic adaptation - readaptation, which has a destructive effect on adaptive mechanisms; stress-generating factors of air flights, long stays outside the usual living conditions in specific rotating teams [1–3]. In addition to the a priori difficult natural and climatic conditions in which oil and gas workers have to work, the expeditionary shift form of work is characterized by a mobile mode and remoteness of workplaces from the base enterprises, constant moving of workers through significant distances [4–6]. Mobile work is associated with an increase in the intensity of work during the shift, longer working shifts, reduced rest periods between shifts with no days off and minimal social and welfare provision, and consequently a pronounced impact of chronic social stressors and reduced adherence to a healthy lifestyle [7–9].

The analysis of data from epidemiological studies and clinical trials has shown that physical activity is the most important factor in the treatment and secondary prevention of coronary heart disease (CHD), and at the same time it has been proven that sedentary lifestyle is one of the independent risk factors (RF) for the occurrence of CHD [10–11]. Since the second half of the 20th century, due to the automation and mechanization of major industries, low physical activity has become a major feature of modern human life, contributing to the high prevalence of RF associated with cardiovascular diseases (CVD) and other conditions [12–14]. In the present era, this is largely true for mobile workers in the Arctic, where the new production technologies have virtually eliminated heavy physical labor [9]. At the same time, due to the impact of many additional production, social, environmental, climatic RF on shift workers, the behavioral characteristics, and especially low physical activity associated with subjective-objective health indicator (attitude to their health and disease prevention), in the extreme conditions of the Arctic region is of particular importance [9].

At the same time, there are not enough scientific publications devoted to the study of the attitude to CVD prevention among persons engaged in mobile labor in the oil and gas production complex of the Arctic zone of Russia [5, 8]. It is extremely necessary to study the real situation with a regard to the profile of conventional and unconventional cardiovascular risk factors in ecologically unfavorable regions of Russia, since these territories employ a large contingent of labor resources, carrying a significant share of the country's economic potential [7–9].

The aim of the study was to determine the associations of some parameters of physical activity and disease prevention among men engaged in mobile labor in the Arctic zone of Russia depending on the duration of work on expedition watch.

Methods

The subject of the study was a "random" representative sample of male workers, aged 25–54 years, engaged in expeditionary shift work at the industrial enterprise EURACORE in the Arctic latitudes of the

Tyumen Oblast. The one-stage cross-sectional study was conducted within the framework of the budget themes № NIOCTR: 122020300112-4 and NIITPM № FWNR-2024-0002. The representative sample was formed from the lists of male workers engaged in expeditionary and shift work at the industrial enterprise EURACORE, which has an extensive network of oil pipeline construction in the Arctic zone of Western Siberia. For the sample formation the generally accepted method of "random numbers" was used, implemented in the computer version, the sample included 750 men at the age of 25-54 years, the response rate was 82,4%.

Inclusion criteria: 1) persons working as expeditionary shift workers at the EURACORE industrial enterprise; 2) persons working at the EURACORE industrial enterprise facilities in the Arctic zone; 3) male gender; 4) age at the time of sample formation in the range of 25 to 54 years; 5) voluntary signing of the informed consent to participate in the study.

Exclusion criteria: 1) stationary workers at the EURACORE industrial enterprise; 2) persons working at the EURACORE industrial enterprise facilities outside the Arctic zone; 3) female gender; 4) age at the time of sample formation outside the range of 25–54 years; 5) refusal to sign the informed consent to participate in the study.

The length of work in the Arctic was assessed according to three parameters: 1) 3 years or less; 2) 4-9 years; 3) 10 years or more.

The standard WHO MONOICA-MOPSY questionnaire [19] was given to each of the subjects included in the representative sample for self-completion. Attitudes towards physical activity, their health and disease prevention were determined by analyzing the statements from the list of fixed answers of the WHO MONOICA-MOPSY standard questionnaire "Knowledge and attitudes towards health".

Statistical analysis

Statistical processing of the study results was performed using IBM STATISTICA 21.0 software. The results were presented as proportions (percentages) - for categorical data. Pearson's chi-squared test (x2) was used to assess the reliability of differences between the sample proportions of the population in the two groups. In all statistical analysis procedures, the achieved level of significance (p) was calculated, and the critical level of significance in the study was considered to be 0.05.

Results

Given the previously established low physical activity in more than a quarter of shift workers and less than a half of shift workers having positive attitude to disease prevention, we considered the specifics of associations of the obtained indicators depending on the length of work in the Arctic [6, 8].

The figures present data on the associations of the parameters of the attitude to disease prevention with the presence or absence of low physical activity among persons engaged in mobile labor in the Arctic zone of the Russian Federation (Fig. 1-3).

If the duration of expeditionary shift work was 3 years or less, those with low physical activity were significantly more likely than those without it to consider the possibility of contracting a serious disease in the next 5-10 years as unlikely (27.3% vs. 8.7%, p=0.0210). At the same time, statistically significant differences were found in the absence of low physical activity, with the proportion of "possible" answers increasing with 10 or more years of experience (85.4% vs. 66.2%, p=0.0176) (Fig. 1).

Regarding the possibility of avoiding some serious diseases by taking preventive measures, the most certain positive answer in the absence of low physical activity (LPhA) significantly prevailed in the group with the maximum number of years of expedition work experience (68.3% vs. 47.6%, p=0.0191). The more uncertain response option "maybe yes" in case of LPhA showed a statistically significant decrease compared to respondents with LPhA with experience of 10 or more years (26.8% vs. 48.3%, p=0.0145) (Fig. 2).

As the duration of expeditionary work increased, the number of those with LPhA who definitely recognized the benefit of health screening decreased significantly: 4-9 years (30.7% vs. 59.6%, p=0.0001) and 10 years and more (58.6% vs. 82.9%, p=0.0042). The most positive response to the question of the possible benefit of a preventive health check was found in LPhA individuals with 10 years or more of expeditionary shift work experience (46.3% vs. 17.3%, p=0.0393) (Fig. 3).

Discussion

The problem of population participation in the preventive programs aimed at changing behavioral habits is

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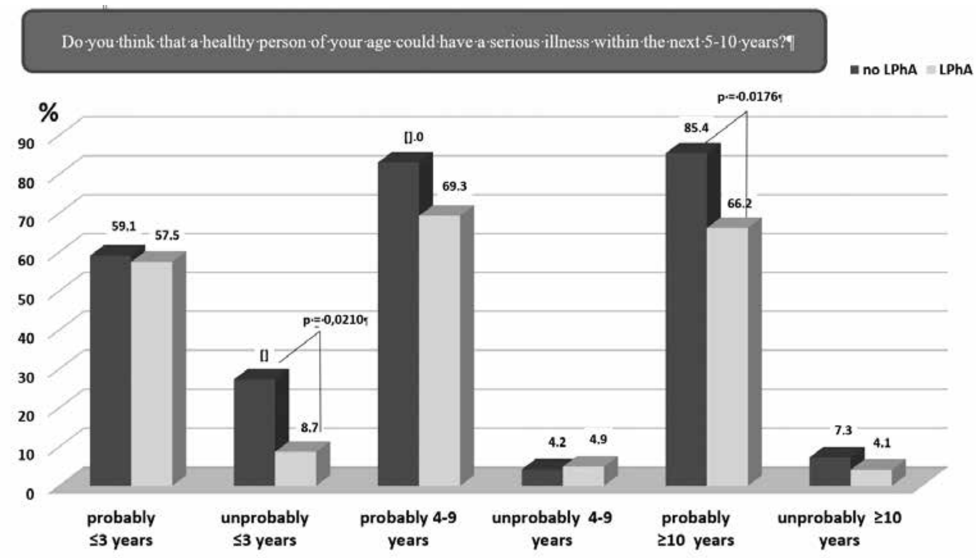

Fig. 1. Awareness of the risks of non-communicable diseases among working on expeditionary shift in the Arctic depending on the presence of low physical activity, %

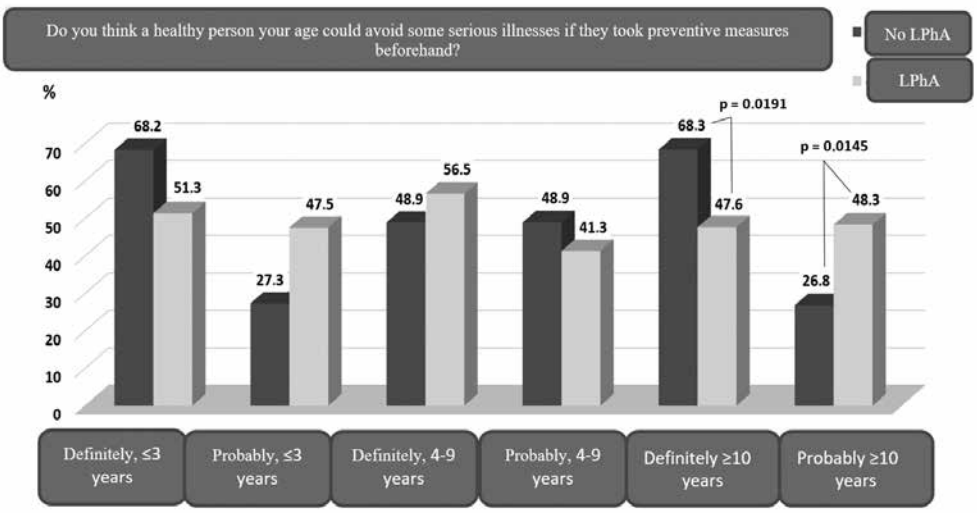

Fig. 2. Attitude to health among those working on expeditionary shift in the Arctic depending on the presence of low physical activity, %

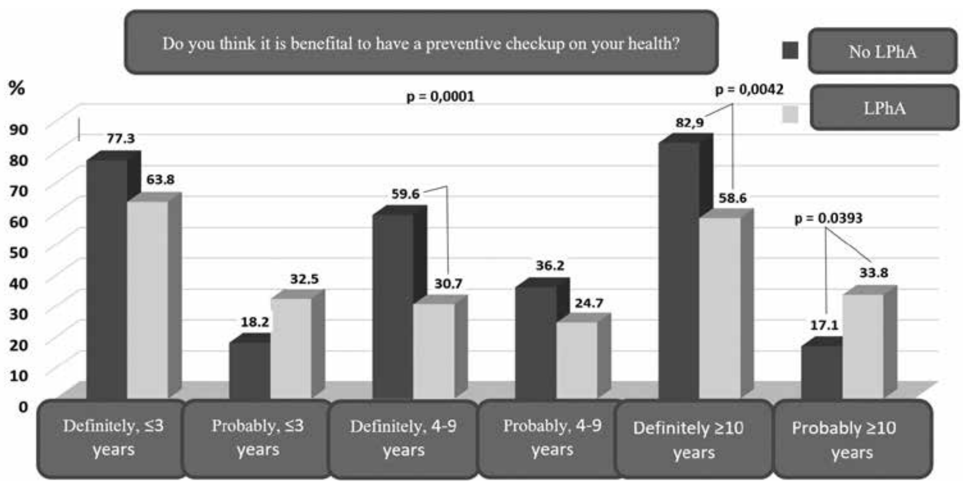

Fig. 3. Attitude towards disease prevention among those working on expedition shift in the Arctic depending on the presence of low physical activity, %

still relevant, since the lack of basic health culture, together with stress, unfavorable environmental conditions, multiply the risks of morbidity and mortality from chronic non-communicable diseases. According to experts, these deaths are premature and can be prevented through prophylactic measures [15]. However, for the success of the preventive programs, the efforts of medical workers alone are not enough, it is necessary to have a conscious desire of the patients themself to change behavioral stereotypes. A kind of indicator of such aspirations is the attitude to one's own health and disease prevention, which is considered to be one of the main socio-psychological factors influencing the activity of the population in ensuring its health improvement [11].

The present study revealed regularities reflecting the relationship between behavioral characteristics and attitudes to their health depending on the length of service as an expeditionary rotational worker in the extreme conditions of the Arctic. The obtained data seem to be confirmed by the results of our previous works on the subjective-objective health indicator among the population of Tyumen, as well as on factors of chronic social stress, whose interrelation with behavioral factors is proved [8]. The paterns found in our previous studies among Tyumen men of working age regarding the decrease in physical activity in groups of low social status were also comparable with the results of the present study [13]. Perhaps this is also due to the new conditions in oil and gas production enterprises, where manual labor is largely replaced by modern computer technologies. The insufficient volume of living space also has an impact. The everyday life of shift workers is not characterized by diversity, the gyms of shift settlements cannot accommodate all comers [9].

In our opinion, the population regularities revealed by the relationships between the subjective-objective health indicator and physical activity in shift workers with minimal work experience are reasonable. This may be due to the fact that in the initial stage of adaptation to the extreme conditions of the Arctic, social and domestic problems are likely to be prioritized, while concern for one's health is more likely to be inherent in persons who have been exposed to it before, i.e. who have purposefully engaged in increasing their physical activity.

Thus, the results of determining the associations of LPhA and the parameters of attitudes toward disease prevention in the organized population of oil and gas extraction workers, depending on the length of service in the expeditions, should be used as an important part of a comprehensive preventive program in industrial enterprises of the Arctic region.

Conclusion

The analysis of the presented study revealed an unfavorable situation in the prevalence of low physical activity and work capacity depending on the length of service in the Arctic region, associated with some parameters of attitude to prevention among workers engaged in expeditionary shift work at industrial enterprises of the oil and gas production complex.

Irrespective of the work duration in the Arctic zone of Russia, the lowest responsibility for their health occurred in the presence of low physical activity. Low awareness of the risks of non-communicable diseases prevailed in the groups with low physical activity at the minimum duration of work on expeditionary shifts, while the most positive attitude to disease prevention prevailed at the maximum duration of work on expeditionary shifts and in the absence of low physical activity.

Conflict of interests: none declared.

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Obesity phenotypes, cardiometabolic risk, and body composition in women with rheumatoid arthritis

Myasoedova S.E., Poltyreva E.S.

Ivanovo State Medical University, Ivanovo, Russia.

AUTHORS

Svetlana E. Myasoedova, MD, PhD, Professor, Head of the Department of Therapy, Endocrinology and Dietetics, Ivanovo State Medical University, Ivanovo, Russia. ORCID: 0000-0001-9500-1011

Elena S. Poltyreva, 2nd year postgraduate student, Ivanovo State Medical University, Ivanovo, Russia. ORCID: 0009-0003-6716-6283

The aim of the study was to assess the cardiometabolic risk and body composition characteristics in women with rheumatoid arthritis (RA).

Methods. The study included 115 women aged 61.5±10.6 years with RA of 1-3 activity levels according to DAS 28. Cardiometabolic risk was assessed while taking into account the body mass index (BMI) and metabolically healthy phenotype (MHPO) or metabolically unhealthy phenotype (MUHPO) of obesity defined by a waist-to-hip ratio measurement (WHR), serum glucose and lipid levels. Body composition was determined by X-ray absorptiometry using fat-free mass index (FFMI), fat mass index (FMI), and abdominal-to-thigh fat ratio (A/G ratio).

Results. The majority of patients had a BMI≥25 kg/m^2. 23.5 % of patients were overweight, while 42.6 % were obese with MUHPO being predominant in 66.7 % of them. With increasing BMI and WHR there was an increase in blood glucose (p=0.03), triglycerides (p=0.00), FMI (p=0.03), A/G ratio (p=0.00) and a decrease in HDL-C cholesterol (p=0.03). In addition, the higher levels of those parameters were predominantly associated with the MUHPO in both the normal BMI<25 kg/m^2 and high BMI≥25 kg/m^2 groups. Regardless of BMI, MUHPO was associated with a higher incidence of arterial hypertension (AH), carotid atherosclerosis (CAS), cardiovascular disease (CVD), and diabetes mellitus (DM). According to X-ray absorptiometry, the majority of patients, including women with BMI<25 kg/m^2, had an increased amount of adipose tissue (>32 %) and abdominal obesity (A/G ratio>1). Sarcopenia (FFMI <6.0 kg/m^2) was detected in 17 (14.8 %) and sarcopenic obesity in 5 (4.3 %) patients. Lower FFMI was associated with lower BMI, higher frequency of sarcopenia and higher VAS pain intensity.

Conclusion. Patients with RA tend to be overweight/obese with MUHPO and have high cardiometabolic risk for dyslipidemia, carbohydrate metabolic disorders, AH and AS, necessitating monitoring of WHR along with BMI. Body composition reflects increased adipose tissue in the majority patients, including the normally weighted ones. There is a trend toward the lower FFMI and the develop-

* Corresponding author. Tel. +7 (910) 997-26-20. E-mail: msemee@mail.ru

ment of sarcopenia/sarcopenic obesity with decreasing BMI, which is associated with greater pain intensity according to VAS.

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Introduction

Rheumatoid arthritis (RA) is a chronic inflammatory disease with predominanly joint involvement and systemic manifestations, characterized by high comorbidity and shortened life expectancy [1], mainly due to the development of cardiovascular (CVD) and cerebrovascular diseases. The risk of CVD mortality in RA is increased 1.5-fold [2], and the risk of CVD development is increased 2-fold, being higher than in diabetes mellitus (DM) [3]. In this context, RA is considered to be an independent cardiovascular risk factor due to an accelerated development of atherosclerosis on the background of chronic inflammation and traditional risk factors (RF). Among them, the arterial hypertension (AH) and overweight/obesity are the most common in RA, which correlates with the prevalence of these factors in the general population and increases the risk of both CVD and DM [4, 5]. At the same time, the "obesity paradox" in RA is well known: both obesity and weight loss increase patients' risk of mortality [6]. To better assess cardiometabolic risk, it is recommended to distinguish obesity phenotypes in addition to the BMI definition [7]. However, there is a lack of information in the literature regarding the characteristics and clinical significance of obesity phenotypes in RA in terms of cardiometabolic risk and body composition changes.

The aim of the study was to assess the cardiometabolic risk and body composition characteristics in women with RA.

Methods

The study was conducted in the Department of Rehabilitation of Patients with Somatic Diseases of the Ivanovo State Medical University Clinic. The study included 115 women with a confirmed diagnosis of RA according to the ACR/EULAR (2010) classification criteria [1], aged 33-81 years (mean age 61.5±10.6 years), with a disease duration of 9.7±9.0 years. Early RA was diagnosed in 16 patients (13.9 %). Seropositive RA was found in 70 (60.9 %) patients with high serum rheumatoid factor (RhF) levels. The DAS-28 index was 3.91±1.04 and the visual analog scale (VAS) pain was 48.1±26.6 mm. All women received anti-inflammatory drugs at baseline, including methotrexate — 86 (74.8 %). 23 patients (20.0 %) were treated with glucocorticosteroids (GCS). Nonsteroidal anti-inflammatory drugs (NSAIDs) were taken regularly (twice a week for at least 2 months) by 51 patients (44.5 %). AH was found in 92 (80 %), carotid atherosclerosis (CAS) in 56 (48.7 %) women. CVD was present in 12 (10.4 %) patients, type 2 DM in 10 patients (8.7 %).

Inclusion criteria were: female patients with a confirmed diagnosis of RA, aged ≥25 years. Exclusion criteria were: infectious and oncological diseases, any chronic disease in the phase of exacerbation and decompensation, pregnancy.

RA activity was assessed by the Disease Activity Score 28 (DAS-28), and the index of functional impairment according to the Health Assessment Questionnaire (HAQ-DI) was also taken into account. Office blood pressure was measured as well [8].

The obesity phenotype was determined based on the subject's body mass index (BMI) and waist-to-hip ratio (WHR). The patients were divided into two groups based on their BMI: those with a BMI below 25 kg/m² and those with a BMI above 25 kg/m². They were then classified as having a metabolically healthy phenotype (MHPO) or a metabolically unhealthy phenotype (MUHPO) based on their WHR, with a WHR of 0.85 or below indicating the former and a WHR above 0.85 indicating the latter [7].

Body composition was evaluated through X-ray dual-energy absorptiometry on a Lunar Prodigy machine (General Electric). The fat-free mass index (FFMI) was calculated as the total lean mass of the upper and lower extremities (kg/height in m²). A value of FFMI < 6 kg/m² was considered to be indicative of sarcopenia [9]. The following ratio was employed as the fat mass index (FMI): total fat mass in kg/height in m². A fat mass ⩾32 % of total mass was considered indicative of obesity. A combination of a BMI of <26 kg/m² and a fat mass content of >32 % was considered to be indicative of sarcopenic obesity. The abdominal to thigh fat ratio (A/G ratio) was also taken into account.

General clinical and laboratory examinations were performed, including the determination of C-reactive protein (CRP), total cholesterol, triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and glucose levels.

The study was conducted in accordance with the ethical standards of the Ethical Committee of Ivanovo State Medical University (protocol number 2, dated April 4, 2018). All patients provided informed consent for participation in the study.

Statistical analysis

The statistical analysis was conducted using the Statistica 10.0 software package (StatSoft, USA, 2018). The median, lower quartile, and upper quartile (Me [25;75]) were used to describe the parameters whose distribution differed from normal. The Mann-Whitney test (U-test) was used to assess the statistical significance of differences between two independent groups with respect to quantitative traits. In the case of a comparison involving three or more samples, the nonparametric ranking method, namely the Kruskal-Wallis test, was employed. Significant differences and correlations between the parameters were deemed reliable at a level of $p < 0.05$.

Results

The mean BMI values were 29.1 ± 5.5 kg/m², and the mean WHR was 0.98 ± 0.16. A total of 27 women (23.5 %) were classified as having normal body weight, while the remaining patients were were overweight or obese. Of the latter group, 39 women (33.9 %) were classified as overweight, and 49 women (42.6 %) were classified as obese. The results of the body composition analysis revealed that 17 patients (14.8 %) had a FFMI indicative of sarcopenia (⩽6.0 kg/m²), while 107 patients (93.0 %) demonstrated a fat mass content exceeding 32 %. The presence of sarcopenic obesity was observed in 5 (4.3 %) patients.

Four distinct groups of patients with varying phenotypes were identified. The first group consisted of 16 patients with a BMI <25 kg/m² and MHPO. The second group included 11 patients with a BMI <25 kg/m² and MUHPO. The third group comprised 11 patients with a BMI ⩾25 kg/m² and MHPO. The fourth group consisted of 77 patients with a BMI ⩾25 kg/m² and MUHPO. The groups were comparable with the regard to age, duration of rheumatoid arthritis (RA), number of painful and swollen joints, methotrexate dose, HAQ-DI scores, and C-reactive protein (CRP) (Table 1).

The characteristics of the various obesity phenotypes are presented in Table 2. With the regard to cardiometabolic parameters, there were a statistically significant increase in blood glucose (p=0.03), TG (p=0.00), FMI (p=0.03), and A/G ratio (p=0.00), and a statistically significant decrease in HDL-C cholesterol (p=0.03) as BMI increased from group 1 to group 4. Furthermore, higher values were predominantly associated with the MUHPO phenotype in both the normal weight and overweight/obese categories. This is corroborated by a comparison of groups 1 and 2 of

Table 1. **Main parameters in different obesity phenotypes* in RA**

Parameters	Normal BMI, MHPO (A/G ratio≤0.85) Abs/%	BMI, MUHPO Normal (A/G ratio>0.85) Abs/%	BMI>25 kg/m², MHPO (A/G ratio≤0.85) Abs/%	BMI>25 kg/m², MUHPO (A/G ratio>0.85) Abs/%
Number, abs/%	16/13.90	11/9.57	11/9.57	77/66.96
Age, years	64 [51.5; 70]	67 [54; 75]	55 [44; 66]	63 [57; 68]
Average RA duration, yeas	6.5 [1.21; 11.75]	9 [5.5; 15]	8 [3; 13]	8 [3; 13.5]
Amount of painful joints	7 [5; 15]	10 [4; 13]	10 [6; 18]	7 [4; 11]
Amount of swollen joints	2 [0; 5]	0 [0; 3]	2 [0; 11]	1 [0; 4]
Taking methotrexate, abs/%	10/62.5	7/63.64	8/72.73	61/79.22
Methotrexate dose, mg/week	12.5 [10; 17.5]	10 [10; 12.5]	12.5 [7.5; 21.25]	12.5 [10; 17.5]
CRP, mg/l	7.56 [4.69; 10.83]	3.77 [2.16; 8.84]	5.59 [2.90; 15.79]	5.99 [2.76; 9.82]
HAQ-DI	1.06 [0.69; 1.5]	0.875 [0.375; 1.25]	1.12 [0.63; 2.25]	1.125 [0.625; 1.875]

*p>0.05 when comparing all parameters in different obesity phenotypes.

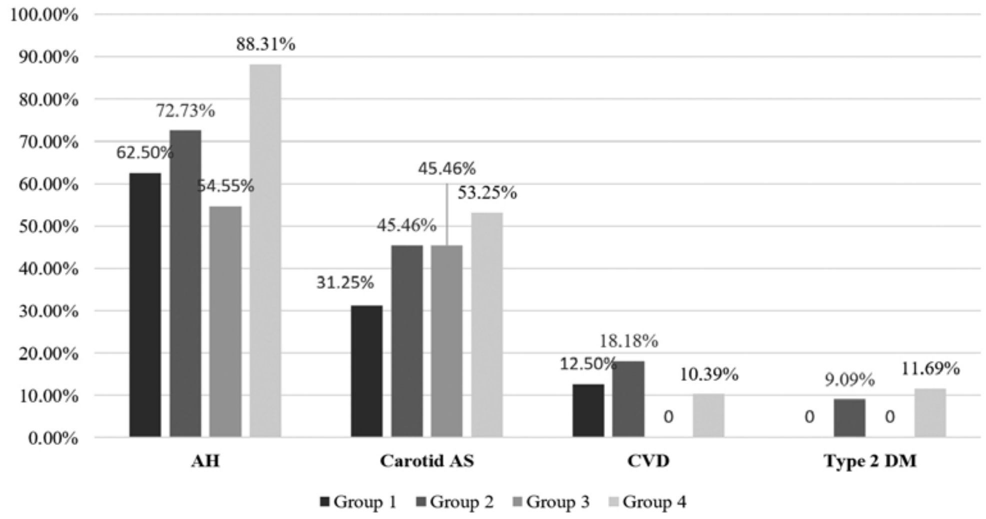

Fig. 1. Frequency of AH, carotid artery AS, CVD and type 2 DM in RA patients with different obesity phenotypes (n=115)

patients with a BMI of less than 25 kg/m². Patients with a MUHPO phenotype (group 2) exhibited higher BMI (p=0.01), FMI (p=0.01), and A/G ratio (p=0.00) values. Similar trends were observed at BMI≥25 kg/m² in groups 3 and 4. A comparison of these groups revealed higher BMI (p=0.00), FMI (p=0.00), and glucose (p=0.04) and TG (p=0.01) in group 4 (MUHPO) relative to group 3 (MHPO).

The prevalence of AH, carotid artery AS, and CVD was higher in groups 2 and 4 than in groups 1 and 3, respectively. The prevalence of diabetes mellitus (DM) was observed to be 9.1 % and 11.7 %, respectively, in groups 2 and 4, which exhibited the MUHPO phenotype. In contrast, DM was not found in groups 1 and 3, which illustrated the MHPO phenotype (Figure 1).

The analysis of body composition revealed a unidirectional tendency for increases from group 1 to group 4 in both adipose tissue according to FMI (p=0.03) and A/G ratio (p=0.00) and skeletal muscle mass according to FFMI (p=0.00). The majority of patients had a high fat mass, with a percentage value of 32 % or greater. The prevalence was 62.5 % and 81.8 % in groups 1 and 2, respectively, and 100 % in groups 3 and 4. In contrast, the prevalence of sarcopenia (defined as FFMI <6 kg/m²) was significantly higher in groups 1 and 2 (56.4 % and 45.5 %, respectively) compared to groups 3 and 4 (9.1 % and 2.6 %, respectively). The diagnosis of sarcopenic obesity was made in individual cases across all groups of patients with rheumatoid arthritis (RA).

Table 2. **Main parameters of metabolic disorders and body composition in different phenotypes of obesity in RA**

	Normal BMI, MHPO (WHR ≤0,85) Group 1	Normal BMI, MUHPO (WHR>0,85) Group 2	BMI>25 kg/m², MHPO (WHR ≤0,85) Group 3	BMI>25 kg/m², MUHPO (WHR>0,85) Group 4	p
Number, abs/%	16/13.90	11/9.57	11/9.57	77/66.96	–
BMI, kg/m²	21.37[21.01;22.75]	23.53[22.23;24]	26.7 [25.7; 28.16]	31.63[27.83;33.71]	0.00
Fasting glucose, mmol/l	4.59[4.26; 4.77]	4.62[4.38; 4.83]	4.37 [4.21; 4.56]	4.88 [4.32; 5.29]	0.03
Triglycerides, mmol/l	0.85[0.73; 1.16]	1.20[0.77; 1.29]	0.90 [0.83; 1.04]	1.31 [1.04; 1.70]	0.00
HDL-C, mmol/l	1.95[1.54; 2.31]	1.72[1.59; 1.95]	1.73 [1.33; 1.91]	1.59 [1.32; 1.81]	0.03
FMI, kg/m²	7.07[5.41;7.59]	7.98[7.53;10.63	10.59[9.02;11.33]	14.37[11.96;16.08]	0.03
Fat mass >32 %, abs/%	10/62.5	9/81.8	11/100	77/100	–
A/G ratio	0.76 [0.62; 0.82]	0.97 [0.9; 1.05]	0.80 [0.75; 0.84]	1.06 [1.00; 1.13]	0.00
FFMI, kg/m²	5.92[5.62; 6.25]	6.12 [5.9; 6.45]	7 [6.38; 7.22]	7.15 [6.50; 7.59]	0.00
FFMI<6 kg/m², abs/%	9/56.3	5/45.5	1/9.1	2/2.6	–
Sarcopenic obesity abs/%	1/6.25	1/9.09	1/9.1	2/2.59	–
RhF	131.8[40.1; 232.2]	37.75 [17.75; 123.70]	59.65 [40.15; 84.0]	62.6 [18.4; 160.8]	0.35
DAS-28	3.91 [3.07; 4.98]	3.90 [3.35; 4.55]	4.90 [3.58; 5.12]	3.76 [3.13; 4.43]	0.21
Pain according to VAS, mm	58.82 [31.09; 70.59]	25.21 [4.2; 30.25]	47.9 [39.5; 62.18]	50.42 [34.45; 68.07]	0.01

*p — significance of differences when comparing more than 3 samples

No definitive correlation was found between RA activity (DAS-28 and RhF) and BMI or metabolic phenotypes (see Table 2). However, there was a significant decrease in VAS pain intensity from group 1 to group 4 (p=0.01). Furthermore, when the body mass index (BMI) was less than 25 kg/m², the rheumatoid factor (RhF) was higher in group 1 (MHPO) than in group 2 (MUHPO), with a value of 131.8 [40.1; 232.2] and 37.75 [17.75; 123.70] IU, respectively (p=0,04). Furthermore, at a BMI of ≥25 kg/m², the RA activity as measured by DAS-28 was higher in group 3 (MHPO) compared to group 4 (MUHPO) (4.90 [3.58; 5.12] and 3.76 [3.13; 4.43], respectively; p=0.01).

Discussion

Obesity represents a significant RF for a number of major health concerns, including cardiovascular disease (CVD), diabetes mellitus (DM), and cancer. It is a prominent medical and social issue on a global scale. In Russia, 59.2 % of the population is overweight and 24.1 % is obese [7]. A comparable trend is evident among patients with RA, wherein individuals with an underweight status are scarce, and the majority are either overweight or obese [4]. These findings are corroborated by the results of our study, which revealed that the majority of patients were either overweight (33.9 %) or obese (42.6 %), with no underweight individuals present. Therefore, obesity was the predominant condition in our cohort of RA patients, occurring more frequently than in the general Russian population. Our data indicate that MUHPO, a marker of cardiometabolic risk due to AH, high glucose levels, hypertriglyceridemia, and reduced HDL-C cholesterol, was the predominantly observed in women with RA. Conversely, individuals with MUHPO were more likely to have AH, carotid artery AS, CVD, and type 2 DM, which was found in patients with both elevated and normal BMI.

The findings of epidemiological studies indicate that there is an increased risk of autoimmune diseases, including rheumatoid arthritis (RA), associated with obesity [10], as well as with metabolic syndrome (MS) and its components, including waist size, HDL-C, and high glucose [11]. A potential mechanism underlying the relationship between MS and RA may be CRP, which has been shown to contribute to the development of RA to a significant extent, estimated to be approximately 10 % [11]. The influence of obesity on RA activity has been the subject of considerable debate, with findings across studies being contradictory [12]. While some studies have identified a correlation between BMI and RA activity, others have not been able to confirm this association. In our study, the high prevalence of obesity was observed not only according to BMI data, but also according to the results of body composition assessment. The majority of patients exhibited a composition where the adipose tissue was predominant and an A/G ratio greater than 1, which is characteristic of abdominal obesity [13]. However, these data require cautious evaluation in this single cohort study and may be related not only to the features of RA as an underlying disease, but also to the older age of the patients and GCC intake. With regard to the relationship between obesity and its associated phenotypes and RA activity, no clear associations were identified in our cohort of patients, the majority of whom exhibited moderate disease activity. It is important to note, however, that higher RA activity was observed in patients with a BMI of less than 25 kg/m² and MHPO compared to those with a MUHPO, as indicated by separate indicators such as pain severity according to VAS, RhF, and DAS-28. This is associated with a higher incidence of sarcopenia in these patients.

The DEXA body composition study represents the "gold standard" for the assessment of a patient's nutritional status, facilitating a more precise evaluation of the distribution of fat and muscle tissue. It is also capable of diagnosing sarcopenia and sarcopenic obesity. Sarcopenia is defined by quantitative and qualitative alterations in skeletal muscle tissue, which are associated with an elevated risk of falls and fractures. Furthermore, the development of sarcopenic obesity is associated with an increased risk of cardiovascular disease (CVD) and mortality. The primary diagnostic criterion for sarcopenia is the determination of fat-free mass index (FFMI) [9]. Prior research has documented alterations in body composition among individuals with RA that differentiate them from those without it. These changes include reduced muscle mass accompanied by increased adipose tissue content, which in turn increases the likelihood of developing sarcopenia and sarcopenic obesity [14]. Furthermore, our study demonstrated a relatively high prevalence of sarcopenia in women with RA (14.8 %) and sarcopenic obesity in over one-third of them (4.3 %). Concurrently, the distinctive characteristics of the nutritional status of patients with RA manifest as increased muscle mass in conjunction with elevated BMI. Conversely, in the general population, there is a reduction in muscle tissue content with increasing obesity [7].

It is possible that alterations in body composition in RA may be attributable to chronic autoimmune inflammation and depend on the activity of RA. It is likely that decreases in BMI, fat mass, and muscle mass with may reflect higher RA activity. In general, the maintenance of fat mass and BMI in the absence of significant obesity in patients with RA may be protective and explain the "obesity paradox" described in the literature [6]. It is evident that a lower BMI is a principal predictor of sarcopenia in RA. This should be considered alongside other predictors, such as advanced age, severity of RA, presence of osteopenia or osteoporosis, and use of glucocorticoid-containing medications [15].

In our study, no patients were identified as underweight. However, it is likely that individuals with normal body weight may also require special attention in the presence of other RF of sarcopenia in RA. The development of sarcopenia has a markedly adverse impact on the prognosis of these patients, leading to frailty with a substantial decline in life quality and an elevated risk of premature mortality. Speaking of sarcopenic obesity, it was observed in one-third of patients with sarcopenia, occurring in all groups, including those with a BMI of less than 25 kg/m² in both MUHPO and MHPO cohorts. In patients with a BMI of 25 kg/m² or greater, all cases of sarcopenia were accompanied by obesity, which had a detrimental impact on prognosis.

The limitations of this study include the relatively small cohort of patients (115 women), the predominance of middle-aged and elderly women with predominantly moderate RA activity, the absence of morbid obesity, and the one-stage nature of the study without data on BMI dynamics.

Therefore, in order to assess the cardimetabolic risk in patients with RA, it is essential to consider the obesity phenotype in conjunction with BMI, and to supplement these data with the study of body composition in order to identify the presence of sarcopenia and sarcopenic obesity in groups at risk of its development.

Conclusion

Patients with RA tend to be overweight or obese with metabolic syndrome and high cardiometabolic risk for developing dyslipidemia, carbohydrate metabolism disorders, AH and AS. Regardless of BMI, MUHPO is more frequently accompanied by AH, carotid AS, CVD, and type 2 DM compared with MHPO.

An increase in adipose tissue is evident in the majority of patients, including those with a normal weight. A downward trend in FFMI and an increased prevalence of sarcopenia/sarcopenic obesity have been observed in individuals with a BMI below 25 kg/m². This is associated with a higher level of VAS pain intensity.

In patients with RA, it is reasonable to monitor both BMI and WHR to assess the cardiometabolic risk. A MUHPO at any BMI level indicates an increased risk of developing cardiovascular complications and disorders of carbohydrate metabolism. In addition to cardiometabolic risk, nutritional status should be assessed with body composition analysis to identify the presence of sarcopenia and sarcopenic obesity in groups at risk for their development.

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Markers of visceral obesity dysfunction and association with cardiovascular risk

Rasulova Z.D.[1,2], Nuritdinova M.J.[1,2], Shaikhova U.R.[1,2]

[1] Central Consultative and Diagnostic Polyclinic №1, the Main Medical Department Under the Administration of the President of the Republic of Uzbekistan, Tashkent, Uzbekistan.

[2] Military Medical Academy of the Armed Forces of the Republic of Uzbekistan, Tashkent, Uzbekistan.

AUTHORS

Zulfiya D. Rasulova*, MD, PhD, Senior Researcher, Head of the Therapy Department, Central Consultative and Diagnostic Polyclinic №1, the Main Medical Department Under the Administration of the President of the Republic of Uzbekistan; Professor, Department of Therapy, Military Medical Academy of the Armed Forces of the Republic of Uzbekistan, Tashkent, Uzbekistan. ORCID: 0000-0003-3260-1030

Malika J. Nuritdinova, PhD student, Military Medical Academy of the Armed Forces of the Republic of Uzbekistan, Tashkent, Uzbekistan. ORCID: 0009-0007-2381-3388

Umida R. Shaikhova, MD, PhD, Deputy Chief Physician, Central Consultative and Diagnostic Polyclinic № 1, the Main Medical Department Under the Administration of the President of the Republic of Uzbekistan; PhD student, Military Medical Academy of the Armed Forces of the Republic of Uzbekistan, Tashkent, Uzbekistan. ORCID: 0009-0008-9683-0995

The aim of the study was to evaluate apelin-12 in obese patients in relation to the imdices of visceral obesity.

Methods. A total of 167 individuals aged 40-70 years without diagnosed cardiovascular diseases (CVD) were studied. All patients were divided according to the degree of obesity: group 1 with excessive body weight consisted of 27 individuals, group 2 with class 1 obesity — 108 individuals, group 3 with class 2 obesity — 32 individuals. The control group consisted of 27 healthy subjects. Cardiovascular risk (CVR) was assessed using the SCORE-2 scale. The examination included assessment of anthropometric parameters; determination of lipids, glucose, apelin-12 in blood serum; echocardiography; assessment of body composition by bioimpedance analysis. To evaluate the state of lipid metabolism, we also used special highly specific indices such as: Kahn's lipid accumulation products (LAP); Amato's visceral obesity index (VOI), fatty liver index (FLI) and hepatic steatosis index (HSI).

Results. The study of apelin-12 levels with the parameters of visceral adipose tissue (VAT) dysfunction depending on CVR showed correlations, which allows to predict the progression of visceral obesity by using additional markers. Assessment of such markers as apelin-12 for prediction of lipid metabolism disorders progression, VAT dysfunction together with assessment of estimated VAT indices (VOI, % of adipose tissue, visceral fat level according to bioimpedance analysis, FLI, HSI, epicardial adipose

* Corresponding author. Tel. +998909446211. E-mail: zulye4ka@mail.ru

tissue thickness) can be included in the algorithm of patient examination for assessment of VAT dysfunction and CVR prevention.

Conclusion. Apelin-12 can be used to assess and predict the progression of lipid metabolism disorders, VAT dysfunction, and together with the assessment of estimated VAT indices (VOI, % adipose tissue, visceral fat level according to bioimpedance analysis, HSI and FLI) may be included in the algorithm of patient examination to assess VAT dysfunction and to prevent CVR.

Keywords: obesity, visceral obesity, biomarkers, apelin-12, cardiovascular diseases.

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Introduction

Obesity has gained the status of a non-infectious pandemic in the XXI century. The associated metabolic disorders are becoming one of the major risk factors (RF) for the development and progression of cardiovascular diseases (CVD). The greatest risk of CVD is associated with visceral obesity and its characteristic metabolic shifts (insulin resistance (IR), hyperglycemia, dyslipidemia, imbalance of adipokines and inflammatory markers). Visceral obesity is associated with an increased risk of carbohydrate and lipid metabolism disorders development, as well as with cardiovascular complications [1]. Currently, many adipokines are known: leptin, adiponectin, apelin, etc. An increase in the concentration of apelin in obesity and its association specifically with the visceral type of adipose tissue distribution has been noted [2]. Thus, a number of authors indicate that the increase in the degree of abdominal obesity (AO) is accompanied by a statistically significant increase in plasma apelin levels [3]. Apelin is positively correlated with waist circumference (WC) and the ratio of WC to hip circumference (HC).

Foreign authors note an increase in the level of apelin in obesity in combination with hyperinsulinemia [4]. In this regard, prediction and early detection of cardiometabolic disorders is an urgent task of modern medicine, the solution of which can be achieved by clinical methods, functional diagnostics, as well as by methods of non-invasive laboratory diagnostics. Currently, there are a number of anthropometric and instrumental methods for quantitative assessment of adipose tissue. However, not all of them fully reflect the degree of visceral obesity and cardiovascular risk (CVR). According to several authors, serum levels of apelin were higher in obese subjects compared to controls, with concentrations of the biomarker positively correlated with body mass index (BMI), cholesterol, insulin, fasting glucose, and IR, with apelin being a more sensitive biomarker of visceral adipose tissue (VAT) dysfunction than adiponectin and leptin [5]. The search for new reliable biomarkers and diagnostic methods for visceral obesity is an important task in the prevention of cardiometabolic complications.

The aim of the study was to evaluate apelin-12 in obese patients in relation to indicators of visceral obesity.

Methods

A total of 167 overweight and obese individuals with first and second classes of obesity, aged 40–70 years, without previously diagnosed CVD were studied. The mean age was 49.3±12.1 years. 42 patients (25%) were men and 125 patients (75%) were female.

The scientific research was conducted within the innovation project № IL-402104184: "Creation of mobile application of personal health card and development of individual wellness program for prevention of cardiovascular diseases at the level of primary health care" in the Central Consultative and Diagnostic Polyclinic №1, the Main Medical Department Under the Administration of the President of the Republic of Uzbekistan. The study was performed on an outpatient basis.

Exclusion criteria were: unstable angina or previous myocardial infarction, chronic coronary heart disease (CHD), chronic heart failure; clinically evident atherosclerosis with hemodynamically significant stenosis of the main arteries, etc., musculoskeletal problems significantly limiting walking; uncontrolled angina pectoris or arterial hypertension, heart rate greater than 120 beats/min, other significant diseas-

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es, the course of which may worsen due to functional impairment.

The control group consisted of 27 healthy individuals with low CVR according to SCORE-2 and normal body weight. All patients were distributed depending on the class of obesity: group 1 with excessive body weight consisted of 27 individuals with body mass index (BMI) = 29.3±1.4 kg/m^2 (women — 22, men — 5), group 2 with class 1 obesity consisted of 108 individuals with BMI = 34.9±1.3 kg/m^2 (women — 78, men — 30), group 2 with class 2 obesity — 32 individuals with BMI = 39.2±2.4 kg/m^2 (women — 25, men — 7).

CVR was assessed according to SCORE-2: 82 subjects were with low and moderate CVR, 49 subjects — with high CVR, 36 subjects — with very high CVR without coronary CVD. The examination included assessment of anthropometric parameters such as body mass (BM), height, WC and HC, BMI (BMI = kg/height, m2), WC/HC ratio. Clinical and laboratory parameters such as blood pressure, serum total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), calculated by formula non-HDL-C (TC — LDL-C), serum glucose, serum apelin-12 were also determined. Echocardiography (EchoCG) with determination of cardiac structural and geometric parameters such as left ventricular end diastolic dimension (LVEDD), left ventricular end systolic dimension (LVESD), and epicardial adipose tissue thickness (EATT) by coronary sulcus (CS) was performed [1, 4]. Apelin-12 levels in blood serum were determined by enzyme immunoassay method with "Apelin-12 (Human, Rat, Mouse, Bovine) EIA Kit" reagent kit from Phoenix Pharmaceuticals (USA) [6]. Body composition was assessed by bioimpedance analysis: determination of the percentage of visceral and total adipose tissue. To assess the state of lipid metabolism, we also used the following indices [7]:

The lipid accumulation product (LAP) was calculated by Kahn,

$$LAP = (WC\ (cm)–65)×TG;$$

Visceral obesity index (VOI) was calculated by Amato:

— in males:

$$VOI = (WC/39.68 + 1.88×BMI)×(TG/1.03)×(1.31/HDL–C);$$

— in females:

$$VOI = (WC/36.58+1.89×BMI)×(TG/0.81)×(1.52/HDL\text{-}C).$$

The VOI of 1.93 is considered normal, 1.94–2.32 indicates mild adipose tissue dysfunction, 2.32–3.25 — moderate adipose tissue dysfunction, VAI >3.25 — high adipose tissue dysfunction;

Fatty liver index

$$(FLI) = –3{,}5856+(0{,}0141×age)+(0{,}4711×DM)+ (4{,}4373×WC/height×100).$$

It the diabetes is present, then DM — 1, else — 0;

Hepatic steatosis index (HSI) = 8× ALT/AST+BMI (+2 in case of type 2 DM, +2 if female). HSI values>36.0 indicate the presence of hepatic steatosis in the patient with a sensitivity of 93.1 %, specificity of 92.4 % with an AUROC accuracy of 0.812.

Statistical analysis

Statistical processing of the results was carried out by "Excel 2019" program. Quantitative data were described by descriptive statistics and are presented as mean ± standard deviation (median and range are given in parentheses for data with non-normal distribution type). Qualitative data are presented as absolute and relative frequencies. Comparisons between groups were performed using analysis of variance (ANOVA), including its non-parametric variant (ranked ANOVA) for non-normal data distribution. To assess the intragroup dynamics under the condition of normal distribution of data and equality of dispersions we used paired Student's t-test with the Levene and Welch modifications. Wilcoxon signed-rank test was used in case of other types of distribution. The dynamics of change in proportions within the group was assessed using the McNemar test. The Cochran-Armitage test for linear trend was used to assess the tendency of proportions changes. Correlations were assesed by the Spearman's rank correlation coefficient. The level of statistical significance was $p < 0.05$.

Results

While assessing the anthropometric parameters we evaluated BM, height, WC and HC with their ratio, BMI, as well as additional data from bioimpedance analysis of body composition: determination of the percentage of visceral and total adipose tissue, biochemical markers of lipid metabolism disorders, glucose, apelin-12, calculated indices of visceral obesity. These parameters are shown in Table 1.

Significant differences in anthropometric parameters were observed in high-risk and very high-risk individuals compared to the control group. There was an increase in WC/HC ratio, BMI in overweight and obese individuals, respectively, compared to the con-

Table 1. **VAT dysfunction indices, parameters of fat and lipid metabolism in groups depending on the class of obesity**

№	Parameters	Control (n=27)	Overweight (n=27)	Class 1 obesity (n=108)	Class 2 obesity (n=32)
1	Age, years	32.6±6.9	54±9.8	59.3±6.8	45.5±4.3
2	CVR according to SCORE-2	1.25±1.1	5.5±7.1	10.5±8.7	11.5±7.8
3	BM, kg	63.4±7.7	88.7±9.0*	103.2±13.8*	119.1±15.2*
4	WC, cm	76.7±5.9	99.6±9.2*	109.9±10.5*	118±12.2*
5	HC, cm	93.7±5.8	111.8±7.2*	120.9±7.5*	127.4±9.1*
6	WC/HC	0.82±0.08	0.90±0.07*	0.91±0.08*	0.93±0.1*
7	BMI	22.8±2.3	29.3±1.4*	34.9±1.3*	39.2±2.4*
8	Adipose tissue, %	26.4±7.9	40.16±8.01*	43.4±8.1*	45.8±5.6*
9	Visceral (abdominal) fat	5.11±1.8	11.7±3.1*	14.5±4.2*	17.3±4.1*
10	TC, mmol/l	4.8±0.8	5.2±0.8	5.32±0.8*	5.75±0.8*
11	TG, mmol/l	1.2±0.9	1.69±1.01	1.81±1.0*	2.1±1.2*
12	LDL-C, mmol/l	2.5±0.8	3.26±0.9	3.41±0.9*	3.6±0.9*
13	HDL-C, mmol/l	1.04±0.2	0.9±0.3	1.0±0.3	1.01±0.3*
14	Non-HDL-C, mmol/l	2.4±0.8	2.8±0.8	3.52±0.8*	4.51±0.82*
15	ALT, u/l	15.6±5.6	17.9±6.07	16.7±6.3	16.6±5.8
16	AST, u/l	17.2±6.6	16.05±6.06	16.9±6.5	17±5.5
17	CRP, mg/l	1.8±0.7	3.5±1.5*	4.8±2.1*	5.2±1.8*
18	LAP	70.5±8.2	72.6±9.1	76.3±8.5	82.6±9.5*
19	VOI	2.7±0.32	3.5±0.3*	4.5±0.4*	5.3±0.5*
20	FLI	–0.568±0.1	–0.497±0.15*	–0.395±0.09*	–0.387±0.09*
21	HSI	32.0±4.5	36.8±5.3	47.3±4.3*	50.3±6.0*
21	Apelin-12, pg/ml	0.79±0.4	3.18±0.55*	7.09±2.9*	19.49±8.1*
22	EchoCG EATT in CS, mm	2.8±0.9	5.18±1.55*	7.09±2.9*	9.5±4.3*

Note. * — significant differences, p<0.05.

trol group; the direct correlation of BMI in groups 1, 2, 3 with CVR according to SCORE-2 was revealed (r=0.68, 0.65 and r=0.76, respectively). Obesity and overweight are among the leading causes of CVD and significantly increase the pathophysiological effects of CVR factors [1].

Indices highly specific for CVR and mortality, such as LAP according to Kahn; VOI according to Amato, HIS were used [7].

According to the results of our study, we found a correlation between WC/HC ratio and visceral fat index according to bioimpedance analysis of body composition with a correlation coefficient of r=0.74. LAP index values highly correlated with BMI. The Spearman rank correlation coefficient between LAP index values and BMI was 0.73 in men (p<0.05) and 0.77 in women (p<0.05) [7].

When comparing the functional indices of obesity, significant differences were found. LAP in the class 2 obesity group was 17% (p<0.05) higher compared to the control (p<0.05). VOI in the groups with excess body weight, class 1 obesity, and class 2 obesity was 25.7% (p<0.05), 42% (p<0.05) and 51% (p<0.05) higher compared to the control. Increased VOI and LAP indicated VAT dysfunction and excessive visceral fat accumulation. There was a significant increase in % of adipose tissue and visceral fat levels in all groups; even the indices in the overweight group were 23.3% (p<0.05) and 57.2% (p<0.05) higher, respectively, compared to controls, which may be an indicator of visceral obesity in groups even with normal BM. More significant and reliable increase in % of adipose tissue and visceral fat according to bioimpedance analysis of body composition was found in obese groups: 29% (p<0.05) and 65.5% (p<0.05) in class 1 obesity, 32.7% (p<0.05) and 71% (p<0.05) in class 2 obesity, compared to control group.

When comparing the functional indices of VAT, reliable differences were found: increase of HSI in groups 1, 2 and 3 by 11.7%, 31% (p<0.05) and 35% (p<0.05), respectively, compared to the control group. HSI values >36.0 indicate the presence of hepatic steatosis in the patient with a sensitivity of 93.1%, specificity of 92.4% and AUROC accuracy of 0.812 [8]. There was a significant increase in HSI in overweight, class 1 obesity and class 2 obesity groups by 15% (p<0.05), 44.8% (p<0.05) and 47.8% (p<0.05), respectively, compared to control.

AO was detected by WC/HC ratio in 69% of subjects; in 96% of subjects by BMI, % of adipose tissue

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and by visceral fat, which are reliable indicators of impaired lipid metabolism and independent CVD RF.

According to the results of our study, there was a significant increase in the level of TC, LDL-C, non-HDL-C, TG in groups with class 1 and 2 obesity. There was a direct correlation between BMI and non-HDL-C and LDL-C (r=0.86 and r=0.76, p<0.05). Thus, we can assess the dysfunction of lipid metabolism in all groups: in overweight and obese subjects with high CVR without CVD and with CVD, and in overweight, obese and normal BM.

The results showed a significant increase in EATT in overweight, class 1 obesity, and class 2 obesity groups by 85% (p<0.05), 150% (p<0.05), and 239% (p<0.05), respectively, compared to control. There was a correlation of EATT with the level of CVR according to SCORE-2 and BMI with correlation coefficients of r=0.82 and r=0.70, respectively (p<0.05). Increased EATT is associated with high CVR as well as with IR. With EATT of more than 9.5 mm, IR becomes significantly more frequent.

Analysis of apelin-12 as an early predictor of adipose tissue dysfunction in overweight, class 1 obesity and class 2 obesity groups showed a significant increase of 75% (p<0.05), 88.8% (p<0.05) and 95.9% (p<0.05), respectively, compared to control. There was a high correlation between apelin-12 and BMI, visceral fat level, CVR according to SCORE-2, and EATT with correlation coefficients of r=0.80, r=0.86, r=0.70, and r=0.40, respectively (p<0.05).

Thus, the analysis of VAT dysfunction indices showed an increase in VOI, visceral fat level by bioimpedance analysis, HSI and FLI, EATT with increasing degree of obesity. The revealed results showed that such a marker as apelin-12 can be used to assess and predict the progression of lipid metabolism disorders, VAT dysfunction, and it can be included together with the assessment of estimated VAT, EATT indices in the algorithm of examination of overweight patients and individuals with high CVR [9, 10].

Discussion

One of the more recent methods to assess abdominal adipose tissue status is VOI, a marker of VAT dysfunction. In many studies, elevated indices of VAT dysfunction such as VOI, visceral fat level by bioimpedance analysis, HSI, and HSI have been associated with high cardiometabolic risk, both in the general population and in patients without metabolic disorders [9]. Epicardial adipose tissue is now known to be a marker of visceral obesity and increased CVR. In turn, the association between obesity and CVD is determined by both the degree of obesity and the distribution of adipose tissue. EATT, like any other adipose tissue, serves as an active hormone-producing system (expressing adipokines, chemokines, tumor necrosis factor-α, interleukin-1 and interleukin-6, free fatty acids, angiotensin II, etc.) involved in inflammatory processes in the vascular wall, development of metabolic disorders, thrombosis and atherogenesis [10]. The result of our study showed a significant increase in EATT in groups with overweight, class 1 and class 2. The increase in EATT is associated with IR. With EATT of more than 9.5 mm, IR becomes significantly more frequent. According to the data of Drapkina et al., it is possible to diagnose IR with high accuracy when the EATT is from 2.7 to 4.5 mm and the diastolic function parameter E/A is less than 0.8.

The production of adipokines and the activity of their signaling pathways are altered in obesity, which plays an important role in the relationship between obesity, IR, and increased CVR. We investigated the role of apelin-12 as a biomarker of VAT dysfunction and increased CVR, which is also consistent with previous studies. Currently, apelin is being actively studied as a predictor of obesity complications in different age-sex groups [11].

Visceral obesity is not chosen by chance as the main criterion for the diagnosis of metabolic syndrome (MS). It is a powerful RF of metabolic disorders and contributes to the development of IR and compensatory hyperinsulinemia. Abdominal fat has some characteristics that lead towards the formation of IR, while subcutaneous fat accumulation — does not, and may even be protective against MS [5]. In addition, an increase in EATT is associated with signs of vascular wall remodeling, endothelial dysfunction, impaired lipid metabolism, and impaired left ventricular (LV) diastolic function [9]. A close correlation between the amount of epicardial fat and CHD was also found (r=0.3). EATT less than 7 mm predisposes to the development of subclinical atherosclerosis, while more than 7 mm — to the development of CHD. According to some authors, EATT correlates with myocardial hypertrophy and LV diastolic function [10].

Abdominal fat is hormonally active. VAT is known to produce many different bioactive substances naned adipokines. Adipokines play an important role in the formation of IR. Apelin adipokine is poorly studied. It has been observed that its level increases in obesity and is directly related to the visceral type of adipose tissue distribution. Plasma apelin concentration has been found to rise significantly with increasing degree of AO and directly correlated with WC and WC/HC ratio [3]. High levels of apelin have also been reported in obesity associated with hyperinsulinemia. The work of researchers investigating the relationship between plasma apelin concentrations and cardiac remodeling in AO patients is of particular interest. It was shown that the concentration of apelin in obese patients was higher than in the control group of healthy people, and the levels of the marker negatively correlated with structural changes of the heart, which may indicate the importance of apelin as a factor with cardioprotective properties [9, 11].

Conclusion

The results indicate VAT dysfunction and excessive visceral fat accumulation in high and very high risk patients with both obese, overweight and normal BM. The established correlations make it possible to predict the intensification of visceral obesity with additional markers that are simple, easily reproducible and inexpensive, and may find wide application in daily clinical practice. Such a marker as apelin-12 can be used to assess and predict the progression of lipid metabolism disorders, VAT dysfunction, and can be included together with the assessment of estimated VAT indices (VOI, % of adipose tissue, visceral fat level by bioimpedance analysis, HSI and FLI) in the algorithm of patient examination to assess VAT dysfunction and prevent CVR.

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Challenges of early diagnosis and prevention of cardiovascular disease in Sub-saharan Africa

Eteneneng E.J.

Cardio-Metabolic Health Research Group, Faculty of Natural Sciences, Walter Sisulu University, South Africa.

AUTOR

Enoh Jude Eteneneng*, Researcher, PhD in chemical pathology, Cardio-Metabolic Health Research Group, Faculty of Natural Sciences, Walter Sisulu University, South Africa. ORCID: 0000-0001-5941-0774

Abstract
Cardiovascular disease (CVD) is a significant global health issue, with a particularly high burden in Africa. Recent data suggests that CVDs are responsible for about 13% of all deaths and 38% of all non-communicable disease deaths in Sub-Saharan Africa. However, the true burden of CVD in this region is often underestimated due to poor, delayed and unrecognized diagnosis.
Thoroughly assessing literature data shows that risk factors of CVD are often more prevalent in areas of poverty, low education, and uncontrolled urbanization. Early diagnosis and prevention of CVD are critical for improving patient outcomes, particularly in high-risk populations like Sub-Saharan Africa. However, resource constraints, socioeconomic disparities, and healthcare system challenges often hinder this. Collaborative initiatives and a multifaceted community engagement approach are essential to addressing these challenges and could help ensure the effective management of CVD in Africa.
Keywords: Sub-Saharan Africa, Cardiovascular Diseases, Early Diagnosis, Challenges.

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Introduction

The phrase "cardiovascular disease" (CVD) refers to disorders affecting the heart and blood vessels, such as deep vein thrombosis, pulmonary embolism, peripheral arterial disease, rheumatic heart disease, congenital heart disease, coronary heart disease, and cerebrovascular disease[1]. CVD and its risk factors are

[1] World Health Organization Africa Region. Noncommunicable Diseases Key facts: Cardiovascular Diseases.

* Corresponding author. Tel.: (+27) 834321592. E-mail: jenoh@wsu.ac.za; enoh.jude@yahoo.com

extremely common in Africa. However, there is a lack of understanding and awareness of the condition and a negative perception of the risk factors [1].

Cardiovascular diseases (CVDs) are a major worldwide health issue with differing effects in different parts of the world, including Africa. In sub-Saharan Africa (SSA), cardiovascular diseases (CVDs) are a major health concern. Current data casts doubt on the long-held myth that CVDs are uncommon in this area [2]. However, the true burden of CVD tends to be underestimated, with model forecasts estimating that CVDs are responsible for about 13% of all deaths and 38% of all non-communicable disease (NCD) deaths in SSA [3]. These estimates are primarily based on urban hospital-based clinical area data [3]. In order to effectively manage patients with cardiovascular disease mortality in SSA, it is imperative to address the various problems that come with cardiovascular diagnosis. The current COVID-19 epidemic has brought even more attention to the need for improving Sub-Saharan African cardiovascular healthcare services [4, 5]. Disparities in healthcare infrastructure and financial restrictions are frequently blamed for discrepancies in the burden of cardiovascular disease (CVD) and related risk factors [6]. Multidisciplinary and interdisciplinary approaches are needed to address this issue from policy to practice. Making cardiovascular health a priority is essential to lowering the increasing morbidity and mortality linked to CVD in Africa [5].

Recall that cardiac arrests and strokes can serve as the initial warning indicators of underlying diseases, which is why CVDs are frequently referred to as "silent killers"[2]. Therefore, it's very important to be aware of the challenges of early diagnosis and to keep spreading knowledge and encouraging preventative actions to enhance cardiovascular health in sub-Saharan Africa.

The author extracted key data and findings from English peer-reviewed articles, reports, and studies focused on diagnosing and preventing cardiovascular disorders in Africa. Search terms like "cardiovascular disease in Africa", "Challenges of diagnosis of cardiovascular diseases," "Challenges in preventing cardiovascular disease in Africa", and "common risk factors of cardiovascular disease in Africa" were used. The author gathered the material from publications published in PubMed, Google Scholar, Scopus, Health Websites (WHO, CDC, etc), and other health-related research platforms. Research studies or articles that did not fulfil quality standards or were irrelevant to the main topic and issues were excluded.

Common risk factors and burden of cardiovascular disease

Non-communicable diseases (NCDs) such as CVD coexist with infectious diseases and dietary deficiencies in Africa, creating a dual burden of disease [7, 8]. The epidemiology of infectious diseases has given way to NCDs, especially CVD, throughout Africa [7, 8]. Population ageing, urbanization, and lifestyle modifications all have an impact on CVD. The prevalence of CVD has increased with urbanisation because it causes sedentary behaviour, poor dietary habits, and elevated stress levels [9]. Heart disease and stroke are two of the most common causes of death worldwide, with about one in three fatalities globally attributable to CVDs[3]. More than a million deaths in sub-Saharan Africa were linked to cardiovascular disease (CVD) in 2019, making up 13% of all deaths in Africa and 5.4% of all deaths worldwide[4]. There are an estimated 20 million people with high blood pressure in the African Region, which makes them a substantial risk factor for CVDs[5]. High blood pressure among other metabolic risk factors is responsible for cardiovascular-related deaths as presented in figure 1.

About 80% of coronary heart disease and stroke are caused by behavioural risk factors. The main contributors to cardiovascular disease include bad eating habits, hazardous alcohol consumption, physical inactivity, and tobacco use[6]. According to research

[2] World Health Organization Africa Region. Noncommunicable Diseases Key facts: Cardiovascular Diseases. Available at: https://www.afro.who.int/health-topics/cardiovascular-diseases (accessed on 11 February 2024).

[3] World Health Organization Africa Region. Noncommunicable Diseases Key facts: Cardiovascular Diseases. Available at: https://www.afro.who.int/health-topics/cardiovascular-diseases (accessed on 11 February 2024).

[4] Africa | Where We Work | World Heart Federation. LIVING WITH CC3 IN AFRICA. Available at: https://world-heart-federation.org/where-we-work/africa/ (accessed on 21 February 2024) (accessed on 21 February 2024).

[5] WHO Regional Office for Africa. Overview (Cardiovascular diseases). Available at: https://www.afro.who.int/node/5537 (accessed on 21 February 2024).

[6] WHO Regional Office for Africa. Overview (Cardiovascular diseases). Available at: https://www.afro.who.int/node/5537 (accessed on 21 February 2024).

DOI: 10.24412/2311-1623-2024-42-33-40

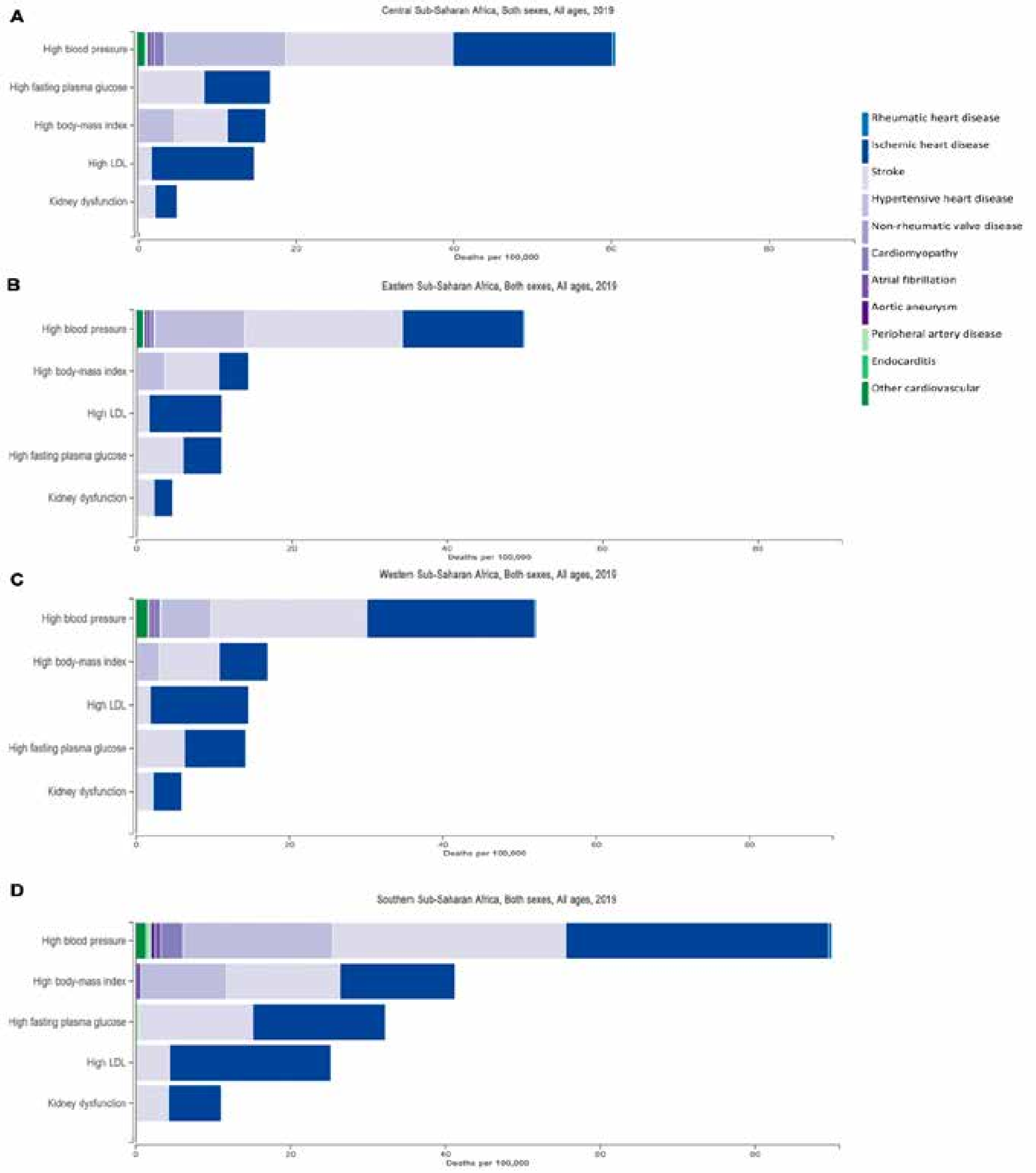

Fig. 1. Metabolic risk factors and their contribution to the burden of cardiovascular disease in four regions in Sub-Saharan Africa [10]

done in Ethiopia, 70% of individuals engage in several cardiovascular risk behaviours (drinking alcohol, smoking, eating a poor diet, and not exercising), while 70% believe that their chance of developing heart disease in the future is low [11]. Environmental factors (urbanisation, climate change, air, noise, and light pollution, figure 2) and behavioural factors have been reported to be significant contributors to cardiovascular diseases, with about 25% of all cases of ischemic heart disease (IHD) related to an unhealthy environment, especially air pollution [12], which could be seen in figure 3.

In Africa, most patients suspected of diabetes and hypercholesteremia face gaps in care, including un-

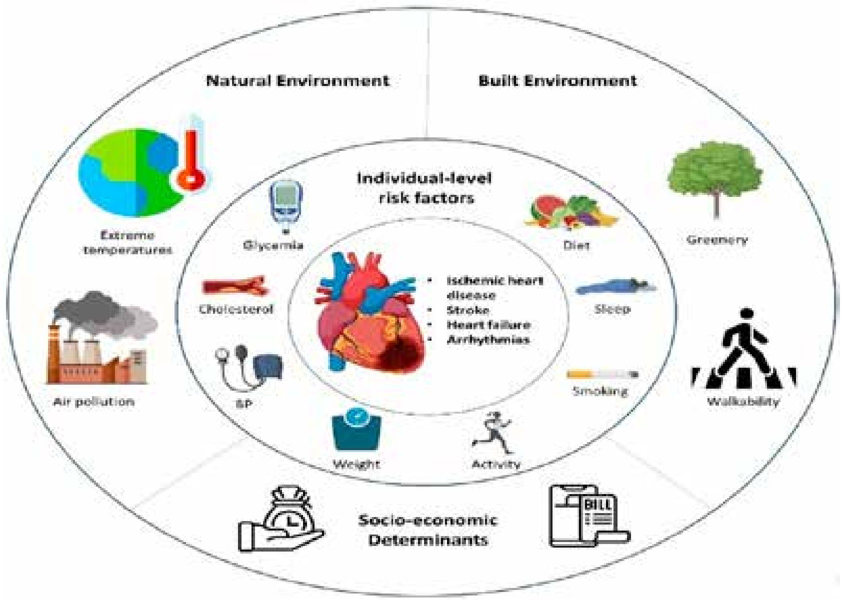

Fig. 2. Individual-level, Natural, and built environmental risk factors, and their contribution to some cardiovascular disease [13]

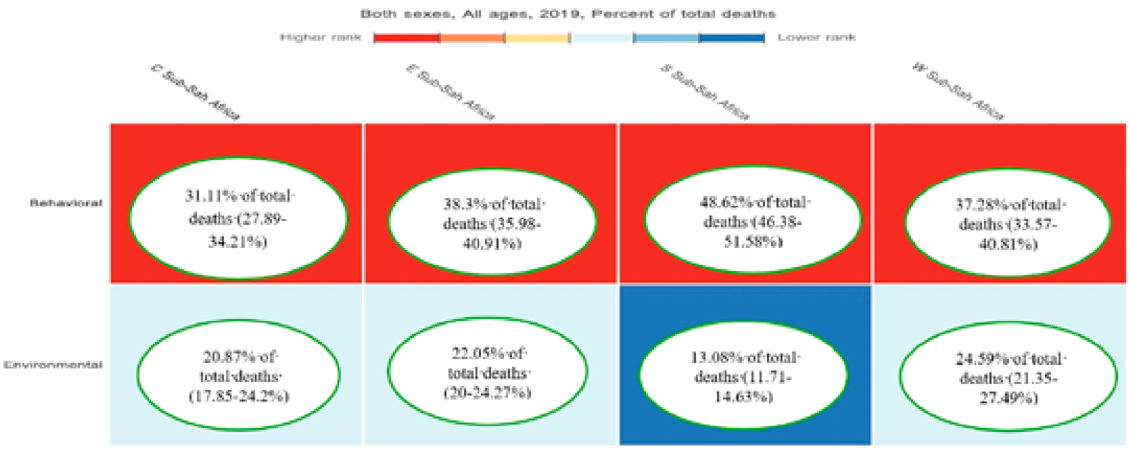

Fig. 3. Behavioral and environmental risk factors and their contribution to the burden of cardiovascular disease in four regions in sub-Sahara Africa[7]

diagnosed, delayed diagnosis and limited access to therapies[8,9]. It is a severe matter because diabetes and high cholesterol are often under-recognized in some countries, such as South Africa, a nation where cardiovascular disease is the second biggest cause of death, accounting for almost 210 fatalities daily. Therefore, early detection, prevention and treatment are especially critical for people with cardiovascular disease or those who are at high risk due to diseases like hypertension, diabetes, or hyperlipidemia[10]. Limited resources, inadequate healthcare, and difficulties accessing timely diagnosis impact timely lifestyle adoption and treatment seeking, which could contribute to the rising CVD burden as estimated in figure 4[11].

[7] Institute for Health Metrics and Evaluation [IHME]. GBD Compare Data Visualization. Available online at: https://vizhub.healthdata.org/gbd-compare/ (Accessed on 10 May 2024).

[8] Diabetes in Africa – 2021. Available at: https://diabetesatlas.org/idfawp/resource-files/2022/01/IDF-Atlas-Factsheet-2021_AFR.pdf (accessed on 21 February 2024).

[9] Analytical fact Sheet: Diabetes is a silent killer in Africa. World Health Organisation African Region. Available at: https://files.aho.afro.who.int/afahobckpcontainer/production/files/iAHO_Diabetes_Regional_Factsheet.pdf (accessed on 10 March 2024.

[10] WHO Regional Office for Africa. Overview (Cardiovascular diseases). Available at: https://www.afro.who.int/node/5537 (accessed on 21 February 2024).

[11] Global Alliance for Patient Access: Cholesterol Management in South Africa. Available at: https://heartfoundation.co.za/wp-content/uploads/2021/03/Policy-Report_Cholesterol-Management-in-South-Africa.pdf (accessed on 10 March 2024).

DOI: 10.24412/2311-1623-2024-42-33-40

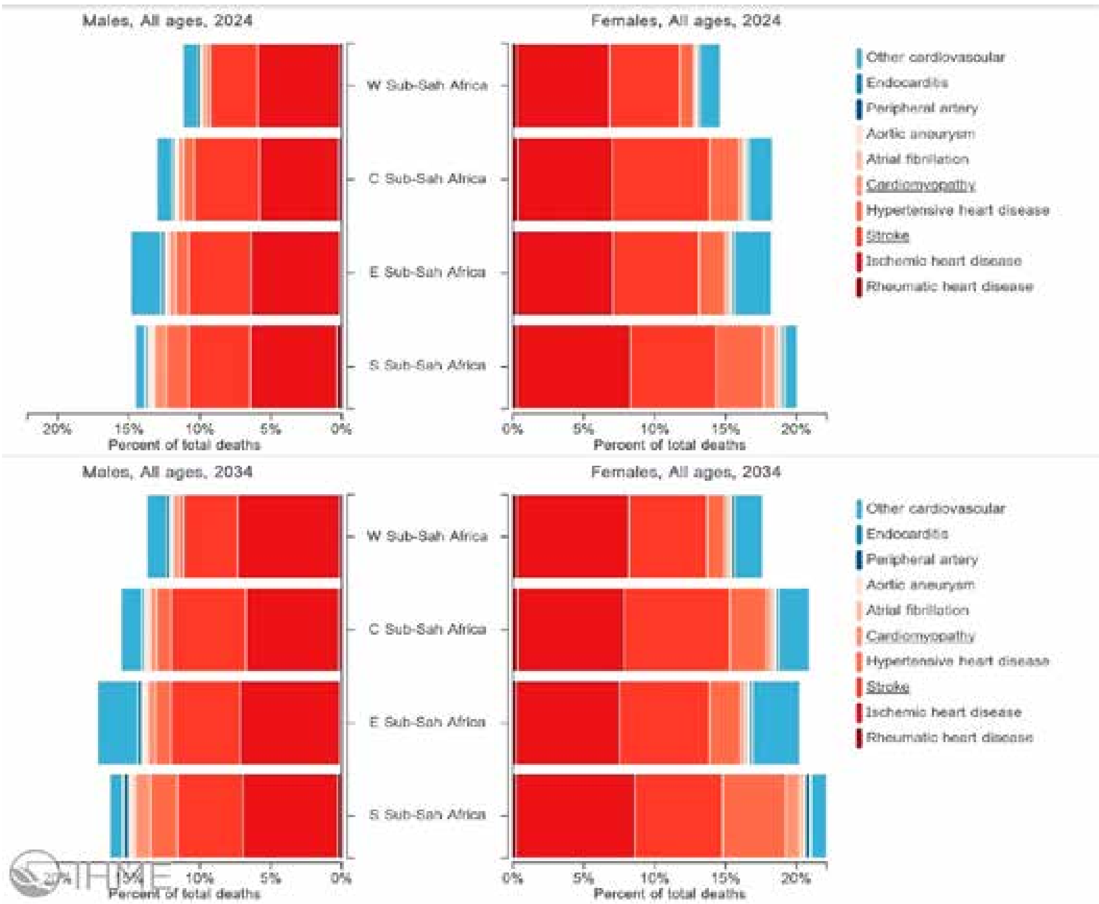

Fig. 4. A ten-year foresight (2024–2034) comparison of Cardiovascular Disease Burden in Sub-Saharan Africa[11]

Challenges in early diagnosis and prevention of cardiovascular diseases

Reducing salt consumption, increasing fruit and vegetable intake, and managing stress are all effective ways to reduce the risk of cardiovascular disease[12]. Cardiovascular risk factors can be more widely distributed in areas of poverty, low education, and uncontrolled urbanization[13], which could be due to difficulties in preventing them. Health disparities exist both between and within African countries. These disparities disproportionately affect vulnerable groups, including the poor, women, children, elderly, and displaced populations[14].

Resource Constraints

Firstly, in Africa, the prevention of diseases faces significant challenges due to resource constraints. Limited financial, human, and infrastructural resources hinder effective prevention efforts [9]. These constraints impact access to healthcare services, diagnostic tools, and medications. The lack of reliable systems to track CVD patients and a lack of a standardised curriculum for preventative cardiovascular nursing among nurses are some of the major obstacles obstructing Africa's prevention of CVD[15]. Stronger health information systems are necessary for better healthcare delivery. Health information technology mainly aims to remove a number of obstacles that prevent and effectively manage CVD [14]. Due to budgetary limitations and infrastructural issues in Africa, access to non-invasive cardiac imaging modalities (such as cardiac magnetic resonance im-

[12] WHO Regional Office for Africa. Overview (Cardiovascular diseases). Available at: https://www.afro.who.int/node/5537 (accessed on 21 February 2024).

[13] WHO Regional Office for Africa. Overview (Cardiovascular diseases). Available at: https://www.afro.who.int/node/5537 (accessed on 21 February 2024).

[14] Health inequities and their causes. World Health Organization (2018). Available at: https://www.who.int/news-room/facts-in-pictures/detail/health-inequities-and-their-causes (accessed on 12 March 2024)

[15] Remote Patient Monitoring for Cardiovascular Disease. Available at: https://rpmhealthcare.com/remote-patient-monitoring-for-cardiovascular-disease/

aging, cardiac computed tomography, and echocardiography) is restricted [15].

Social and Economic Factors

The influence of socioeconomic disparities and status is important in shaping attempts to avoid cardiovascular disease (CVD). Even with universal healthcare access, social poverty is still linked to increased mortality and risk of CVD[16]. Geographical barriers limit access to healthcare services and eventually limit the prevention of CVD[17]. A lack of financial stability, unemployment, and poverty contribute to poor access to healthcare and noncompliance with preventive measures. Inadequate resources present difficulties for management and prevention[18]. Access to treatments, drugs, and healthcare services is impacted by economic reasons[13]. It is critical to address healthcare disparities, particularly in systems of care that are financially burdened; breakthroughs in cardiovascular imaging technology are frequently inadequate[19]. In order to implement successful preventive and treatment plans, it is imperative to address gaps in access to diagnostic imaging and find sustainable solutions. Africa has a heterogeneous socioeconomic landscape that shapes behaviour, risk, and access to healthcare, all of which have an impact on treatment choices and diagnostic precision [28]. Tailored strategies are required to meet specific demands, and it is critical to integrate data from multiple sources (medical history, physical examination, laboratory testing, imaging) and use of modern technology [28].

Healthcare System

The healthcare systems of many African countries are plagued by basic issues, including a deficiency of medical professionals to provide acceptable care, inadequate training, and poor facilities [9]. As is typical in African settings, there is suboptimal teamwork between doctors and nurses [9,17]. Although frequently absent, health promotion initiatives, including education and awareness campaigns, are crucial for preventing CVD [17]. Patients in Africa frequently experience protracted wait times between presenting symptoms to their doctors and receiving diagnostic tests (echocardiograms or natriuretic peptide tests) [18]. The wait time for referral and diagnosis is even longer for older patients, female patients, and people from lower socioeconomic backgrounds [15]. Therefore, well-organized/structured healthcare systems with collaboration with other stakeholders such as schools and traditional, and religious Leaders can thus enhance prevention efforts.

Limited Data and Research

Significant research on cardiovascular health has been produced in the last few decades [19, 20]. To improve cardiovascular treatment and outcomes, large-scale collaborative studies have significantly advanced the identification of modifiable risk factors and the development of evidence-based guidelines. There is sometimes a dearth of comprehensive data on CVD risk factors, prevalence, and results in Africa [9, 19]. Evidence-based preventative measures are hard to put into practice without solid research. There are still unanswered questions about effective therapies and local risk factors [19, 20]. Because of the poorer data collection systems in Africa, particularly in rural regions, the prevalence of CVD is frequently underestimated. An underfunding of research as well as a lack of highly qualified personnel are further factors in the underestimate [21].

Political and Governance Issues

Foreign policy and global governance frameworks generally have an impact on disease prevention, with policy and resource allocation in healthcare being impacted by political instability, corruption, and governance issues[20]. Effective disease prevention requires strong political leadership with stable governance and prioritization of health initiatives. Governments must commit to comprehensive health policies that address the complex burden of diseases which is essential for successful disease control initiatives.

[16] National Center for Chronic Disease Prevention and Health Promotion, Division for Heart Disease and Stroke Prevention. Available at: https://www.cdc.gov/dhdsp/health_equity/socioeconomic.htm (accessed on 12 March 2024)

[17] Clove David: "Healthcare Access Disparities among Rural Populations in the United States" Ballard Brief. February 2023. Available at: www.ballardbrief.byu.edu (accessed on 10 April 2024).

[18] Global Alliance for Patient Access: Cholesterol Management in South Africa. Available at: https://heartfoundation.co.za/wp-content/uploads/2021/03/Policy-Report_Cholesterol-Management-in-South-Africa.pdf (accessed on 10 March 2024)

[19] Remote Patient Monitoring for Cardiovascular Disease. Available at: https://rpmhealthcare.com/remote-patient-monitoring-for-cardiovascular-disease/

[20] World Health Organization. Health Diplomacy: Global health security is integral to foreign policy. Available at: https://www.emro.who.int/health-topics/health-diplomacy/foreign-policy.html (accessed on 12 April 2024).

Certain infections like HIV/AIDS get a lot of political attention, but others like CVD in most African nations go unrecognized [9, 22].

Conclusion

Early diagnosis and prevention of CVD remains a critical focus, especially for high-risk populations such as Africa, and is crucial for improving patient outcomes. Timely CVD diagnosis is crucial for effective management and improvement of patient outcomes by giving enough time for lifestyle changes that could slow the progression. Some of the challenges include overlapping symptoms with other conditions, making it challenging to pinpoint the exact cause and underdiagnosed and delayed diagnosis due to a lack of instruments or expertise. It is also evident that improving healthcare access and encouraging adherence to preventative measures are essential to lowering the burden of CVD. Therefore, factors such as poverty, unemployment, governance, research, and financial instability must be addressed to ensure effective management of CVD in Africa. Addressing these challenges may require collaborative initiatives and a multifaceted community engagement approach, including better education, streamlined diagnostic pathways, and increased awareness of symptoms among patients and healthcare professionals.

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Author Guidelines

Manuscript publication rules
in the International heart and vascular disease journal

Edit from December, 2021

Disclaimer: The rules came into effect from December 2021. The rules describe the conditions of publication of manuscripts (articles) through the site http://www.heart-vdj.com. The editorial Board is ready to answer questions and help authors by e-mail: submissions.ihvdj@gmail.com.

The *International heart and vascular disease journal* has been published since 2013. It is official journal of the Cardioprogress Foundation. The target audience of this peer-reviewed journal is cardiologists and internal disease specialists. The journal is primarily focused on questions of epidemiology, prevention, and cardiac pharmacotherapy. It also publishes lectures and literature reviews on various problems of modern cardiology, reports on new diagnostic methods, and other information which is important for the practitioners.

The General criteria for the publication of articles in the International heart and vascular disease journal are the relevance, novelty of the material and its value in theoretical and/or applied aspects.

The languages of publications are Russian and English. Journal is peer-reviewed, with multistage editing. Editorial board is presented by the leading cardiologists from different countries and Russia.

International heart and vascular disease journal aims to ensure that its publications fulfill the requirements of international publishing standards, such as the Uniform Requirements for Manuscripts Submitted to Biomedical Journals: Writing and Editing for Biomedical Publication, by the International Committee of Medical Journal Editors, ICMJE (http://www.icmje.org), and the recommendations by the Committee on Publication Ethics, COPE (http://www.publicationethics.org.uk).

All clinical trials should be performed and described in full accordance with the CONSORT standards (http://www.consort-statement.org), observational research – STROBE (http://www.strobe-statement.org), systematic reviews and meta-analyses – PRISMA (http://www.prisma-statement.org), diagnostic accuracy – STAR (http://www.stard-statement.org).

I. The International heart and vascular disease journal accepts the following manuscripts:

1) *Original papers* present the results of clinical studies. The word limit is 3.000 (including references, tables, and figure legends). The maximal number of references is 15. The structured abstract should contain 5 sections (**Aim, Material and Methods, Results, Conclusion**, and **Key words**), and be no longer than 300 words.

2) *Lectures*, or clinically oriented reviews, are written by experts in broader areas of medicine. Lectures could be focused on epidemiology, pathophysiology, diagnostics, treatment, and prevention. The word limit is 5.000 (including references, tables, and figure legends). The maximal reference number is 80. The unstructured abstract is no longer than 150 words.

3) *Literature reviews* are focused on more specific topics, compared to lectures. The word limit is 4.500 (including references, tables, and figure legends). The maximal reference number is 50. The unstructured abstract is up to 150 words.

4) *Clinical case* is a brief report on a complex diagnostic problem and its solution, or a description of

a rare clinical observation. The word limit is 600 (including references, tables, and figure legends). The maximal number of references is 5. No abstract is required.

5) *Clinical opinion* informs the readers on the topics of cardiovascular medicine and related disciplines. The word limit is 2.500 (including references, tables, and figure legends). The maximal number of references is 15.

The journal accepts for publication original phase 2, 3 and 4 clinical studies. Literature reviews should be based on sources not older than 5 years.

II. Information about the article, which includes the following sections, is combined into a single file "letter (cover)":

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If the manuscript is a part of the thesis, it is necessary **to specify** the estimated terms of thesis defense.

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Names of institutions (write the official name. At the same time – there is a reduction of Federal, STATE, etc.; the quotation marks are placed; Ministry of health of Russia, a city without the letter G.

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Example of design:

THE PREVALENCE OF RISK FACTORS OF NONCOMMUNICABLE DISEASES IN THE RUSSIAN POPULATION IN 2012–2013. THE RESEARCH RESULTS OF THE ESSE-RF

Muromtseva G.A.[1], Kontsevaya A.V.[1], Konstantinov V.V.[1], Artamonova G.V.[2], Galaganova T.M.[3],...

[1] FGBU State research center of preventive medicine of the Ministry of health of Russia, Moscow;

[2] FGBU Research Institute of complex problems of cardiovascular diseases SB RAMS, Kemerovo;

[3] RD VPO North Ossetian state medical Academy, Vladikavkaz;..., Russia.

Information about the authors, where indicated: full name, place of work of all authors, their positions, ORCID; full contact information is required for one (or more) of the author and includes e-mail, available phone number.

All members of the group of authors should meet all four criteria of authorship set forth in the ICMJE recommendations: 1) concept and design development or data analysis and interpretation, and 2) manuscript justification or verification of critical intellectual content, and 3) final approval for publication of the manuscript, and 4) consent to be responsible for all aspects of the work, and assume that issues relating to the thoroughness and diligent execution of any part of the study submitted are duly investigated and resolved. This information should also be contained in the document.

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Example of design:

The study was carried out in accordance with the standards of good clinical Practice (Good Clinical Practice) and the principles of the Helsinki Declaration. The study Protocol was approved by the Ethical committees of all participating clinical centers. Prior to being included in the study, written informed consent was obtained from all participants.

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Summary with key words-sections are drawn up each with a separate line, highlighted in bold. The abstract should contain only those sections that are described in the rules for authors. For example, there is no section "Relevance" in the summary. The authors prescribe the relevance of their work in the introductory section of the manuscript.

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The first reference to an abbreviation is always accompanied by the full spelling of the abbreviated concept, and the abbreviation is indicated in brackets. For example, blood pressure (BP); heart rate (HR). Capital letters are more often used to denote abbreviations. If abbreviations are used only in tables and figures, and are not used in the text, they should not be included in the list of abbreviations, but should be given a transcript in the note to the table or figure. The summary of the article, as a separate document, is subject to the same rules as the article (abbreviations are made when they are used 3 or more times).

Abbreviations should be generally accepted and understandable to the reader, in accordance with the generally accepted norms in the scientific literature. Undesirable abbreviations that coincide in writing with others that have a different meaning.

Abbreviations in the list of abbreviations are written in alphabetical order, separated by commas, in solid text, using "dash". **Example of design:** BP-blood pressure, HR-heart rate.

Text – the text of the manuscript of the original works should be structured: Introduction, Material and methods, Results, Discussion and Conclusion. The text of reviews and lectures can be unstructured.

Text is printed on A4 sheet, font size – 12 pt, line spacing – 1.5, margins 2 cm on all sides. The system of SI units is used for processing the material, the% sign is put through a space from the number, the value of p is written with a semicolon: p < 0.0001; the value of n is written with a small letter (n=20); signs >, <, ±, =, +, – when numerical values are written without a space; the value of "year" or "year" is issued – 2014 or 2002 – 2014.

The article should be carefully verified by the author (s). The authors are responsible for the correctness of citation, doses and other factual materials.

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Statistical methods are described in detail in the Material and methods section.

Acknowledgements – all participants who do not meet the authorship criteria should be listed in the Acknowledgements section, which is located at the end of the article before the Literature section.

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The names of the graphs and figures, as well as notes to them should be placed under the figure/graph or placed at the end of the article.

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The tables should clearly indicate the dimension of the indicators and the form of data (M±m; M±SD; Me; Mo; percentiles, etc.). All figures, totals and percentages should be carefully verified, and also correspond to the mention in the text. The explanatory notes are given below the table, if necessary. The footnotes must be in the following order: *, †, §, ||, ¶, #, **, †† etc.

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Book:

Shlyakhto EV, Konradi AO, Tsyrlin VA. The autonomic nervous system and hypertension. SPb.: Meditsinskoe izdatel'stvo; 2008. Russian. Шляхто Е. В., Конради А. О., Цырлин В. А. Вегетативная нервная система и артериальная гипертензия. СПб.: Медицинское издательство; 2008. ISBN 0000–0000.

Chapter:

Nichols WW, O'Rourke MF. Aging, high blood pressure and disease in humans. In: Arnold E, ed. McDonald's Blood Flow in Arteries: Theoretical, Experimental and Clinical Principles. 3rd ed. London/Melbourne/Auckland: Lea and Febiger; 1990. p.398–420. ISBN 0000–0000.

Russian chapter:

Diagnostics and treatment of chronic heart failure. In. National clinical guidelines 4th ed. Moscow: Silicea-Polygraf; 2011. pp.203–93. Russian Диагностика и лечение хронической сердечной недостаточности. В кн: Национальные клинические рекомендации. 4-е издание. М.: Силицея-Полиграф; 2011.сс.203–96. ISBN 0000–0000.

Webpage:

Panteghini M. Recommendations on use of biochemical markers in acute coronary syndrome: IFCC proposals. eJIFCC 14. http://www.ifcc.org/ejifcc/vol14no2/1402062003014n.htm (28 May 2004)

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XIV. Journal subscription

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Official sites where information about the journal is placed:

http://www.heart-vdj.com

On the reception of the articles, making decisions about publication, reviews – mmamedov@mail.ru

On organizational issues (working with the site, subscription) – editor.ihvdj@gmail.com

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Room 213, Building 2, Prospect Gostinichny 6, Moscow 127106, Russia

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