

CRR
JOURNAL
OF CARDIORESPIRATORY RESEARCH

ISSN 2181-0974
DOI 10.26739/2181-0974
Impact Factor SJIF 2022: 5.937

Journal of

**CARDIORESPIRATORY
RESEARCH**



Volume 7, Issue 2/1

2026

МИНИСТЕРСТВО ЗДРАВООХРАНЕНИЯ
РЕСПУБЛИКИ УЗБЕКИСТАН

Журнал кардиореспираторных исследований

JOURNAL OF CARDIORESPIRATORY RESEARCH

Главный редактор: Э.Н.ТАШКЕНБАЕВА

Учредитель:

Самаркандский государственный
медицинский университет

Tadqiqot.uz

Ежеквартальный
научно–практический
журнал

ISSN: 2181-0974
DOI: 10.26739/2181-0974



№ 2/1
2026

Главный редактор:

Ташкенбаева Элеонора Негматовна

доктор медицинских наук, профессор, заведующая кафедрой внутренних болезней и кардиологии №2 Самаркандского Государственного медицинского университета, председатель Ассоциации терапевтов Самаркандской области.
<https://orcid.org/0000-0001-5705-4972>

Заместитель главного редактора:

Хайбулина Зарина Руслановна

*доктор медицинских наук, руководитель отдела биохимии с группой микробиологии
ГУ «РСНПМЦХ им. акад. В. Вахидова» <https://orcid.org/0000-0002-9942-2910>*

ЧЛЕНЫ РЕДАКЦИОННОЙ КОЛЛЕГИИ:

Аляви Анис Лютфуллаевич

академик АН РУз, доктор медицинских наук, профессор, Председатель Ассоциации Терапевтов Узбекистана, Советник директора Республиканского специализированного научно-практического центра терапии и медицинской реабилитации (Ташкент)
<https://orcid.org/0000-0002-0933-4993>

Бокерия Лео Антонович

академик РАН, доктор медицинских наук, профессор, Президент научного центра сердечно-сосудистой хирургии им. А.Н. Бакулева (Москва), <https://orcid.org/0000-0002-6180-2619>

Курбанов Равшанбек Давлетович

академик АН РУз, доктор медицинских наук, профессор, Советник директора Республиканского специализированного научно-практического медицинского центра кардиологии (Ташкент), <https://orcid.org/0000-0001-7309-2071>

Шкляев Алексей Евгеньевич

д.м.н., профессор, ректор Федерального государственного бюджетного образовательного учреждения высшего образования «Ижевская государственная медицинская академия» Министерства здравоохранения Российской Федерации

Michał Tendera

профессор кафедры кардиологии Верхнесилезского кардиологического центра, Силезский медицинский университет в Катовице, Польша (Польша)
<https://orcid.org/0000-0002-0812-6113>

Покушалов Евгений Анатольевич

доктор медицинских наук, профессор, заместитель генерального директора по науке и развитию сети клиник «Центр новых медицинских технологий» (ЦНМТ), (Новосибирск), <https://orcid.org/0000-0002-2560-5167>

Зуфаров Миржамол Мирумарович

доктор медицинских наук, профессор, руководитель отдела ГУ «РСНПМЦХ им. акад. В. Вахидова» <https://orcid.org/0000-0003-4822-3193>

Акилов Хабибулла Атауллаевич

доктор медицинских наук, профессор, Директор Центра развития профессиональной квалификации медицинских работников (Ташкент)

Насирова Зарина Акбаровна

DSc, доцент кафедры внутренних болезней и кардиологии №2 Самаркандского Государственного Медицинского университета (ответственный секретарь) ORCID: 0000-0002-8722-0393 (ответственный секретарь)

Ризаев Жасур Алимджанович

доктор медицинских наук, профессор, Ректор Самаркандского государственного медицинского университета, <https://orcid.org/0000-0001-5468-9403>

Зиядуллаев Шухрат Худойбердиевич

доктор медицинских наук, профессор, первый заместитель директора по академической деятельности Самаркандского филиала Международного Университета Кимё в Ташкенте
<https://orcid.org/0000-0002-9309-3933>

Джан Ковак

Профессор, председатель Совета Европейского общества кардиологов по инсульту, руководитель специализированной кардиологии, заведующий отделением кардиологии, кардио- и торакальной хирургии, консультант-кардиолог, больница Гленфилд, Лестер (Великобритания)

Сергио Бернардини

Профессор клинической биохимии и клинической молекулярной биологии, главный врач отдела лабораторной медицины, больница Университета Тор Вергата (Рим, Италия)

Ливерко Ирина Владимировна

доктор медицинских наук, профессор, заместитель директора по науке Республиканского специализированного научно-практического медицинского центра фтизиатрии и пульмонологии Республики Узбекистан (Ташкент)
<https://orcid.org/0000-0003-0059-9183>

Цурко Владимир Викторович

доктор медицинских наук, профессор Первого Московского государственного медицинского университета им. И.М. Сеченова (Москва)
<https://orcid.org/0000-0001-8040-3704>

Тригулова Ранса Хусановна

Доктор медицинских наук, руководитель лаборатории превентивной кардиологии, ведущий научный сотрудник лаборатории ИБС и атеросклероза. Республиканский специализированный научно-практический медицинский центр кардиологии (Ташкент)
ORCID- 0000-0003-4339-0670

Тураев Феруз Фатхуллаевич

доктор медицинских наук, Директор Республиканского специализированного научно-практического медицинского центра эндокринологии имени академика Ю.Г. Туракулова

Bosh muharrir:

Tashkenbayeva Eleonora Negmatovna

tibbiyot fanlari doktori, professor, Samarqand davlat tibbiyot universiteti 2-sonli ichki kasalliklar va kardiologiya kafedrasini mudiri, Samarqand viloyati vrachlar uyushmasi raisi
<https://orsid.org/0000-0001-5705-4972>

Bosh muharrir o'rinbosari:

Xaibulina Zarina Ruslanovna

tibbiyot fanlari doktori, "akad V. Vohidov nomidagi RIJM davlat institutining mikrobiologiya guruhi bilan biokimyo kafedrasini mudiri" <https://orcid.org/0000-0002-9942-2910>

TAHRIRIYAT A'ZOLARI:

Alyavi Anis Lyutfullayevich

O'zbekiston Respublikasi Fanlar akademiyasining akademigi, tibbiyot fanlari doktori, professor, O'zbekiston Terapevtlar uyushmasi raisi, Respublika ixtisoslashtirilgan ilmiy va amaliy tibbiy terapiya markazi va tibbiy reabilitatsiya direktori maslahatchisi (Toshkent), <https://orcid.org/0000-0002-0933-4993>

Bockeria Leo Antonovich

Rossiya fanlar akademiyasining akademigi, tibbiyot fanlari doktori, professor, A.N. Bakuleva nomidagi yurak-qon tomir jarrohligi ilmiy markazi prezidenti (Moskva)
<https://orcid.org/0000-0002-6180-2619>

Kurbanov Ravshanbek Davlatovich

O'zbekiston Respublikasi Fanlar akademiyasining akademigi, tibbiyot fanlari doktori, professor, Respublika ixtisoslashtirilgan kardiologiya ilmiy-amaliy tibbiyot markazining direktor maslahatchisi (Toshkent)
<https://orcid.org/0000-0001-7309-2071>

Shklyayev Aleksey Evgenievich

Tibbiyot fanlari doktori, professor, Rossiya Federatsiyasi Sog'liqni saqlash vazirligining "Izhevsk davlat tibbiyot akademiyasi" Federal davlat byudjeti oliy ta'lim muassasasi rektori

Mixal Tendera

Katovitsadagi Sileziya Tibbiyot Universiteti, Yuqori Sileziya Kardiologiya Markazi kardiologiya kafedrasini professori (Polsha)
<https://orcid.org/0000-0002-0812-6113>

Pokushalov Evgeniy Anatolevich

tibbiyot fanlari doktori, professor, "Yangi tibbiy texnologiyalar markazi" (YTTM) klinik tarmog'ining ilmiy ishlar va rivojlanish bo'yicha bosh direktorining o'rinbosari (Novosibirsk) <https://orcid.org/0000-0002-2560-5167>

Zufarov Mirjamol Mirumarovich

tibbiyot fanlari doktori, professor, "akad V. Vohidov nomidagi RIJM davlat muassasasi" bo'limi boshlig'i"
<https://orcid.org/0000-0003-4822-3193>

Akilov Xabibulla Ataulayevich

tibbiyot fanlari doktori, professor, Tibbiyot xodimlarining kasbiy malakasini oshirish markazi direktori (Toshkent)

Nasirova Zarina Akbarovna

Samarqand davlat tibbiyot universiteti 2-sonli ichki kasalliklar va kardiologiya kafedrasini dotsenti, DSc (mas'ul kotib) ORCID: 0000-0002-8722-0393 (*mas'ul kotib*)

Rizayev Jasur Alimjanovich

tibbiyot fanlari doktori, professor, Samarqand davlat tibbiyot universiteti rektori
<https://orcid.org/0000-0001-5468-9403>

Ziyadullayev Shuxrat Xudoyberdiyevich

tibbiyot fanlari doktori, professor, Toshkent shahridagi Kimyo xalqaro universitetining Samarqand filiali direktorining akademik faoliyat bo'yicha birinchi o'rinbosari (Toshkent)
<https://orcid.org/0000-0002-9309-3933>

Jan Kovak

Yevropa kardiologiya jamiyati insult kengashi raisi, 2017 yildan buyon ixtisoslashtirilgan kardiologiya kafedrasini rahbari, kardiologiya, yurak va torakal jarrohlik kafedrasini mudiri, maslahatchi kardiolog Glenfield kasalxonasi, Lester (Buyuk Britaniya)

Sergio Bernardini

Klinik biokimyo va klinik molekulyar biologiya bo'yicha professor - Laboratoriya tibbiyoti bo'limi bosh shifokori – Tor Vergata universiteti kasalxonasi (Rim-Italiya)

Liverko Irina Vladimirovna

tibbiyot fanlari doktori, professor, Respublika ixtisoslashtirilgan fiziologiya va pulmonologiya ilmiy-amaliy tibbiyot markazining ilmiy ishlar bo'yicha direktor o'rinbosari (Toshkent)
<https://orcid.org/0000-0003-0059-9183>

Surko Vladimir Viktorovich

tibbiyot fanlari doktori, professori I.M. Sechenov nomidagi Birinchi Moskva Davlat tibbiyot universiteti (Moskva)
<https://orcid.org/0000-0001-8040-3704>

Trigulova Raisa Xusainovna

Tibbiyot fanlari doktori, Profilaktik kardiologiya laboratoriyasi mudiri, YuIK va ateroskleroz laboratoriyasining yetakchi ilmiy xodimi. Respublika ixtisoslashtirilgan kardiologiya ilmiy-amaliy tibbiyot markazi (Toshkent) ORCID- 0000-0003-4339-0670

Turayev Feruz Fatxullayevich

tibbiyot fanlari doktori, akademik Y.X.To'raqulov nomidagi Respublika ixtisoslashtirilgan endokrinologiya ilmiy amaliy tibbiyot markazi direktori
<https://orcid.org/0000-0002-1321-4732>

Chief Editor:

Tashkenbaeva Eleonora Negmatovna

Doctor of Medical Sciences, professor, Head of the Department of Internal Diseases and cardiology No. 2 of the Samarkand State Medical University, Chairman of the Association of Physicians of the Samarkand Region. <https://orsid.org/0000-0001-5705-4972>

Deputy Chief Editor:

Xaibulina Zarina Ruslanovna

Doctor of Medical Sciences, Head of the Department of Biochemistry with the Microbiology Group of the State Institution "RSSC named after acad. V. Vakhidov", <https://orcid.org/0000-0002-9942-2910>

MEMBERS OF THE EDITORIAL BOARD:

Alyavi Anis Lutfullaevich

Academician of the Academy of Sciences of the Republic of Uzbekistan, Doctor of Medical Sciences, Professor, Chairman of the Association of Physicians of Uzbekistan, Advisor to the Director of the Republican Specialized Scientific - Practical Center of Therapy and Medical Rehabilitation (Tashkent) <https://orcid.org/0000-0002-0933-4993>

Bockeria Leo Antonovich

Academician of the Russian Academy of Sciences, Doctor of Medical Sciences, Professor, President of the Scientific Center for Cardiovascular Surgery named after A.N. Bakuleva (Moscow) <https://orcid.org/0000-0002-6180-2619>

Kurbanov Ravshanbek Davletovich

Academician of the Academy of Sciences of the Republic of Uzbekistan, Doctor of Medical Sciences, Professor, Advisor to the Director Republican Specialized Scientific and Practical Medical Center of Cardiology, (Tashkent) <https://orcid.org/0000-0001-7309-2071>

Shklyayev Aleksey Evgenievich

Doctor of Medical Sciences, Professor, Rector of the Federal State Budgetary Educational Institution of Higher Education "Izhevsk State Medical Academy" of the Ministry of Health of the Russian Federation

Michal Tendera

Professor of the Department of Cardiology, Upper Silesian Cardiology Center, Silesian Medical University in Katowice, Poland (Poland) <https://orcid.org/0000-0002-0812-6113>

Pokushalov Evgeny Anatolyevich

Doctor of Medical Sciences, Professor, Deputy Director General for Science and Development of the Clinic Network "Center for New Medical Technologies" (CNMT), (Novosibirsk) <https://orcid.org/0000-0002-2560-5167>

Akilov Xabibulla Ataullovich

Doctor of Medical Sciences, Professor, Center for the development of professional qualifications of medical workers (Tashkent)

Nasyrova Zarina Akbarovna

DSc, Associate Professor of the Department of Internal Diseases and cardiology No. 2 of the Samarkand State Medical University (Executive Secretary) ORCID: 0000-0002-8722-0393 (Executive Secretary)

Rizaev Jasur Alimjanovich

Doctor of Medical Sciences, Professor, Rector of the Samarkand State Medical University <https://orcid.org/0000-0001-5468-9403>

Ziyadullaev Shuhrat Khudoyberdievich

Doctor of Medical Sciences, Professor, Deputy Director for Scientific Doctor of Medical Sciences, Professor, First Deputy Director for Academic Affairs of the Samarkand branch of Kimyo International University in Tashkent <https://orcid.org/0000-0002-9309-3933>

Jan Kovac

Professor Chairman, European Society of Cardiology Council for Stroke, Lead of Specialised Cardiology, Head of Cardiology, Cardiac and Thoracic Surgery, Consultant Cardiologist, Glenfield Hospital, Leicester (United Kingdom)

Sergio Bernardini

Full Professor in Clinical Biochemistry and Clinical Molecular Biology -Head Physician of the Laboratory Medicine Unit- University of Tor Vergata Hospital (Rome-Italy)

Liverko Irina Vladimirovna

Doctor of Medical Sciences, Professor, Deputy Director for Science of the Republican Specialized Scientific and Practical Medical Center for Phthiology and Pulmonology of the Republic of Uzbekistan (Tashkent) <https://orcid.org/0000-0003-0059-9183>

Zufarov Mirjamol Mirumarovich

Doctor of Medical Sciences, Professor, Head of the Department of the State Institution "RSNPMTSH named after acad. V. Vakhidov" <https://orcid.org/0000-0003-4822-3193>

Tsurko Vladimir Viktorovich

Doctor of Medical Sciences, professor Of Moscow State Medical University by name I.M. Sechenov (Moscow) <https://orcid.org/0000-0001-8040-3704>

Trigulova Raisa Khusainovna

Doctor of Medical Sciences, Head of the Laboratory of Preventive Cardiology, Leading Researcher of the Laboratory of IHD and Atherosclerosis. Republican Specialized Scientific and Practical Medical Center of Cardiology (Tashkent) ORCID- 0000-0003-4339-0670

Turaev Feruz Fatxullaevich

Doctor of Medical Sciences, Director of the Republican Specialized Scientific and Practical Medical Center of Endocrinology named after Academician Yu.G. Turakulova

Алимов Дониёр Анварович
доктор медицинских наук, директор
Республиканского научного центра
экстренной медицинской помощи

Абдуллаев Акбар Хатамович
доктор медицинских наук, главный
научный сотрудник Республиканского
специализированного научно-
практического центра медицинской
терапии и реабилитации
<https://orcid.org/0000-0002-1766-4458>

Агабабян Ирина Рубеновна
кандидат медицинских наук, доцент,
заведующая кафедрой терапии ФПДО,
Самаркандского Государственного
медицинского института

Алиева Нигора Рустамовна
доктор медицинских наук, заведующая
кафедрой Госпитальной педиатрии №1
с основами нетрадиционной медицины
ТашПМИ

Исмаилова Адолат Абдурахимовна
доктор медицинских наук, профессор,
заведующая лабораторией
фундаментальной иммунологии
Института иммунологии геномики
человека АН РУз

Камалов Зайнитдин Сайфутдинович
доктор медицинских наук, профессор,
заведующий лабораторией
иммунорегуляции Института
иммунологии и геномики
человека АН РУз

Каюмов Улугбек Каримович
доктор медицинских наук, профессор,
заведующий кафедрой внутренних
болезней и телемедицины Центра
развития профессиональной
квалификации медицинских работников

Хусинова Шоира Акбаровна
кандидат философских наук, доцент,
заведующая кафедрой общей практики,
семейной медицины ФПДО
Самаркандского Государственного
медицинского института

Шодиколова Гуландом Зикрияевна
д.м.н., профессор, заведующая
кафедрой внутренних болезней № 3
Самаркандского Государственного
Медицинского Института
(Самарканд)
<https://orcid.org/0000-0003-2679-1296>

Doniyorova Farangisbonu Alisher qizi
Toshkent Davlat tibbiyot universiteti
nevrologiya va xalq tabobati kafedrasida
dotsenti, DSc.
<https://orcid.org/0009-0004-4140-4797>

Alimov Doniyor Anvarovich
tibbiyot fanlari doktori, Respublika
shoshilinch tibbiy yordam ilmiy markazi
direktori (Toshkent)

Abdullayev Akbar Xatamovich
tibbiyot fanlari doktori, O'zbekiston
Respublikasi Sog'liqni saqlash
vazirligining "Respublika
ixtisoslashtirilgan terapiya va tibbiy
reabilitatsiya ilmiy-amaliy
tibbiyot markazi" davlat
muassasasi bosh ilmiy xodimi
<https://orcid.org/0000-0002-1766-4458>

Agababyan Irina Rubenovna
tibbiyot fanlari nomzodi, dotsent, DKTF,
terapiya kafedrasida mudiri, Samarqand
davlat tibbiyot instituti

Alieva Nigora Rustamovna
tibbiyot fanlari doktori, 1-sonli gospital
pediatriya kafedrasida mudiri, ToshPTI

Ismoilova Adolat Abduraximovna
tibbiyot fanlari doktori, professor,
O'zbekiston Respublikasi Fanlar
akademiyasining Odam genomikasi
immunologiyasi institutining fundamental
immunologiya laboratoriyasining mudiri

Kamalov Zaynitdin Sayfutdinovich
tibbiyot fanlari doktori, professor,
O'zbekiston Respublikasi Fanlar
akademiyasining Immunologiya va inson
genomikasi institutining Immunogenetika
laboratoriyasi mudiri

Qayumov Ulug'bek Karimovich
tibbiyot fanlari doktori, professor,
Tibbiyot xodimlarining kasbiy malakasini
oshirish markazi, ichki kasalliklar va
teletibbiyot kafedrasida mudiri (Toshkent)

Xusinova Shoira Akbarovna
tibbiyot fanlari nomzodi, dotsent,
Samarqand davlat tibbiyot instituti DKTF
Umumiy amaliyot va oilaviy tibbiyot
kafedrasida mudiri (Samarqand)

Shodiqulova Gulandom Zikriyevna
tibbiyot fanlari doktori, professor,
Samarqand davlat tibbiyot instituti 3-
ichki kasalliklar kafedrasida mudiri
(Samarqand)
<https://orcid.org/0000-0003-2679-1296>

Doniyorova Farangisbonu Alisher qizi
dozent kafedrasida nevrologiya va
xalq tabobati kafedrasida dotsent,
Toshkent davlat tibbiyot universiteti
nevrologiya va xalq tabobati kafedrasida
dotsenti, DSc.
<https://orcid.org/0009-0004-4140-4797>

Alimov Doniyor Anvarovich
Doctor of Medical Sciences, Director of
the Republican Scientific Center of
Emergency Medical Care

Abdullaev Akbar Xatamovich
Doctor of Medical Sciences,
Chief Researcher of the State Institution
"Republican Specialized Scientific and
Practical Medical Center for Therapy and
Medical Rehabilitation" of the Ministry of
Health of the Republic of Uzbekistan,
<https://orcid.org/0000-0002-1766-4458>

Agababyan Irina Rubenovna
PhD, Associate Professor, Head of the
Department of Therapy, FAGE,
Samarqand State Medical Institute

Alieva Nigora Rustamovna
Doctor of Medical Sciences, Head of the
Department of Hospital Pediatrics
No. 1 with the basics of alternative
medicine, TashPMI

Ismailova Adolat Abduraximovna
doctor of Medical Sciences, Professor,
Head of the Laboratory of Fundamental
Immunology of the Institute of
Immunology of Human
Genomics of the Academy of Sciences
of the Republic of Uzbekistan

Kamalov Zaynitdin Sayfutdinovich
doctor of Medical Sciences, Professor,
Head of the Laboratory of
Immunogenetics of the Institute of
Immunology and Human Genomics
of the Academy of Sciences of the
Republic of Uzbekistan

Kayumov Ulugbek Karimovich
Doctor of Medical Sciences, Professor,
Head of the Department of Internal
Diseases and Telemedicine of the Center
for the development of professional
qualifications
of medical workers

Khusinova Shoira Akbarovna
PhD, Associate Professor, Head of the
Department of General Practice,
Family Medicine FAGE of the
Samarqand State Medical Institute

Shodikulova Gulandom Zikriyevna
Doctor of Medical Sciences, professor,
head of the Department of Internal
Diseases N 3 of Samarqand state medical
institute (Samarqand)
<https://orcid.org/0000-0003-2679-1296>

Doniyorova Farangisbonu Alisher kizi
Associate Professor, Department of
Neurology and Traditional Medicine,
Tashkent State Medical University, DSc.
<https://orcid.org/0009-0004-4140-4797>

Халиков Каххор Мирзаевич
кандидат медицинских наук, доцент
заведующий кафедрой биологической
химии Самаркандского
государственного медицинского
университета

Тулабаева Гавхар Миракбаровна
Заведующая кафедрой кардиологии,
Центр развития профессиональной
квалификации медицинских
работников, д.м.н., профессор

**Абдумаджидов Хамидулла
Амануллаевич**
Бухарский государственный
медицинский институт имени Абу
Али ибн Сино. Кафедра «Хирургические
болезни и реанимация». Доктор
медицинских наук, профессор.

Саидов Максуд Арифович
к.м.н., директор Самаркандского
областного отделения
Республиканского специализированного
научно-практического медицинского
центра кардиологии (г. Самарканд)

Срождинова Нигора Зайнутдиновна
д.м.н. Заведующая научно-
исследовательской лабораторией
кардиодиабета и метаболических
нарушений РСНПМЦК

Носирова Дилангиз Акбаровна
Ассистент кафедры внутренних
болезней и кардиологии №2
Самаркандского государственного
медицинского университета
(технический секретарь)

Эсанкулов Мухаммад Олимович
Ассистент кафедры внутренних
болезней и кардиологии №2
Самаркандского государственного
медицинского университета
(технический секретарь)

Xalikov Qaxxor Mirzayevich
Tibbiyot fanlari nomzodi, dotsent
Samarqand davlat tibbiyot universiteti
Biologik kimyo kafedrasini mudiri

Tulabayeva Gavxar Mirakbarovna
kardiologiya kafedrasini mudiri, tibbiyot
xodimlarining kasbiy malakasini rivojlantirish
markazi, tibbiyot fanlari doktori, professor

Abdumadjidov Xamidulla Amanullayevich
«Abu Ali ibn Sino nomidagi Buxoro davlat
tibbiyot oliygohi» Xirurgiya kasalliklari va
reanimatsiya kafedrasini professori, tibbiyot
fanlari doktori.

Saidov Maqsud Arifovich
tibbiyot fanlari nomzodi,
Respublika ixtisoslashgan kardiologiya
ilmiy amaliy tibbiyot markazi Samarqand
viloyat mintaqaviy filiali direktori
(Samarqand)

Srojidinova Nigora Zaynutdinovna
t.f.d. Kardiodiabet va metabolik buzilishlar
ilmiy tadqiqot laboratoriyasi mudiri

Nosirova Dilangiz Akbarovna
Samarqand davlat tibbiyot universiteti 2-son
ichki kasalliklar va kardiologiya kafedrasini
assistenti (texnik kotib)

Esankulov Muxammad Olimovich
Samarqand davlat tibbiyot universiteti 2-son
ichki kasalliklar va kardiologiya kafedrasini
assistenti (texnik kotib), PhD

Khalikov Kakhor Mirzayevich
Candidate of Medical Sciences,
Associate Professor, Head of the Department
of Biological Chemistry, Samarkand State
Medical University

Tulabayeva Gavxar Mirakbarovna
Head of the Department of Cardiology,
Development Center professional
qualification of medical workers,
MD, professor

**Abdumadjidov Khamidulla
Amanullayevich**
“Bukhara state medical institute named
after Abu Ali ibn Sino”. DSc, professor.

Saidov Maksud Arifovich
Candidate of Medical Sciences, Director
of the Samarkand Regional Department of
the Republican Specialized Scientific and
Practical Medical Center of Cardiology
(Samarkand)

Srojidinova Nigora Zaynutdinovna
DSc, Head of Kardiodiabetes and Metabolic
Disorders Laboratory

Dilangiz Akbarovna Nosirova,
Assistant of the Department of Internal
Diseases and Cardiology No. 2, Samarkand
State Medical University (Technical Secretary)

Esankulov Muhammad Olimovich,
Assistant of the Department of Internal
Diseases and Cardiology No. 2, Samarkand
State Medical University (Technical Secretary)

МЕЖДИСЦИПЛИНАРНЫЕ ПОДХОДЫ В КАРДИОЛОГИИ

1.	<p>М.Д. Абдуллоева, Д.О. Расулова Оценка эффективности миокардиальной реваскуляризации на основе клинико-инструментальных данных у больных ишемической болезнью сердца M.D. Abdullaeva, D.O. Rasulova Assessment of myocardial revascularization effectiveness in patients with ischemic heart disease based on clinical and instrumental data M.D. Abdulloeva, D.O. Rasulova Yurak ishemik kasalligi bilan og'rigan bemorlarda klinik-asbobiy ma'lumotlar asosida miokard revaskulyarizatsiyasi samaradorligini baholash.....</p>	11
2.	<p>З.А. Абдуллаева, С.Т. Джумаева Роль искусственного интеллекта в прогнозировании факторов риска синдрома Дауна: систематический обзор и анализ современных данных Z.A. Abdullayeva, S.T. Djumayeva The role of artificial intelligence in predicting risk factors for Down syndrome: a systematic review and analysis of current evidence Z.A. Abdullayeva, S.T. Djumayeva Daun sindromi uchun xavf omillarini bashorat qilishda sun'iy intellektning roli: mavjud dalillarni tizimli ko'rib chiqish va tahlil qilish.....</p>	17
3.	<p>И.Р. Агабабян, Ю.А. Исмоилова Новые возможности немедикаментозной терапии неалкогольной жировой болезни печени I.R. Agababayan, Y.A. Ismoilova New possibilities of non-drug therapy of non-alcoholic fatty liver disease I.R. Agababayan, Y.A. Ismoilova Jigar noalkogol yog' kasalligini dori-darmonsiz davolashning yangi imkoniyatlari.....</p>	20
4.	<p>Ш.А. Амирова Особенности фибрилляции предсердий у пациентов с ишемической болезнью сердца в сочетании с патологией щитовидной железы Sh.A. Amirova Features of atrial fibrillation in patients with ischemic heart disease combined with thyroid pathology Sh.A. Amirova Qalqonsimon bez patologiyasi bilan birga kechuvchi yurak ishemik kasalligida bo'lmachalar fibrillyatsiya xususiyatlari</p>	24
5.	<p>Н.А. Бобоева, Ж.А. Ризаев Алгоритмы эхокардиографической оценки для персонализации программ медицинской реабилитации после инфаркта миокарда N.A. Boboeva, J.A. Rizaev Echocardiographic assessment algorithms for personalization of cardiac rehabilitation programs after myocardial infarction N.A. Boboyeva, J.A. Rizayev Miokard infarktidan keyin tibbiy reabilitatsiya dasturlarini shaxsiylashtirish uchun tibbiy exokardiografik baholash algoritmlari</p>	30
6.	<p>Б.З. Джалалов, Э.Н. Ташкенбаева Клинико-биохимическая характеристика маркеров повреждения миокарда у пациентов с инфарктом миокарда в условиях аридного климата B.Z. Jalalov, E.N. Tashkenbaeva Clinical and biochemical characteristics of myocardial injury markers in patients with myocardial infarction under arid climate conditions B.Z. Jalalov, E.N. Tashkenbayeva Quruq iqlim sharoitida miokard infarkti bilan og'rigan bemorlarda miokard shikastlanishi biomarkerlarining klinik-biokimyoviy xususiyatlari.....</p>	36
7.	<p>Н.О. Исмати, З.А. Насырова Комплексная клинико-инструментальная оценка эффективности реваскуляризации миокарда у больных ишемической болезнью сердца N.O. Ismati, Z.A. Nasyrova Comprehensive clinical and instrumental assessment of myocardial revascularization efficiency in patients with ischemic heart disease N.O. Ismati, Z.A. Nasirova Ishemik yurak kasalligiga chalingan bemorlarda miokard revaskulyarizatsiyasining samaradorligini kompleks klinik-instrumental baholash.....</p>	41
8.	<p>Д.Ж. Камолова Гипертензивные состояния при беременности: клинические особенности и материнско перинатальные исходы D.J.Kamolova Hypertensive Disorders in Pregnancy: Clinical Features and Maternal perinatal outcomes D.J.Kamolova Homiladorlikdagi gipertenziv buzilishlar: klinik belgilari va ona perinatal natijalar.....</p>	46

9.	<p>Г.Х. Карабаева, А.Е. Холбаев Оценка кардиоваскулярного риска при хронической болезни почек: клинико-прогностический подход G.Kh. Karabaeva, A.E. Kholbayev Assessment of cardiovascular risk in chronic kidney disease: clinical and prognostic approach Г.Х. Карабаева, А.Е. Холбаев Surunkali buyrak kasalligida kardiovaskulyar xavfni baholash: klinik va prognostik yondashuv.....</p>	50
10.	<p>Х.Б. Каримова, М.И. Усмонкулов, З.А. Насирова Морфофункциональное состояние сердечно-сосудистой системы в послеоперационном периоде у детей с тетрадой Фалло Kh.B. Karimova, M.I. Usmonkulov, Z.A. Nasirova Morphofunctional state of the cardiovascular system in the postoperative period in children with Tetralogy of Fallot Х.Б. Каримова, М.И. Усмонкулов, З.А. Насирова Fallo tetradası bilan og'rigan bolalarda operatsiyadan keyingi davrda yurak-qon tomir tizimining morfofunktsional holati</p>	54
11.	<p>Г.А. Каспарова Эффективность интеграции симуляционной практики в медицинское образование: влияние на компетенции студентов-медиков и безопасность пациентов G.A. Kasparova The effectiveness of integrating simulation-based practice into medical education: impact on medical students' competencies and patient safety Г.А. Каспарова Tibbiy ta'limda simulyatsion amaliyotni integratsiya qilishning samaradorligi: tibbiyot talabalarining kompetensiyalari va bemorlar xavfsizligiga ta'siri.....</p>	58
12.	<p>З.А. Насырова, Ш.Р. Шарипов Роль эндотелиальной дисфункции и микроциркуляторных нарушений в формировании толерантности к физической нагрузке у пациентов с синдромом замедленного коронарного кровотока Z.A. Nasirova, Sh.R. Sharipov Role of endothelial dysfunction and microcirculatory disorders in the formation of exercise tolerance in patients with coronary slow flow phenomenon Z.A. Nasirova, Sh.R. Sharipov Sekinlashgan koronar qon oqimi sindromi bo'lgan bemorlarda endotelial disfunktsiya va mikrosirkulyatsiya buzilishlarining jismoniy yuklamaga chidamlilik shakllanishidagi roli.....</p>	63
13.	<p>М.Б. Норматов Влияние уровня гликемического контроля на диастолическую функцию и ремоделирование левого желудочка у пациентов с сахарным диабетом 2 типа с учетом артериальной гипертензии M.B. Normatov Impact of glycemic control level on diastolic function and left ventricular remodeling in patients with type 2 diabetes mellitus considering arterial hypertension M.B. Normatov 2-toifa qandli diabet bilan kasallangan bemorlarda arterial gipertenziyani hisobga olgan holda glikemik nazorat darajasining chap qorincha diastolik funktsiyasi va remodellashuviga ta'siri.....</p>	69
14.	<p>Д.А. Носирова, М.Х. Хайриллоева Современные подходы к реабилитации после катетерной абляции при фибрилляции предсердий на фоне ишемической болезни сердца D.A. Nosirova, M.Kh. Khayrilloeva Modern approaches to rehabilitation after catheter ablation in atrial fibrillation associated with coronary artery disease Д.А. Носирова, М.Х. Хайриллоева Yurak ishemik kasalligi fonida bo'lmachalar fibrillyatsiyasida kateter ablatatsiyadan keyin rehabilitatsiyaning zamonaviy yondashuvlari.....</p>	73
15.	<p>Э.Н. Ташкенбаева, И.И. Салиева Клинические предикторы прогрессирования хронической болезни почек у пациентов с сахарным диабетом после аортокоронарного шунтирования E.N. Tashkenbaeva, I.I. Salieva Clinical predictors of chronic kidney disease progression in patients with diabetes mellitus after coronary artery bypass grafting Э.Н. Ташкенбаева, И.И. Салиева Qandli diabetli bemorlarda aortokoronar shuntlashdan keyin surunkali buyrak kasalligi progressiyasining klinik prediktorlari.....</p>	77
16.	<p>Э.Н. Ташкенбаева, С.Н. Мухтаров, Э.Э. Эргашзода Клинико-прогностическое значение нарушений функции почек в прогрессировании ишемической болезни сердца и разработка клинико-ориентированной системы поддержки принятия решений на основе искусственного интеллекта E.N. Tashkenbaeva, S.N. Muxtarov, E.E. Ergashzoda Clinical and prognostic significance of renal dysfunction in the progression of ischemic heart disease and development of an AI-based clinical decision support system Э.Н. Ташкенбаева, С.Н. Мухтаров, Э.Э. Эргашзода Yurak ishemik kasalligi rivojlanishida buyrak funksiyasi buzilishining klinik-prognostik ahamiyati va sun'iy intellekt asosida klinik qaror qabul qilish tizimini ishlab chiqish.....</p>	83

17.	<p>Э.Н. Ташкенбаева, А.И. Мухиддинов, Ш.Х. Бекмуродов, М.А. Мухтарова, А.Ф. Уралов, Ш.А. Усаров Методы и критерии диагностики артериальной гипертензии у пациентов с риском кардиоренальных осложнений E.N. Tashkenbaeva, A.I. Mukhiddinov, Sh.Kh. Bekmurodov, M.A. Mukhtarova, A.F. Uralov, Sh.A. Usarov Diagnostic methods and criteria for hypertension in patients at risk of cardiorenal complications E.N. Tashkenbaeva, A.I. Muxiddinov, Sh.X. Bekmurodov, M.A. Muxtarova, A.F. Uralov, Sh.A. Usarov Kardiorrenal asoratlar xavfi bo'lgan bemorlarda arterial gipertenziya kasalligini tashxislash usullari va diagnostik mezonlari.....</p>	88
18.	<p>С.К. Туйчиева, Э.Н. Ташкенбаева Клинико-иммунологические особенности ишемической болезни сердца у женщин в зависимости от наличия метаболического синдрома S.K. Tuychieva, E.N. Tashkenbaeva Clinical and immunological features of ischemic heart disease in women depending on the presence of metabolic syndrome S.K. Tuychiyeva, E.N. Tashkenbaeva Ayollarda metabolik sindrom mavjudligiga bog'liq holda yurak ishemik kasalligining klinik-immunologik xususiyatlari</p>	93
19.	<p>Ф.О. Хасанжанова, Ж.А. Ризаев, Э.Н. Ташкенбаева Реабилитации больных трудоспособного возраста после комплексной коррекции ИБС на фоне аномальных отхождений коронарных артерий F.O. Xasanjanova, J.A. Rizayev, E.N. Tashkenbaeva Mehnatga layoqatli yoshdagi bemorlarda YuIKni koronar arteriyaning anomal chiqishlari fonida kompleks korreksidan keyingi reabilitatsiyasi F.O. Xasanjanova, J.A. Rizayev, E.N. Tashkenbaeva Rehabilitation of working-age patients after comprehensive correction of coronary artery disease in the presence of anomalous origin of the coronary arteries.....</p>	98
20.	<p>У.Е. Чарипова, Д.М. Рахманова, Т.А. Арыстанова Фармакологическое обоснование комбинированного применения статинов и глицирризиновой кислоты U.E. Charipova, D.M. Rakhmanova, T.A. Arystanova Pharmacological rationale for the combined use of statins and glycyrrhizic acid U.E. Charipova, D.M. Rakhmanova, T.A. Arystanova Statinlar va glitsirrizin kislotasining kombinatsiyalangan qo'llanilishining farmakologik asoslari.....</p>	102
21.	<p>С.Х.Ярмухамедова Особенности эхокардиографических и молекулярных показателей у больных артериальной гипертензией S.Kh. Yarmukhamedova Characteristics of echocardiographic and molecular parameters in patients with arterial hypertension S.X. Yarmuhamedova Arterial gipertenziya bilan bemorlarda ekokardiografik va molekular parametrelarning xususiyatlari.....</p>	109



Бобоева Н.А.

Самаркандский государственный медицинский университет
Самарканд, Узбекистан

Ризаев Ж.А.

Самаркандский государственный медицинский университет
Самарканд, Узбекистан

АЛГОРИТМЫ ЭХОКАРДИОГРАФИЧЕСКОЙ ОЦЕНКИ ДЛЯ ПЕРСОНАЛИЗАЦИИ ПРОГРАММ МЕДИЦИНСКОЙ РЕАБИЛИТАЦИИ ПОСЛЕ ИНФАРКТА МИОКАРДА

For citation: Boboyeva N.A., Rizayev J.A. ECHOCARDIOGRAPHIC ASSESSMENT ALGORITHMS FOR PERSONALIZATION OF CARDIAC REHABILITATION PROGRAMS AFTER MYOCARDIAL INFARCTION. Journal of cardiorespiratory research. 2026, vol 7, issue 2/1.



<http://dx.doi.org/10.26739/2181-0974/2026/7/2/1/5>

АННОТАЦИЯ

Актуальность. Инфаркт миокарда остаётся одной из ведущих причин смертности и инвалидизации, а эффективность медицинской реабилитации во многом определяет отдалённый прогноз пациентов. В современных условиях особое значение приобретает персонализация реабилитационных программ с учётом функционального состояния сердечно-сосудистой системы. **Цель исследования.** Оценить роль эхокардиографических параметров в разработке алгоритмов персонализации медицинской реабилитации у пациентов после инфаркта миокарда.

Материалы и методы. В исследование включено 111 пациентов, разделённых на основную группу (n=68), получавшую персонализированную реабилитацию с учётом эхокардиографических показателей, и контрольную группу (n=43), получавшую стандартную терапию. Проводилась оценка систолической и диастолической функции левого желудочка, показателей физической работоспособности (VO₂max, 6-минутный тест ходьбы, PWC170).

Результаты. У пациентов основной группы отмечено достоверное улучшение фракции выброса левого желудочка, снижение показателя E/E', улучшение функции правого желудочка и значительный прирост физической работоспособности. Установлены достоверные корреляции между эхокардиографическими параметрами и функциональным состоянием пациентов. **Заключение.** Использование эхокардиографических алгоритмов позволяет эффективно персонализировать программы медицинской реабилитации, улучшая клинические исходы и качество жизни пациентов после инфаркта миокарда.

Ключевые слова: инфаркт миокарда, эхокардиография, кардиореабилитация, персонализация, фракция выброса, диастолическая функция

Бобоева Н.А.

Samarkand State Medical University
Samarkand, Uzbekistan

Rizaev J.A.

Samarkand State Medical University
Samarkand, Uzbekistan

ECHOCARDIOGRAPHIC ASSESSMENT ALGORITHMS FOR PERSONALIZATION OF CARDIAC REHABILITATION PROGRAMS AFTER MYOCARDIAL INFARCTION

ABSTRACT

Background. Myocardial infarction remains a leading cause of mortality and disability worldwide, while the effectiveness of cardiac rehabilitation significantly determines long-term outcomes. Personalization of rehabilitation programs based on functional cardiovascular assessment is becoming increasingly important.

Objective. To evaluate the role of echocardiographic parameters in developing algorithms for personalized cardiac rehabilitation in patients after myocardial infarction.

Materials and methods. The study included 111 patients divided into a main group (n=68), who underwent personalized rehabilitation based on echocardiographic parameters, and a control group (n=43), who received standard rehabilitation. Systolic and diastolic left ventricular function as well as functional capacity (VO₂max, 6-minute walk test, PWC170) were assessed. **Results.** The main group demonstrated a significant improvement in left ventricular ejection fraction, reduction in E/E' ratio, improved right ventricular function, and a marked increase in exercise capacity. Significant correlations between echocardiographic parameters and functional performance were identified. **Conclusion.** Echocardiography-based algorithms allow effective personalization of cardiac rehabilitation programs, improving clinical outcomes and quality of life in post-myocardial infarction patients.

Keywords: myocardial infarction, echocardiography, cardiac rehabilitation, personalization, ejection fraction, diastolic function

Boboyeva N.A.

Samarqand davlat tibbiyot universiteti
Samarqand, O'zbekiston

Rizayev J.A.

Samarqand davlat tibbiyot universiteti
Samarqand, O'zbekiston**MIOKARD INFARKTIDAN KEYIN TIBBIY REABILITATSIYA DASTURLARINI SHAXSIYLASHTIRISH UCHUN
EXOKARDIOGRAFIK BAHOLASH ALGORITMLARI**

ANNOTATSIYA

Dolzarliligi. Miokard infarkti butun dunyoda o'lim va nogironlikning asosiy sabablaridan biri bo'lib qolmoqda, reabilitatsiya samaradorligi esa bemorlarning uzoq muddatli prognozini belgilaydi. Shu sababli yurak-qon tomir tizimining funksional holatini hisobga olgan holda individual reabilitatsiya dasturlarini ishlab chiqish muhim ahamiyat kasb etadi.

Tadqiqot maqsadi. Miokard infarktidan keyingi bemorlarda exokardiografik ko'rsatkichlarga asoslangan shaxsiylashtirilgan reabilitatsiya algoritmlarining ahamiyatini baholash.

Material va usullar. Tadqiqotga 111 nafar bemor kiritildi: asosiy guruh (n=68) exokardiografik ko'rsatkichlar asosida shaxsiylashtirilgan reabilitatsiya oldi, nazorat guruhi (n=43) esa standart davolash oldi. Chap qorincha sistolik va diastolik funksiyasi hamda jismoniy faollik ko'rsatkichlari (VO₂max, 6 daqiqalik yurish testi, PWC170) baholandi.

Natijalar. Asosiy guruhda chap qorincha chiqarish fraksiyasining oshishi, E/E' ko'rsatkichining pasayishi, o'ng qorincha funksiyasining yaxshilanishi va jismoniy ish qobiliyatining sezilarli ortishi kuzatildi. Exokardiografik ko'rsatkichlar bilan funksional holat o'rtasida ishonchli bog'liqlik aniqlandi.

Xulosa. Exokardiografik algoritmlardan foydalanish reabilitatsiya dasturlarini shaxsiylashtirish imkonini berib, bemorlarning klinik natijalari va hayot sifatini yaxshilaydi.

Kalit so'zlar: miokard infarkti, exokardiografiya, kardio reabilitatsiya, shaxsiylashtirish, chiqarish fraksiyasi, diastolik funksiya

Myocardial infarction remains one of the leading causes of death and disability worldwide, despite significant progress in the field of reperfusion therapy and drug treatment. Modern treatment strategies can significantly reduce hospital mortality, but the long-term prognosis of patients is largely determined by the effectiveness of subsequent medical rehabilitation. The postinfarction period is a critical phase during which the processes of myocardial remodeling are formed, determining the functional state of the cardiovascular system and the risk of complications.

In recent years, the understanding of the pathophysiological mechanisms of post-infarction remodeling has significantly expanded. Along with the traditional assessment of the left ventricular ejection fraction (LVEF), indicators of diastolic function, regional myocardial contractility, and parameters of hemodynamic adaptation are becoming increasingly important. Echocardiography, being an accessible and highly informative imaging method, allows a comprehensive assessment of the structural and functional state of the heart and serves as an important basis for clinical decision-making.

Despite the proven effectiveness of cardiac rehabilitation, the problem of significant interindividual variability in patients' response to standard recovery programs remains in clinical practice. Some patients show a marked improvement in their functional state, while others have a limited effect. This is due to differences in the degree of myocardial damage, the functional reserve of the heart, the presence of concomitant diseases and the peculiarities of metabolic adaptation.

In this regard, the development of personalized approaches to medical rehabilitation is of particular relevance. The integration of echocardiographic parameters into clinical decision-making algorithms makes it possible to more accurately stratify patients by risk level and individualize physical activity. The use of such algorithms contributes to improving the safety of rehabilitation, preventing myocardial overload and achieving optimal functional recovery.

Thus, the development and implementation of echocardiographically oriented algorithms for personalization of rehabilitation is an important area of modern cardiology and rehabilitation aimed at improving clinical outcomes and quality of life of patients after myocardial infarction.

The purpose of the study

To evaluate the clinical and functional significance of echocardiographic parameters and their role in the personalization of medical rehabilitation programs in patients after myocardial infarction.

Materials and research methods

The study was conducted on the basis of the Republican Scientific and Practical Center of Cardiology of the Samarkand regional branch.

The study included 111 patients who had suffered an acute myocardial infarction and were undergoing medical rehabilitation.

All patients were in stable clinical condition and were divided into two groups. The main group consisted of 68 patients, in whom the rehabilitation program was formed taking into account echocardiographic parameters and individual functional characteristics. The comparison group included 43 patients who received standard rehabilitation according to generally accepted clinical recommendations.

Before starting rehabilitation, all patients underwent a comprehensive clinical examination, including anamnesis collection, assessment of risk factors for cardiovascular diseases, electrocardiography and echocardiography. Special attention was paid to the assessment of systolic and diastolic function of the left ventricle.

Transthoracic echocardiography was performed in accordance with international guidelines. The following parameters were evaluated: left ventricular ejection fraction (LVEF), final diastolic and systolic volumes, regional myocardial contractility, as well as indicators of diastolic function, including the E/E' ratio. Additionally, the function of the right ventricle was analyzed using the TAPSE indicator.

The functional state of the patients was assessed using physical performance indicators, including maximum oxygen consumption (VO₂Max), a 6-minute walking test, and a PWC170 score. These parameters were used to assess the tolerance of physical activity and the effectiveness of rehabilitation measures.

The inclusion criteria were confirmed myocardial infarction, stable clinical condition, the possibility of an echocardiographic examination, and informed consent of the patient. Exclusion criteria included unstable state, severe arrhythmias, severe concomitant diseases that limit physical activity, as well as acute inflammatory processes.

Statistical data processing was carried out using the IBM SPSS Statistics program. Quantitative indicators are presented as an average value and a standard deviation (M ± SD). The Student's t-test was used to compare the groups, and nonparametric methods were used for abnormal distribution. The differences were considered statistically significant at p < 0.05.

The results of the study

An analysis of the clinical and demographic characteristics of the patients showed that the main and control groups were comparable in all key indicators, which confirms the correctness of the comparative study. The average age of patients was 57.4 ± 8.2 years in the main group and 58.1 ± 7.9 years in the comparison group (p > 0.05). Both groups were dominated by men (72.1% and 69.7%, respectively), the body mass index was in the overweight range (27.8 ± 3.6 and 28.1 ± 3.9 kg/m²). The incidence of hypertension, diabetes mellitus, smoking, and

recurrent myocardial infarction did not differ significantly ($p>0.05$), which indicates a uniform distribution of risk factors and allows an objective assessment of the impact of rehabilitation approaches.

Table 1. Clinical and demographic characteristics of patients (M ± SD)

Parameter	Main group (n=68)	Control group (n=43)	p
Age, years	57.4 ± 8.2	58.1 ± 7.9	>0.05
Male, %	72.1	69.7	>0.05
BMI, kg/m ²	27.8 ± 3.6	28.1 ± 3.9	>0.05
Arterial hypertension, %	76.5	74.4	>0.05
Diabetes mellitus, %	21.3	23.2	>0.05
Smoking, %	38.2	41.8	>0.05
Recurrent myocardial infarction, %	16.2	18.6	>0.05

Dynamic observation of echocardiographic parameters demonstrated marked differences between the groups in response to the rehabilitation. In the main group, which used a personalized approach based on echocardiographic parameters, there was a significant improvement in the systolic function of the left ventricle. The ejection

fraction increased from $46.8 \pm 6.4\%$ to $52.6 \pm 6.1\%$ ($p<0.01$), reflecting the restoration of myocardial contractility. At the same time, the improvement in this indicator was less pronounced in the comparison group (from $47.1 \pm 6.1\%$ to $49.3 \pm 5.8\%$; $p<0.05$), which indicates the limited effectiveness of standard rehabilitation programs.

Table 2. Dynamics of echocardiographic parameters (M ± SD)

Parameter	Main group (baseline)	Main group (after)	Control (baseline)	Control (after)	p
LVEF, %	46.8 ± 6.4	52.6 ± 6.1	47.1 ± 6.1	49.3 ± 5.8	<0.01
LVEDV, ml	158 ± 28	142 ± 25	155 ± 27	150 ± 26	<0.05
LVESV, ml	86 ± 19	72 ± 17	84 ± 18	80 ± 17	<0.01
E/E'	12.8 ± 3.1	10.6 ± 2.7	12.6 ± 3.0	11.8 ± 2.9	<0.05
TAPSE, mm	19.2 ± 2.4	21.1 ± 2.5	19.0 ± 2.3	19.8 ± 2.4	<0.05

In parallel with the improvement of systolic function in the main group, there was a significant decrease in the end-diastolic and end-systolic volumes of the left ventricle ($p<0.05$ and $p<0.01$, respectively), which indicates a regression of post-infarction remodeling and an improvement in the geometry of the heart. A decrease in the E/E' ratio from 12.8 ± 3.1 to 10.6 ± 2.7 ($p<0.05$) reflects an improvement in diastolic function and a decrease in left ventricular filling pressure, which is important for increasing exercise tolerance. Improvement of the TAPSE index (from 19.2 ± 2.4 to 21.1 ± 2.5 mm; $p<0.05$) indicates a restoration of right ventricular function and an improvement in interventricular interaction. In the control group, similar changes were less pronounced and in most cases did not reach statistical significance.

The analysis of the functional state of the patients confirmed the clinical significance of the echocardiographic changes. In the main group, there was a significant increase in maximum oxygen consumption (VO₂Max) from 18.6 ± 3.2 to 22.4 ± 3.5 ml/kg/min ($p<0.01$), reflecting a significant improvement in aerobic performance. The PWC170 index increased from 630 ± 110 to 790 ± 125 kgm/min ($p<0.01$), and the 6-minute walking distance increased from 412 ± 58 to 495 ± 64 m ($p<0.001$), indicating an increase in physical endurance and functional status of patients. At the same time, there was a decrease in resting heart rate and systolic blood pressure, which indicates an improvement in autonomic regulation and hemodynamic adaptation. There was also a positive trend in the comparison group, but it was less pronounced and in some cases statistically insignificant.

Table 3. Dynamics of functional parameters (M ± SD)

Parameter	Main group (baseline)	Main group (after)	Control (baseline)	Control (after)	p
VO ₂ max, ml/kg/min	18.6 ± 3.2	22.4 ± 3.5	18.9 ± 3.4	20.1 ± 3.6	<0.01
PWC170, kgm/min	630 ± 110	790 ± 125	640 ± 115	710 ± 120	<0.01
6-minute walk test, m	412 ± 58	495 ± 64	418 ± 60	450 ± 62	<0.001
Resting heart rate, bpm	78 ± 9	70 ± 8	77 ± 10	73 ± 9	<0.05
Systolic BP, mmHg	138 ± 14	128 ± 12	137 ± 15	132 ± 13	<0.05

The correlation analysis revealed a close relationship between echocardiographic indicators and the level of physical performance. The most pronounced positive correlation was found between the left ventricular ejection fraction and VO₂Max ($r=0.54$; $p<0.01$), which confirms the key role of systolic function in the formation of aerobic capacity. A similar relationship was found between LVEF and the distance of a 6-minute walk ($r=0.49$; $p<0.01$). At the same time, an increase in the E/E' index reflecting diastolic dysfunction was accompanied by a decrease in physical performance ($r=-0.51$ for VO₂Max and $r=-0.47$ for a 6-minute walk; $p<0.01$), which indicates a significant effect of diastolic disorders on exercise tolerance. Additional

correlations between LV BWT, TAPSE, and physical activity indicators confirm the complex nature of cardiohemodynamic and functional interactions.

The results of the ROC analysis demonstrated the high prognostic significance of echocardiographic parameters in assessing patients' physical performance. The E/E' ratio showed the greatest diagnostic value (AUC=0.81; $p<0.001$), which allows us to consider this indicator as one of the key markers of physical activity restriction. The left ventricular ejection fraction also showed high prognostic significance (AUC=0.78; $p<0.001$), whereas LVEF and TAP had moderate diagnostic accuracy.

Table 4. Correlation analysis (r)

Variables	r	p
LVEF and VO ₂ max	0.54	<0.01
LVEF and 6MWT	0.49	<0.01
E/E' and VO ₂ max	-0.51	<0.01
E/E' and 6MWT	-0.47	<0.01

LVEDV and VO ₂ max	-0.42	<0.05
TAPSE and 6MWT	0.45	<0.05

Thus, the results obtained convincingly demonstrate that the use of an echocardiographically oriented personalized approach to medical rehabilitation provides a more pronounced restoration of both the structural and functional state of the myocardium and the physical performance of patients compared with standard programs. The revealed interrelations between echocardiographic and functional parameters confirm the pathogenetic validity of the proposed approach and its clinical effectiveness.

Discussion

The results obtained confirm that the inclusion of echocardiographic parameters in the algorithm for choosing a medical rehabilitation program after a myocardial infarction can significantly improve its clinical effectiveness. In the main group, where physical activity was selected taking into account echocardiographic stratification, more pronounced positive changes were noted both from the side of the structural and functional state of the myocardium and from the side of physical performance. This allows us to consider a personalized echocardiographic approach not just as an additional diagnostic tool, but as an important component of clinical decision-making in cardiac rehabilitation.

One of the most significant results of the study is a significant increase in the left ventricular ejection fraction in the main group from $46.8 \pm 6.4\%$ to $52.6 \pm 6.1\%$, while in the comparison group the positive dynamics was less pronounced. This indicates that metered-dose physical activity, adapted to the initial state of the myocardium, can contribute to more favorable postinfarction remodeling. The decrease in the final diastolic and final systolic volumes of the left ventricle in the main group additionally confirms the presence of positive structural adaptation and regression of unfavorable remodeling, which in the post-infarction period is one of the main pathophysiological mechanisms of heart failure progression.

Data on the dynamics of diastolic function are of particular importance. The decrease in the E/E' ratio in the main group reflects a decrease in the filling pressure of the left ventricle and an improvement in the processes of myocardial relaxation. This result has important clinical significance, since, as literature data show, it is diastolic function disorders that often become one of the key limitations of physical performance, even in patients without a sharply reduced ejection fraction. In a study by Fontes-Carvalho et al. It has been shown that increased E/E' is one of the strongest echocardiographic predictors of decreased exercise tolerance after myocardial infarction [9]. Our data, including the revealed negative correlation between E/E' and VO₂Max, are fully consistent with these observations and confirm the importance of assessing diastolic function in the rehabilitation planning process.

Equally important is the improvement in the function of the right ventricle, expressed in an increase in TAPSE in the main group. In modern cardiology, more and more attention is being paid to the role of right ventricular function in the formation of general exercise tolerance and prognosis in patients after an acute coronary event. Although TAPSE demonstrated only moderate prognostic value in ROC analysis, its positive dynamics indicates a more harmonious restoration of intracardiac hemodynamics in patients undergoing individualized rehabilitation.

The functional results of the study also deserve special attention. An increase in VO₂Max, an increase in PWC170, and a significant improvement in the 6-minute walking distance in the main group indicate a significant recovery in aerobic capacity and overall physical endurance. This is especially important because physical performance after myocardial infarction is considered not only as an indicator of quality of life, but also as an independent prognostic marker of cardiovascular outcomes. Literature data confirm that participation in structured cardiac rehabilitation programs is associated with improved survival and a decrease in the frequency of adverse events [4, 5, 16]. Our results expand these concepts, showing that the greatest effect is achieved precisely by personalizing the rehabilitation program based on objective echocardiographic parameters.

The correlation analysis confirmed the close relationship between indicators of cardiac function and physical performance. The positive correlation between LVEF and VO₂Max, as well as between LVEF and the 6-minute walking distance, shows that an improvement in contractile function is accompanied by a real increase in the patient's functional capabilities. At the same time, the negative relationship between E/E' and exercise performance confirms that diastolic dysfunction plays an important role in limiting physical reserves. These results correspond to the modern understanding of post-infarction rehabilitation as a process in which not only restoration of pumping function, but also complex hemodynamic adaptation of the heart to physical activity is crucial.

The ROC analysis demonstrated the high predictive value of the E/E' and LVEF indicators for identifying patients with reduced physical performance. It is particularly important that E/E' ≥ 13 showed the highest diagnostic accuracy. This allows us to consider this parameter as one of the key criteria for risk stratification when planning rehabilitation loads. In practical terms, this means that the inclusion of a standard echocardiographic assessment of diastolic function in the cardiac rehabilitation algorithm can contribute to a safer choice of training regimen and earlier identification of patients requiring a gentle and controlled approach.

The results obtained should also be considered in the context of current international trends. Experts from the European Association of Preventive Cardiology emphasize the need to move from standard cardiac rehabilitation programs to more personalized models that take into account the clinical, functional and instrumental characteristics of the patient [10]. Our study actually confirms the practical feasibility of this approach and demonstrates its effectiveness in real clinical conditions. Of additional importance is the fact that the proposed model is based on a widely available method — transthoracic echocardiography, which makes it applicable in everyday clinical practice.

Thus, the results of the study show that the personalization of medical rehabilitation programs after myocardial infarction based on echocardiographic assessment can not only improve the contractile and diastolic function of the heart, but also significantly improve the physical performance of patients. This confirms the pathogenetic and clinical validity of the use of echocardiographic algorithms in cardiac rehabilitation and determines the prospects for further implementation of such approaches in the post-infarction monitoring system.

Conclusions

The inclusion of echocardiographic parameters in the algorithm for planning medical rehabilitation after myocardial infarction provides a more pronounced improvement in the structural and functional state of the heart compared with standard rehabilitation. Personalized rehabilitation based on LVEF, E/E', LVEF, LVEF, and TAPSE assessments contributes to a significant increase in the contractile function of the left ventricle, improved diastolic function, and a more favorable adaptation of the right ventricle. The use of echocardiographic stratification can significantly improve physical performance indicators, including VO₂Max, PWC170 and the results of a 6-minute walking test, which confirms the clinical effectiveness of an individualized approach. The most informative echocardiographic predictors of decreased physical performance in patients after myocardial infarction are the E/E' ratio and the left ventricular ejection fraction. The threshold value E/E' ≥ 13 has high diagnostic accuracy for predicting low load tolerance. Statistically significant correlations have been established between echocardiographic indicators and physical performance parameters, which confirms the possibility of using EchoCG as an objective basis for the personalization of cardiac rehabilitation programs. The developed algorithm of echocardiographic assessment can be recommended for practical application in the system of medical rehabilitation of patients after myocardial infarction in order to increase the safety, effectiveness and prognostic significance of rehabilitation measures.

1. Ambrosetti, M.; Abreu, A.; Corra, U.; Davos, C.H.; Hansen, D.; Frederix, I.; Iliou, M.C.; Pedretti, R.F.; Schmid, J.P.; Vigorito, C.; et al. Secondary prevention through comprehensive cardiovascular rehabilitation: From knowledge to implementation. 2020 update. A position paper from the Secondary Prevention and Rehabilitation Section of the European Association of Preventive Cardiology. *Eur. J. Prev. Cardiol.* 2020, 28, 460–495.
2. Andjic, M.; Spiroski, D.; Ilic Stojanovic, O.; Vidakovic, T.; Lazovic, M.; Babic, D.; Ristic, A.; Mazic, S.; Zdravkovic, M.; Otasevic, P. Effect of short-term exercise training in patients following acute myocardial infarction treated with primary percutaneous coronary intervention. *Eur. J. Phys. Rehabil. Med.* 2016, 52, 364–369.
3. Conraads, V.M.; Pattyn, N.; De Maeyer, C.; Beckers, P.J.; Coeckelberghs, E.; Cornelissen, V.A.; Denollet, J.; Frederix, G.; Goetschalckx, K.; Hoymans, V.Y.; et al. Aerobic interval training and continuous training equally improve aerobic exercise capacity in patients with coronary artery disease: The SAINTEX-CAD study. *Int. J. Cardiol.* 2015, 179, 203–210.
4. De Schutter, A.; Kachur, S.; Lavie, C.J.; Menezes, A.; Shum, K.K.; Bangalore, S.; Arena, R.; Milani, R.V. Cardiac rehabilitation fitness changes and subsequent survival. *Eur. Heart J. Qual. Care Clin. Outcomes* 2018, 4, 173–179
5. de Vries, H.; Kemps, H.M.; van Engen-Verheul, M.M.; Kraaijenhagen, R.A.; Peek, N. Cardiac rehabilitation and survival in a large representative community cohort of Dutch patients. *Eur. Heart J.* 2015, 36, 1519–1528
6. Dhakal, B.P.; Malhotra, R.; Murphy, R.M.; Pappagianopoulos, P.P.; Baggish, A.L.; Weiner, R.B.; Houstis, N.E.; Eisman, A.S.; Hough, S.S.; Lewis, G.D. Mechanisms of exercise intolerance in heart failure with preserved ejection fraction: The role of abnormal peripheral oxygen extraction. *Circ. Heart Fail.* 2015, 8, 286–294.
7. Fletcher, G.F.; Ades, P.A.; Kligfield, P.; Arena, R.; Balady, G.J.; Bittner, V.A.; Coke, L.A.; Fleg, J.L.; Forman, D.E.; Gerber, T.C.; et al. Exercise standards for testing and training: A scientific statement from the American Heart Association. *Circulation* 2013, 128, 873–934.
8. Fontes-Carvalho, R.; Azevedo, A.I.; Sampaio, F.; Teixeira, M.; Bettencourt, N.; Campos, L.; Gonçalves, F.R.; Ribeiro, V.G.; Azevedo, A.; Leite-Moreira, A. The Effect of Exercise Training on Diastolic and Systolic Function After Acute Myocardial Infarction: A Randomized Study. *Medicine* 2015, 94, e1450.
9. Fontes-Carvalho, R.; Sampaio, F.; Teixeira, M.; Rocha-Gonçalves, F.; Gama, V.; Azevedo, A.; Leite-Moreira, A. Left ventricular diastolic dysfunction and E/E' ratio as the strongest echocardiographic predictors of reduced exercise capacity after acute myocardial infarction. *Clin. Cardiol.* 2015, 38, 222–229.
10. Gevaert, A.B.; Adams, V.; Bahls, M.; Bowen, T.S.; Cornelissen, V.; Dörr, M.; Hansen, D.; Kemps, H.M.; Leeson, P.; Van Craenenbroeck, E.M.; et al. Towards a personalised approach in exercise-based cardiovascular rehabilitation: How can translational research help? A 'call to action' from the Section on Secondary Prevention and Cardiac Rehabilitation of the European Association of Preventive Cardiology. *Eur. J. Prev. Cardiol.* 2020, 27, 1369–1385.
11. Houstis, N.E.; Eisman, A.S.; Pappagianopoulos, P.P.; Wooster, L.; Bailey, C.S.; Wagner, P.D.; Lewis, G.D. Exercise Intolerance in Heart Failure With Preserved Ejection Fraction: Diagnosing and Ranking Its Causes Using Personalized O2 Pathway Analysis. *Circulation* 2018, 137, 148–161. [Google Scholar] [CrossRef]
12. Hurley, D.M.; Williams, E.R.; Cross, J.M.; Riedinger, B.R.; Meyer, R.A.; Abela, G.S.; Slade, J.M. Aerobic Exercise Improves Microvascular Function in Older Adults. *Med. Sci. Sports Exerc.* 2019, 51, 773–781.
13. Jayo-Montoya, J.A.; Maldonado-Martin, S.; Aispuru, G.R.; Gorostegi-Anduaga, I.; Gallardo-Lobo, R.; Matajira-Chia, T.; Villar-Zabala, B.; Blanco-Guzman, S. Low-Volume High-Intensity Aerobic Interval Training Is an Efficient Method to Improve Cardiorespiratory Fitness After Myocardial Infarction: Pilot study from the interfarct project. *J. Cardiopulm. Rehabil. Prev.* 2020, 40, 48–54.
14. Kjesbu, I.E.; Mikkelsen, N.; Sibilitz, K.L.; Wilhelm, M.; Pena-Gil, C.; González-Salvado, V.; Iliou, M.C.; Zeymer, U.; Meindersma, E.P.; Ardissino, D.; et al. Greater burden of risk factors and less effect of cardiac rehabilitation in elderly with low educational attainment: The Eu-CaRE study. *Eur. J. Prev. Cardiol.* 2021, 28, 513–519.
15. Knuuti, J.; Wijns, W.; Saraste, A.; Capodanno, D.; Barbato, E.; Funck-Brentano, C.; Prescott, E.; Storey, R.F.; Deaton, C.; Cuisset, T.; et al. 2019 ESC Guidelines for the diagnosis and management of chronic coronary syndromes. *Eur. Heart J.* 2020, 41, 407–477.
16. Kyuno, E.; Iso, Y.; Tsujiuchi, M.; Maeda, A.; Miyazawa, R.; Kowaita, H.; Kitai, H.; Sato, T.; Ebato, M.; Sambe, T.; et al. Impact of Exercise-Based Cardiac Rehabilitation on the Mid-Term Outcomes of Patients After Acute Myocardial Infarction Treated with Current Acute-Phase Management and Optimal Medical Therapy. *Heart Lung Circ.* 2021, 30, 1320–1328.
17. Lang, R.M.; Badano, L.P.; Mor-Avi, V.; Afilalo, J.; Armstrong, A.; Ernande, L.; Flachskampf, F.A.; Foster, E.; Goldstein, S.A.; Kuznetsova, T.; et al. Recommendations for cardiac chamber quantification by echocardiography in adults: An update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. *Eur. Heart J. Cardiovasc. Imaging* 2015, 16, 233–271.
18. Lazzeroni, D.; Castiglioni, P.; Bini, M.; Faini, A.; Camaiora, U.; Ugolotti, P.T.; Centorbi, C.S.; Brambilla, L.; Brambilla, V.; Piepoli, M.F.; et al. Improvement in aerobic capacity during cardiac rehabilitation in coronary artery disease patients: Is there a role for autonomic adaptations? *Eur. J. Prev. Cardiol.* 2017, 24, 357–364.
19. Nichols, S.; Taylor, C.; Goodman, T.; Page, R.; Kallvikbacka-Bennett, A.; Nation, F.; Clark, A.L.; Birkett, S.T.; Carroll, S.; Ingle, L. Routine exercise-based cardiac rehabilitation does not increase aerobic fitness: A CARE CR study. *Int. J. Cardiol.* 2020, 305, 25–34.
20. Peixoto, T.C.; Begot, I.; Bolzan, D.W.; Machado, L.; Reis, M.S.; Papa, V.; Carvalho, A.C.; Arena, R.; Gomes, W.J.; Guizilini, S. Early exercise-based rehabilitation improves health-related quality of life and functional capacity after acute myocardial infarction: A randomized controlled trial. *Can. J. Cardiol.* 2015, 31, 308–313
21. Piepoli, M.F.; Hoes, A.W.; Agewall, S.; Albus, C.; Brotons, C.; Catapano, A.L.; Cooney, M.T.; Corrà, U.; Cosyns, B.; Deaton, C.; et al. 2016 European Guidelines on cardiovascular disease prevention in clinical practice: The Sixth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of 10 societies and by

invited experts): Developed with the special contribution of the European Association for Cardiovascular Prevention & Rehabilitation (EACPR). *Eur. J. Prev. Cardiol.* 2016, 23, Np1–Np96.

22. Pugliese, N.R.; Fabiani, I.; Santini, C.; Rovai, I.; Pedrinelli, R.; Natali, A.; Dini, F.L. Value of combined cardiopulmonary and echocardiography stress test to characterize the haemodynamic and metabolic responses of patients with heart failure and mid-range ejection fraction. *Eur. Heart J. Cardiovasc. Imaging* 2019, 20, 828–836.

23. Shimiie, J.; Sherez, J.; Aviram, G.; Megidish, R.; Viskin, S.; Halkin, A.; Ingbir, M.; Neshet, N.; Biner, S.; Keren, G.; et al. Determinants of Effort Intolerance in Patients With Heart Failure: Combined Echocardiography and Cardiopulmonary Stress Protocol. *JACC Heart Fail.* 2015, 3, 803–814.

24. Smarz, K.; Jaxa-Chamiec, T.; Zaborska, B.; Tysarowski, M.; Budaj, A. Combined use of stress echocardiography and cardiopulmonary exercise testing to assess exercise intolerance in patients treated for acute myocardial infarction. *PLoS ONE* 2021, 16, e0255682.

25. Takagi, S.; Murase, N.; Kime, R.; Niwayama, M.; Osada, T.; Katsumura, T. Aerobic training enhances muscle deoxygenation in early post-myocardial infarction. *Eur. J. Appl. Physiol.* 2016, 116, 673–685.

26. Tashiro, H.; Tanaka, A.; Ishii, H.; Motomura, N.; Arai, K.; Adachi, T.; Okajima, T.; Iwakawa, N.; Kojima, H.; Mitsuda, T.; et al. Reduced exercise capacity and clinical outcomes following acute myocardial infarction. *Heart Vessel.* 2020, 35, 1044–1050.

27. Tucker, W.J.; Lijauco, C.C.; Hearon, C.M., Jr.; Angadi, S.S.; Nelson, M.D.; Sarma, S.; Nanayakkara, S.; La Gerche, A.; Haykowsky, M.J. Mechanisms of the Improvement in Peak VO₂ With Exercise Training in Heart Failure With Reduced or Preserved Ejection Fraction. *Heart Lung Circ.* 2018, 27, 9–21.

28. Weatherald, J.; Sattler, C.; Garcia, G.; Laveneziana, P. Ventilatory response to exercise in cardiopulmonary disease: The role of chemosensitivity and dead space. *Eur. Respir. J.* 2018, 51, 1700860.

29. Werner, C.M.; Hecksteden, A.; Morsch, A.; Zundler, J.; Wegmann, M.; Kratzsch, J.; Thiery, J.; Hohl, M.; Bittenbring, J.T.; Neumann, F.; et al. Differential effects of endurance, interval, and resistance training on telomerase activity and telomere length in a randomized, controlled study. *Eur. Heart J.* 2019, 40, 34–46.

30. Witvrouwen, I.; Pattyn, N.; Gevaert, A.B.; Possemiers, N.; Van Craenenbroeck, A.H.; Cornelissen, V.A.; Beckers, P.J.; Vanhees, L.; Van Craenenbroeck, E.M. Predictors of response to exercise training in patients with coronary artery disease—A subanalysis of the SAINTEX-CAD study. *Eur. J. Prev. Cardiol.* 2019, 26, 1158–1163.