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Methodological Principles and Practical Approaches for Computerized Monitoring of Human Health

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ABSTRACT

Background: The increasing prevalence of chronic non-communicable diseases, mental health disorders, and lifestyle-related health problems requires new approaches to preventive medicine based on early detection of health risks and continuous monitoring of functional status. Existing screening systems usually assess isolated physiological or psychological parameters and therefore provide only limited information for comprehensive health evaluation.

Objective: To present the methodological principles and practical approaches underlying an integrated computerized system for quantitative assessment and long-term monitoring of human health.

Methods: The proposed methodology is based on a holistic concept of health and integrates environmental, morphofunctional, psychophysiological, psychological, and behavioral characteristics into a unified computerized assessment framework. Standardized screening procedures, quantitative evaluation of functional reserves, electronic health passports, and longitudinal monitoring constitute the core components of the system.

Results: The proposed framework supports standardized collection, automated processing, and quantitative integration of multidimensional health data into individualized health profiles. Assessment of functional reserves and health risks is intended to facilitate early identification of unfavorable functional changes, evaluation of health dynamics, and development of personalized preventive recommendations. Its modular architecture allows adaptation to different age groups, educational institutions, occupational settings, and population health programs.

Conclusion: The proposed computerized health monitoring system represents an integrated methodological framework rather than a conventional screening technology. By combining multidimensional health assessment with electronic health passports and longitudinal surveillance, it provides an effective platform for evidence-based preventive medicine, individualized health management, and population health monitoring.

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Introduction

The increasing prevalence of chronic non-communicable diseases, mental health disorders, population aging, and lifestyle-related health problems has become one of the major challenges for healthcare systems worldwide [1,2]. Although remarkable advances have been achieved in diagnostic technologies and clinical treatment, these achievements alone have not resulted in a proportional improvement in population health. Modern public health increasingly recognizes that effective disease prevention and health promotion require continuous monitoring of health status and the early identification of risk factors before clinically significant disorders develop. This shift from disease-oriented

medicine toward preventive and predictive healthcare has become a priority of the World Health Organization and national health systems [3-5].

Consequently, health monitoring is no longer viewed simply as the periodic assessment of individual physiological indicators. Contemporary public health strategies emphasize integrated surveillance systems capable of combining physical, psychological, behavioral, and environmental information to support evidence-based decision-making, individualized prevention, and long-term health management. Digital technologies have considerably expanded these possibilities by enabling standardized data collection, longitudinal follow-up, and rapid analysis of large population datasets [6-8].

Despite these advances, many existing screening systems remain focused on isolated aspects of health, such as physical fitness,

cardiovascular risk, or psychological status. Comprehensive approaches capable of integrating morphofunctional, psychophysiological, behavioral, and environmental characteristics into a single quantitative assessment remain limited. This fragmentation may reduce the effectiveness of preventive interventions and complicate objective evaluation of health dynamics throughout life [9].

We consider health from a holistic perspective as an integrated state of physical, mental, and social well-being determined by the interaction between the individual and the surrounding environment [10,11]. Within this framework, health should be assessed not only by the absence of disease but also by the organism's functional reserves, adaptive capacity, and ability to maintain homeostasis under changing environmental and occupational conditions. Such an approach requires screening technologies that are dynamic, quantitative, accessible, and suitable for repeated large-scale examinations.

Based on these concepts, our research group has developed a computerized system for integrated health monitoring that combines screening assessment of physical, psychophysiological, psychological, behavioral, and environmental characteristics within a unified electronic health passport. Unlike conventional screening approaches, the proposed methodology provides quantitative evaluation of health status, functional reserves, and health risks while supporting long-term individual monitoring and population-level health surveillance [12,13].

The objective of this paper is to present the methodological principles and practical approaches underlying an integrated computerized system for screening, quantitative assessment, and long-term monitoring of human health as a foundation for preventive medicine and evidence-based health management.

Methodological Principles

The proposed computerized health monitoring system is based on several fundamental methodological principles that determine both the conceptual framework of health assessment and the practical organization of large-scale screening examinations. These principles were developed from the standpoint of preventive medicine, systems physiology, and the understanding of health as a dynamic process of adaptation rather than merely the absence of disease [11,14,15]. Together, they provide the scientific foundation for quantitative assessment of health status, functional reserves, and health risks.

Principle 1: Health Assessment Should Be Based on Dynamic Screening Rather Than Disease Detection.

Health assessment should be dynamic, accessible, inexpensive, and suitable for repeated examinations of large population groups without requiring sophisticated medical equipment. The primary objective of screening is not the diagnosis of existing diseases but the early identification of functional deviations and health risk factors before the development of clinically significant pathology. Therefore, screening should evaluate not only the current functional state of the organism but also its adaptive capacity and reserve potential.

Principle 2: Health Should Be Evaluated Using a Holistic Approach.

Health represents an integrated state of physical, mental, and social well-being that enables individuals to realize their biological and social potential while successfully adapting to continuously changing environmental conditions (Fig. 1). Consequently, health

assessment should integrate physical, psychophysiological, psychological, behavioral, and social characteristics rather than relying on isolated physiological indicators.

Principle 3: Functional Reserves Constitute the Principal Criterion of Health

The quantitative evaluation of health should primarily reflect the organism's functional reserves, which determine its ability to maintain homeostasis under varying environmental conditions and functional loads. Reserve capacity provides a more informative measure of health than isolated physiological parameters because it characterizes the organism's adaptive potential and resistance to external influences.

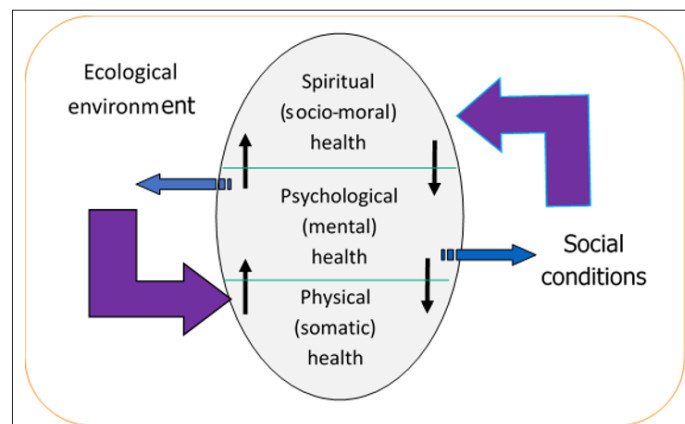


Figure 1: Holistic Model of Human Health (Arrows show the direction of interaction within the organism and the mutual influence of the organism and the external environment)

Principle 4: Human Health Should Be Assessed Within the Context of Environmental Interactions.

The organism and its environment constitute a single integrated biological system (Fig. 1). Health status is continuously influenced by environmental, occupational, educational, hygienic, and lifestyle-related factors. Therefore, the identification of health risks should include an assessment of the surrounding environment together with individual biological characteristics in order to establish cause-and-effect relationships between environmental exposure and functional state.

Principle 5: Health Assessment Should Account for Ontogenetic Development.

The interpretation of health indicators should always consider age-related physiological development. Children and adolescents cannot be evaluated according to adult standards because their organisms undergo continuous structural and functional maturation. Consequently, health assessment should incorporate age-specific reference values and developmental characteristics throughout the entire ontogenetic period.

Together, these methodological principles provide the theoretical basis for an integrated computerized system capable of combining multidimensional health information into a unified quantitative assessment. They also determine the methodological approaches used in the development of electronic health passports and long-term monitoring of individual and population health.

The novelty of the proposed approach lies in the integration of physiological, psychophysiological, psychological, behavioral, and environmental characteristics into a single quantitative health

assessment system that allows dynamic evaluation of functional reserves and health risks throughout human development [16].

Methodological Approaches to Computerized Health Monitoring
The methodological principles described above have been implemented in a computerized health monitoring system designed for large-scale screening examinations and long-term assessment of individual and population health. The system is based on the concept that health cannot be adequately characterized by isolated physiological measurements but should be evaluated through the integration of multiple complementary indicators reflecting the organism's structural, functional, psychological, behavioral, and environmental characteristics.

Accordingly, the computerized monitoring system consists of four interrelated assessment modules that together provide a comprehensive evaluation of health status and health risks.

Module 1: Environmental and Lifestyle Assessment

The first module evaluates environmental and lifestyle factors that may influence human health. These include sanitary and hygienic conditions, educational and occupational environment, physical activity, nutrition, sleep habits, harmful behaviors, psychosocial conditions, and other lifestyle characteristics. Since environmental exposure represents one of the principal determinants of health, these data provide essential information for interpreting individual physiological characteristics and identifying modifiable risk factors.

Module 2: Morphofunctional Assessment

The second module includes anthropometric measurements together with evaluation of the functional state of major physiological systems. Standardized assessment of cardiovascular, respiratory, muscular, and autonomic functions allows quantitative estimation of functional reserves and adaptive capacity. Rather than identifying disease itself, these measurements characterize the organism's ability to maintain physiological stability under functional demands.

Module 3: Psychophysiological and Psychological Assessment

The third module evaluates psychophysiological and psychological characteristics that substantially contribute to health and adaptive functioning. Computerized testing includes assessment of cognitive performance, sensorimotor functions, emotional status, anxiety, stress resistance, motivation, personality characteristics, and other psychological variables depending on the objectives of a particular screening program. These indicators complement physiological measurements by providing information on the individual's functional adaptation and behavioral responses.

Module 4: Integrated Quantitative Health Assessment

The final module combines data obtained from all previous assessments into a unified computerized database. Individual indicators are standardized according to age- and sex-specific reference values and integrated into quantitative indices that characterize health status, functional reserves, and health risks (Fig. 2, 3). This approach enables comprehensive assessment of individual health, longitudinal monitoring of health dynamics, comparison of different population groups, and identification of individuals requiring preventive or corrective interventions.

The integrated assessment forms the basis of the electronic health passport, which accumulates longitudinal information throughout different stages of life. The electronic format enables continuous updating of health information, objective evaluation of changes

over time, and rapid generation of individualized recommendations for health promotion and disease prevention.

Unlike conventional screening systems that focus on individual physiological parameters, the proposed methodology combines environmental, morphofunctional, psychophysiological, and behavioral characteristics within a unified quantitative framework. Such integration substantially increases the diagnostic value of screening examinations and provides a scientific basis for evidence-based preventive medicine and population health management.

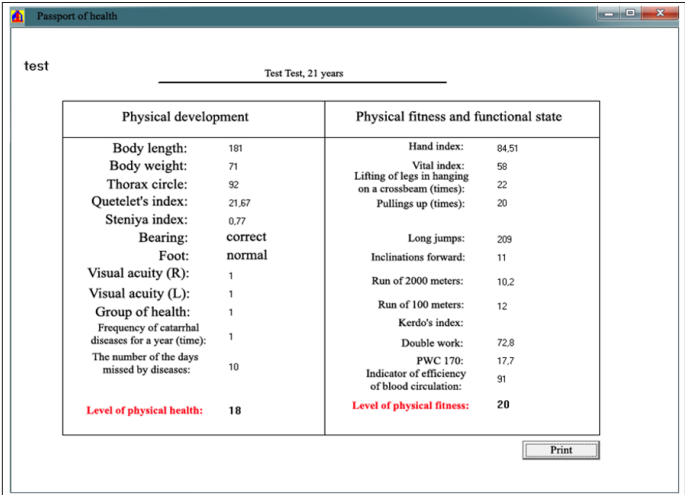


Figure 2: The Electronic Passport Includes the Final Result of Physical Health Assessment of a Person in the Numeric Format

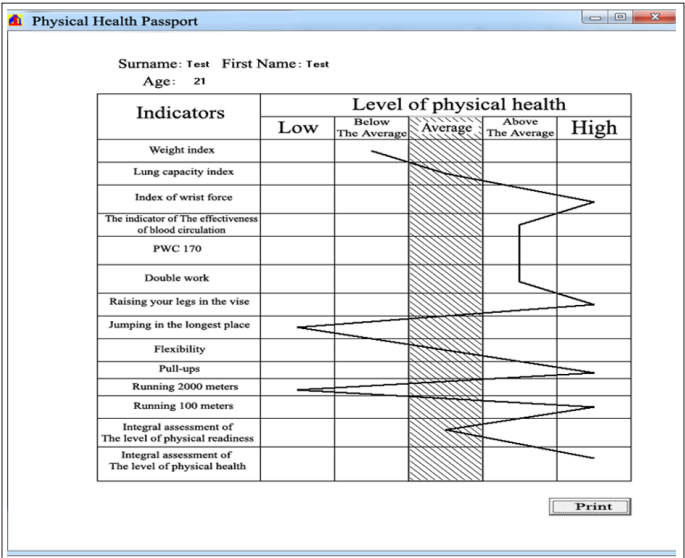


Figure 3: The Electronic Passport Includes the Final Result of Physical Health Assessment of a Person in the Graphic Format

Computerized methods for comprehensive health assessment of different population groups have received state registration certificates for computer programs in the Russian Federation [17-22].

Implementation of the Computerized Health Monitoring System
The methodological principles and approaches described above have been implemented in a computerized health monitoring system intended for preventive examinations, longitudinal health surveillance, and evidence-based health management.

The software platform was designed as an integrated decision-support system that combines data acquisition, automated processing, quantitative evaluation, data storage, and generation of individualized recommendations. Unlike conventional screening programs that present separate physiological measurements, the proposed system integrates heterogeneous information into a unified health profile that reflects both the organism's current functional state and its adaptive potential.

The computerized system provides several complementary functions.

First, it performs standardized collection of anthropometric, physiological, psychophysiological, psychological, behavioral, and environmental information using unified examination protocols. Standardization minimizes operator-dependent variability and ensures comparability of results obtained in different educational institutions, occupational settings, and population groups.

Second, the software automatically converts individual measurements into standardized age- and sex-adjusted indicators using appropriate reference values. This allows objective comparison between individuals and facilitates long-term monitoring of health dynamics throughout different stages of life.

Third, all measured variables are integrated into a computerized electronic health passport that accumulates individual health information during repeated examinations. The electronic database enables longitudinal assessment of functional changes, early identification of unfavorable trends, and objective evaluation of preventive interventions.

Fourth, the system automatically generates quantitative health indices and identifies the principal health risk factors requiring medical, psychological, educational, or lifestyle interventions. Consequently, screening results become not only descriptive but also practically useful for individualized health management.

An important advantage of the proposed methodology is its flexibility. Depending on the objectives of a particular screening program, additional physiological, psychological, environmental, or behavioral modules may be incorporated without changing the overall architecture of the monitoring system. This modular design allows adaptation of the program for children, adolescents, university students, industrial workers, athletes, military personnel, and elderly populations.

The computerized monitoring system has been applied in educational settings for preventive examinations, health education programs, and research observations. These applications support its feasibility for longitudinal data collection; however, broader clinical utility and transferability to other populations require external validation.

Advantages and Practical Applications of the Proposed System

The computerized health monitoring system was developed to provide not only quantitative assessment of individual health but also practical support for preventive medicine, health education, and public health management. Its principal advantage lies in integrating heterogeneous health indicators into a unified analytical framework suitable for both individual and population-level evaluation.

Unlike conventional screening programs that focus primarily on identifying diseases or isolated risk factors, the proposed

methodology emphasizes early detection of functional deviations, assessment of adaptive reserves, and prediction of potential health deterioration before clinically significant disorders develop.

The system's computerized architecture provides several important practical advantages.

First, standardized examination protocols ensure high reproducibility and comparability of results obtained in different educational institutions, occupational organizations, and geographical regions.

Second, automated processing substantially reduces examination time while minimizing subjective errors associated with manual data interpretation.

Third, longitudinal accumulation of information within the electronic health passport allows continuous monitoring of individual health trajectories throughout different stages of life. Such longitudinal assessment enables objective evaluation of preventive interventions and timely correction of unfavorable functional changes.

Fourth, quantitative integration of physiological, psychophysiological, psychological, behavioral, and environmental information facilitates objective identification of the principal determinants of health risks in both individuals and population groups.

An additional advantage of the proposed methodology is its scalability. The modular structure of the computerized system permits adaptation to different age groups, occupational categories, educational institutions, and public health programs without modification of the fundamental methodological principles.

Consequently, the computerized health monitoring system has potential applications in school health services, occupational medicine, university health programs, sports medicine, epidemiological surveillance, and preventive healthcare. Beyond its screening function, the system may support evidence-based health management and strategic planning of preventive interventions, provided that appropriate validation, data-governance, and implementation requirements are met [3,5,7,8].

General Discussion

Preventive medicine increasingly focuses on preserving health rather than treating disease, thereby emphasizing early identification of functional disturbances and health risks before irreversible pathological changes develop [1,2].

Within this context, health monitoring should not be regarded merely as periodic medical examination or collection of physiological measurements. Rather, it should represent a continuous process of quantitative evaluation of human functional status, adaptive reserves, and interactions with environmental and behavioral factors throughout life.

The computerized methodology presented in this paper reflects this conceptual transition. Instead of evaluating isolated physiological parameters, it integrates morphofunctional, psychophysiological, psychological, behavioral, and environmental characteristics into a unified analytical framework capable of supporting both individual and population-level health assessment.

One of the principal advantages of this approach is its dynamic character. Human health is not a static condition but a continuously changing process influenced by age, lifestyle, occupational activity, education, environmental exposure, and psychosocial adaptation. Consequently, repeated computerized assessments provide substantially greater diagnostic value than single cross-sectional examinations because they allow evaluation of health trajectories rather than isolated measurements.

An equally important feature of the proposed methodology is the assessment of functional reserves. Whereas conventional medical examinations primarily identify already developed pathological conditions, evaluation of adaptive capacity enables recognition of preclinical functional changes that may precede disease development. Such information considerably expands the possibilities of preventive interventions and individualized health management.

The proposed methodology also supports the contemporary transition toward digital public health. Integration of standardized electronic health passports with computerized databases creates opportunities for epidemiological surveillance, identification of population health trends, evidence-based decision-making, and optimization of preventive healthcare programs [3,4,7,8]. At the same time, population-level use requires attention to interoperability, completeness, data quality, privacy, and representativeness [9].

Finally, the modular architecture of the proposed system ensures flexibility for future development (Fig. 4). Additional diagnostic modules, wearable technologies, mobile applications, telemedicine platforms, and artificial intelligence algorithms may be incorporated without changing the fundamental methodological principles presented in this paper. Thus, the proposed framework should be regarded not as a fixed technological solution but as an evolving methodological platform for preventive medicine.

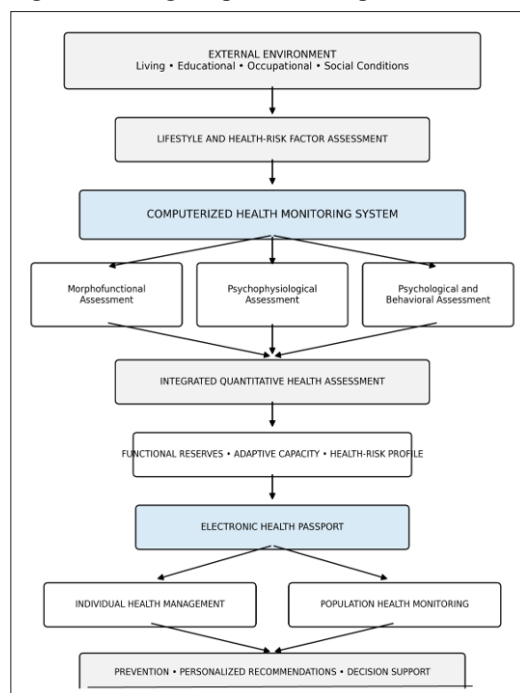


Figure 4: Conceptual Framework of the Proposed Computerized Human Health Monitoring System, Integrating Environmental, Morphofunctional, Psychophysiological, Psychological, and Behavioral Assessments into a Unified Platform for Quantitative Health Evaluation, Electronic Health Passports, Individualized Preventive Interventions, and Population Health Monitoring.

Conclusion

The present paper proposes an integrated methodological framework for computerized human health monitoring based on systems physiology, preventive medicine, and a holistic concept of health.

Unlike conventional screening programs that evaluate isolated physiological indicators, the proposed methodology combines environmental, morphofunctional, psychophysiological, psychological, behavioral, and functional characteristics into a unified quantitative assessment system capable of evaluating health status, adaptive reserves, and health risks.

The implementation of electronic health passports and computerized longitudinal monitoring substantially expands the possibilities for early detection of unfavorable functional changes, individualized preventive interventions, and objective evaluation of health dynamics throughout life.

Beyond its practical application as a screening technology, the proposed system represents a methodological platform that integrates individual health assessment with population health surveillance, thereby supporting evidence-based preventive medicine and strategic public health management.

The proposed computerized system should therefore be viewed not merely as a health monitoring technology but as an integrated health intelligence framework that combines multidimensional assessment, longitudinal surveillance, quantitative risk evaluation, and decision support for preventive medicine. Such an approach reflects the ongoing transformation of healthcare from disease management toward predictive, preventive, personalized, and participatory medicine.

Future development should focus on external validation in diverse populations, integration with wearable monitoring devices, interoperability with contemporary health-information systems, transparent predictive algorithms, and robust data-protection procedures [3,7,8].

Highlights

- Holistic computerized health monitoring is proposed.
- Functional reserves are used as the principal health criterion.
- Environmental and behavioral factors are integrated into health assessment.
- Electronic health passports support lifelong monitoring.
- The framework strengthens evidence-based preventive medicine.

Limitations

The proposed system has several limitations. It has been tested primarily in one region (Novosibirsk Oblast) among students in grades 8-11 and university students; therefore, its applicability to working adults, older people, and populations in other regions or countries has not been established. The current article presents a methodological framework rather than a diagnostic-accuracy study, and it does not provide estimates of sensitivity, specificity, predictive validity, or effects on clinical and public-health outcomes. Reference values may require recalibration for different demographic, occupational, cultural, and geographic groups. Future multicenter studies should evaluate reproducibility, external validity, acceptability, data security, and the effectiveness of recommendations generated by the system.

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References

- World Health Organization (2026) World Health Statistics 2026: Monitoring Health for the SDGs, Sustainable Development Goals. Geneva: World Health Organization 59.
- Ulumbekova GE (2018) Healthcare of Russia: 2018–2024. What to do? Healthcare management: news, views, education. *Bulletin of VSHOUZ* 1: 9-16.
- World Health Organization (2024) Tackling NCDs: Best Buys and Other Recommended Interventions for the Prevention and Control of Noncommunicable Diseases. 2nd ed. Geneva: World Health Organization 23.
- World Health Organization (2024) Strategy for optimizing national routine health information systems. World Health Organization 18.
- World Health Organization (2024) Going Digital for Noncommunicable Diseases: The Case for Action. Geneva: World Health Organization 79.
- Babu M, Lautman Z, Lin X, Sobota MHB, Snyder MP (2024) Wearable devices: implications for precision medicine and the future of health care. *Annual Review of Medicine* 75: 401-415.
- Guralnik E (2023) Utilization of electronic health records for chronic disease surveillance: a systematic literature review. *Cureus* (2023) 15(4):e37975. doi:10.7759/cureus.37975.
- Lewis AE, Weiskopf N, Abrams ZB, Foraker R, Lai AM, et al. (2023) Electronic health record data quality assessment and tools: a systematic review. *Journal of the American Medical Informatics Association* 30 1730-1740.
- Jørgensen T, Rotar O, Juhl CB, Linneberg A (2024) What Is the Effectiveness of Systematic Population-Level Screening Programs for Reducing the Burden of Cardiovascular Diseases? 2nd ed. WHO Health Evidence Network Synthesis Report 78. Copenhagen: WHO Regional Office for Europe; 118 p. License: CC BY-NC-SA 3.0 IGO.
- Aizman RI (2012) Modern concepts of health and criteria for its assessment. *Siberian Pedagogical Journal*: 85-90.
- Aizman RI (2015) *Physiological Foundations of Health: A Textbook*. Moscow INFRA-M 351.
- Aizman RI, Aizman NI, Lebedev AV, Rubanovich VB, Trofimovich EM, et al. (2015) Methodology and techniques for population health monitoring using exercise tests and computer technologies. *Occupational Medicine and Human Ecology*: 15-21.
- Aizman RI, Lebedev AV, Aizman NI, Rubanovich VB (2011) Computer screening program for monitoring the health status of participants in the educational process. *Siberian Teacher* 2: 36-39.
- Aizman RI (2019) Methodological principles and approaches to monitoring student health and health-preserving activities of educational organizations. *Bulletin of Pedagogical Innovations* 1: 5-13.
- Aizman RI, Lysova NF, Zavyalova YaL (2024) Age-Related Anatomy, Physiology and Hygiene for Pedagogical Specialties. Moscow Knorus 416.
- Aizman RI, Lebedev AV, Aizman NI, Rubanovich VB (2017) Screening diagnostics of human health using information technologies as a basis of preventive medicine. *Advanced Techniques in Biology & Medicine* 5: 219.
- Aizman RI, Aizman NI, Lebedev AV (2011) Program for Psychological Testing of Personnel. Registration Certificate No. 21413; November 22. Electronic Publication.
- Aizman RI, Lebedev AV, Aizman NI, Rubanovich VB (2013) Comprehensive Assessment of Students' Health. State Registration Certificate for Computer.
- Aizman RI, Lebedev AV, Aizman NI, Rubanovich VB (2013) Comprehensive Assessment of Teachers' Health. State Registration Certificate for Computer.
- Aizman RI, Lebedev AV, Aizman NI, Rubanovich VB, Shvedov EN (2015) Electronic Passport of a Conscript. State Registration Certificate for Computer.
- Lebedev AV, Aizman RI, Rubanovich VB, Aizman NI (2013) Program for Comprehensive Assessment of Health and Development of Students of Higher and Secondary Educational Institutions. State Registration Certificate for Computer December 6.
- Lebedev AV, Aizman RI (2023) Program for assessing the psycho-emotional state of students. State Registration Certificate for Computer October 17.

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