ABSTRACT

of the doctoral dissertation by **SAULE NURAKYSH TOKTARBAIKYSY** entitled **"Evaluation of the Effectiveness of Implementing Information Technology in the Disease Management Program"** submitted in partial fulfillment of the requirements for the degree of **Doctor of Philosophy (PhD)** in the educational program **6D110200 – Public Health**

Relevance of the research topic. Chronic non-communicable diseases (NCDs) remain the leading cause of morbidity, disability, and premature mortality worldwide and represent one of the key threats to the sustainable development of healthcare systems. According to the World Health Organization, NCDs account for approximately 74% of all deaths globally, equivalent to 41 million deaths annually, with a significant portion of premature mortality occurring in low- and middle-income countries. NCDs form the main disease burden, expressed in terms of lost "healthy life years" (DALYs), including both premature death and years lived with disability, and are accompanied by substantial socio-economic losses for society and the state.

A significant contribution to the global NCD burden comes from mental and behavioral disorders, including depression and anxiety, which are closely associated with low treatment adherence, reduced quality of life, and loss of productivity. According to WHO estimates, the cumulative economic losses related to mental disorders and decreased productivity reach approximately USD 1 trillion annually, highlighting the critical importance of a comprehensive approach to chronic disease management and the need for patient self-management support.

In response to the growing NCD burden, international health strategies are shifting from fragmented treatment of complications toward prevention, early detection, risk factor control, and active patient engagement in disease management. Central to these strategies is the development of primary healthcare and the use of digital technologies, including electronic medical records, remote monitoring systems, and mobile applications aimed at improving treatment adherence and the sustainability of therapeutic outcomes.

In recent years, the Republic of Kazakhstan has demonstrated positive trends in reducing the NCD burden. The country has achieved targeted reductions in premature mortality from NCDs by 25%, facilitated by the development of specialized medical care, the implementation of national screening programs, the expansion of preventive measures, and the enforcement of tobacco control policies, including the ban on electronic cigarettes. At the same time, there remains a need to further enhance the effectiveness of NCD management, primarily at the primary healthcare level, where the main framework for long-term patient follow-up is formed.

A key instrument for systematic NCD management in Kazakhstan has become the Disease Management Program (DMP), implemented since 2013. Initially piloted in selected regions, the program aimed to standardize patient care, develop self-management, and introduce elements of team-based care. Since 2016, the DMP has been scaled nationally and integrated into primary healthcare practices, becoming

an important component of digital health transformation. However, experience in its implementation has shown that the mere presence of digital tools does not guarantee sustainable clinical and organizational effects and requires scientifically grounded evaluation of the effectiveness of the applied information technologies.

Analysis of DMP implementation in pilot and scaled regions showed that arterial hypertension (AH) remains one of the most common and socially significant chronic diseases in Kazakhstan, defining the priority of its control within the national NCD strategy. Official statistics indicate a prevalence of AH of approximately 24.3%, whereas epidemiological studies suggest significantly higher rates — up to 37–45% among the adult population, particularly among older adults, women, and urban residents. AH is the leading factor in cardiovascular mortality and one of the main determinants of DALYs losses.

Under these conditions, the use of information and digital health technologies for patient monitoring, improving adherence to therapy, and personalizing the management of patients with AH becomes particularly relevant. At the same time, domestic practice still lacks comprehensive scientific studies aimed not only at assessing the clinical but also the organizational effectiveness of implementing digital platforms within the DMP, as well as their impact on the transformation of the multidisciplinary team (MDT) role model and decision-making processes in primary healthcare.

The high prevalence of arterial hypertension, the persistent NCD burden, the strategic role of primary healthcare, and the need for a scientifically grounded digital transformation of disease management programs determine the high relevance of this study, aimed at evaluating the effectiveness of information technology implementation in the DMP in Kazakhstan.

The aim of the study is to assess the effectiveness of introducing digital medical technologies, including a mobile application and the DMS information-automated platform, in the implementation of the Disease Management Program for patients with arterial hypertension.

Research objectives:

1. To study international and domestic experience in the implementation of disease management programs and practices for managing chronic diseases.
2. To analyze and evaluate the use of a mobile application in promoting therapy adherence among patients with arterial hypertension.
3. To conduct a comparative analysis of the operability of digital tools used in the Disease Management Program in the Republic of Kazakhstan.
4. To analyze the organizational and managerial capabilities of the DMS digital platform and its impact on the transformation of the role model of the multidisciplinary team (MDT) within the DMP.
5. To evaluate the effectiveness of implementing the DMS platform within the Disease Management Program among patients with arterial hypertension and to develop practical recommendations for its scaling and integration into primary health care activities.

Research methods: To achieve the aim and solve the set tasks, a comprehensive methodological strategy was applied, combining qualitative,

quantitative and analytical approaches in the context of real-world primary healthcare practice (based on City Polyclinics No. 15 and No. 36 in Almaty).

For Task 1, international and domestic experiences were studied, and the implementation of disease management programs and chronic disease management practices were systematically analyzed and scientifically structured.

For Task 2, the "gold standard" of evidence-based medicine was used – a randomized controlled trial involving 425 patients with arterial hypertension to assess the impact of a mobile application on treatment adherence.

For Task 3, an expert-analytical approach was applied with the formation of an interdisciplinary group (n=15) and the use of an author-developed IT checklist for a comparative audit of the operability of three generations of DMP digital tools (Excel registers, "DMP Cardio", DMS).

For Task 4, a qualitative organizational design was implemented using the author's method of interactive role mapping (based on 15 situational tasks) and focus groups (n=12) to analyze the transformation of the multidisciplinary team's work.

For Task 5, a quasi-experimental "before-after" design with paired analysis of data from 265 patients for 2023 and 2024 was used to assess the clinical and organizational effectiveness of the DMS platform.

Thus, the research relies on a combination of rigorous quantitative methods (RCT, quasi-experiment), in-depth qualitative analysis and structured expert assessment, ensuring the completeness and validity of the obtained results.

The object of the study is the Disease Management Program (DMP) as an organizational and digital model for managing patients with arterial hypertension (AH) in the setting of primary health care (PHC).

The study focuses on the following components:

1. A cohort of PHC patients with AH managed under the standard care model (to assess the effect of an isolated digital behavioral intervention based on a mobile application);
2. A cohort of patients formally enrolled in the DMP according to clinical and organizational criteria (to evaluate an integrated organizational and digital intervention based on the DMS platform);
3. Digital tools and information systems supporting the DMP (Excel-based registries, the “DMP Cardio” platform, and the integrated medical information system DMS);
4. Work processes of the multidisciplinary team (MDT) within the DMP and their transformation under the influence of digital solutions.

Research volume. The empirical basis of the dissertation consisted of two cohorts of respondents. To address the first objective within the framework of a randomized controlled trial (RCT), a sample of 425 patients with arterial hypertension was formed (224 in the intervention group and 201 in the control group), who were followed for 12 months with adherence to therapy assessed using the validated LMAS-14 scale. To address the subsequent objectives related to the evaluation of the DMS digital platform, data from 265 patients enrolled in the Disease Management Program at two urban polyclinics in Almaty (Polyclinic No. 15, n = 187; Polyclinic No. 36, n = 78) were used, with a paired analysis of indicators

conducted for 2023 (Excel registries period) and 2024 (DMS period). For the qualitative component of the study, 12 members of the multidisciplinary team (general practitioners, nurses, a cardiologist, and a psychologist) participated as experts, all of whom had experience working with various generations of digital tools within the Disease Management Program.

Subject of the study. The subject of the dissertation research is the digital transformation of the DMP as a comprehensive organizational-technological intervention that restructures the clinical, informational, and managerial processes of managing patients with chronic diseases at the PHC level. The focus of the analysis is on: 1) the influence of isolated digital tools (mobile application) on behavioral aspects (treatment adherence); 2) the operability and evolution of the architecture of DMP digital solutions; 3) mechanisms for institutionalizing normative roles of the MDT through a digital platform; 4) the clinical and organizational effectiveness of the integrated DMS system, assessed through the dynamics of objective health indicators and the structure of healthcare utilization.

The main provisions submitted for defense

1. Digital self-management support tools, such as the MyTherapy mobile application, are an effective and scalable means of improving population-level adherence to pharmacotherapy among patients with arterial hypertension (AH) within the Kazakhstani primary health care (PHC) system.

2. The operability and clinical-organizational effectiveness of DMP digital tools in real-world healthcare practice are directly determined by their architectural robustness and the degree of seamless integration into the core information frameworks of the medical organization.

3. The implementation of a digital platform within the DMP represents a systemic organizational intervention, serving as a key mechanism for institutionalizing the normative model of the multidisciplinary team (MDT), formalizing the distribution of functions, and enabling the transition from a nominal to a functionally integrated model of collaborative work.

4. It has been established that sustained improvement in treatment adherence and clinical outcomes is associated with the combined impact of three key components: automation of monitoring via the digital platform, enhancement of patient medication adherence, and mandatory inclusion of structured psychological support in the patient management cycle.

Description of the Main Research Results

The dissertation presents new scientifically substantiated results reflecting a comprehensive assessment of the clinical, behavioral, and organizational effectiveness of implementing the integrated digital medical platform DMS within the Disease Management Program (DMP) for patients with arterial hypertension in primary healthcare settings in the Republic of Kazakhstan. The conducted study covered multiple levels of analysis—from the individual patient level to the level of healthcare organizations and healthcare management systems—providing a holistic understanding of the mechanisms through which digital technologies impact treatment outcomes and healthcare organization.

It was established that the digitalization of DMP is not an isolated technological intervention but a systemic organizational intervention exerting multi-level effects on clinical, behavioral, and managerial processes. Evidence shows that the use of digital tools outside the context of transforming the organizational care delivery model does not ensure sustainable and reproducible results. Conversely, integrating a digital platform with functional restructuring of the multidisciplinary team (MDT), redefining roles and responsibilities of its members, and implementing behavioral and motivational interventions creates a pronounced synergistic effect, manifested both in improved clinical outcomes and enhanced healthcare system performance.

The implementation of the DMS digital medical platform in DMP for arterial hypertension was accompanied by statistically and clinically significant improvements in blood pressure control. The mean reduction in systolic blood pressure was approximately 7 mmHg, and in diastolic blood pressure approximately 4 mmHg, demonstrating clinically meaningful reductions in cardiovascular risk. These results are consistent with international studies on the use of integrated digital platforms and remote monitoring systems for chronic diseases, confirming the validity and reproducibility of the proposed patient digital support model.

The study also assessed the role of the MyTherapy mobile application as an individual digital self-management tool. It was found that its use was associated with a statistically significantly higher level of adherence to antihypertensive therapy over a 12-month follow-up. This positive association persisted after adjustment for age, sex, and comorbidities, including obesity, diabetes mellitus, and atrial fibrillation ($\beta = 4.85$; 95% CI: 3.12–6.58; $p < 0.001$), indicating an independent behavioral effect of the digital intervention at the patient level. However, it was shown that the effect of the mobile application is limited without integration into the organizational and managerial processes of DMP.

The highest effectiveness was achieved by centralizing DMP digital tools within a single autonomous DMS platform, providing end-to-end digital patient management. This was accompanied by achieving the maximum level of digital maturity in medical organizations (6 out of 6) and a significant increase in operational efficiency, including reducing staff time spent on data management to 5–7 minutes per patient, eliminating duplicate data entry, and transitioning from fragmented record-keeping to a proactive model of patient flow and clinical data management.

Implementation of the DMS platform eliminated so-called “role diffusion” and established a functionally integrated multidisciplinary team with clearly defined responsibilities among physicians, nurses, and other specialists. These organizational changes were accompanied by a statistically significant reduction in staff workload: time spent managing one patient decreased by 39–46% ($p < 0.001$), reflecting improved manageability, stability, and reproducibility of the DMP model in real clinical practice.

The identified organizational transformations were closely associated with changes in healthcare utilization by patients with arterial hypertension. Under digital support, there was a significant reduction in emergency visits, including a decrease

in home physician visits from 85% to 57% ($p < 0.0001$), emergency medical calls from 58% to 39% ($p < 0.0001$), and hospitalizations from 22% to 14% ($p < 0.001$). These data indicate a shift from a reactive care model to proactive disease management focused on early risk detection and complication prevention.

A significant scientific finding of the study is the identification of a synergistic effect of three interrelated components: digitalization of record-keeping and monitoring processes, functional restructuring of the multidisciplinary team, and mandatory integration of behavioral interventions into routine practice. It was demonstrated that sustainable clinical and organizational effects are achieved only through their comprehensive and coordinated implementation, whereas isolated application of individual elements does not yield comparable results.

Thus, the dissertation provides compelling evidence that the implementation of the integrated DMS digital platform within the Disease Management Program for arterial hypertension is an effective instrument for systemic transformation of primary healthcare, ensuring improved clinical outcomes, increased therapy adherence, optimization of multidisciplinary team performance, and rationalization of medical resource utilization. The obtained results confirm the full achievement of the research objective and the solution of all set tasks.

Conclusions:

International and national experience demonstrates that effective management of chronic non-communicable diseases (especially arterial hypertension) is achieved only through the integration of programmatic approaches, teamwork, and self-management support with digital infrastructure. In Kazakhstan, DMP has evolved from a pilot to a nationally standardized model with digital support, but further enhancement of quality, interoperability, and sustainability of IT solutions is required.

The use of the MyTherapy mobile application was associated with a statistically significantly higher level of adherence to antihypertensive therapy over 12 months and maintained an independent positive association after adjustment for age, sex, obesity, diabetes mellitus, and atrial fibrillation ($\beta = 4.85$; 95% CI: 3.12–6.58; $p < 0.001$).

Centralization of DMP digital tools within an autonomous integrated DMS system was associated with increased digital maturity to the maximum level (6/6) and accompanied by measurable gains in operational efficiency, including reducing data management time to 5–7 minutes per patient, eliminating duplicate data entry, and transitioning to proactive digital patient management.

Implementation of the DMS digital medical platform facilitated the elimination of “role diffusion” and the formation of a functionally integrated multidisciplinary team with clearly defined responsibilities, accompanied by a statistically significant reduction in MDT workload: time spent per patient decreased by 39–46% ($p < 0.001$).

The combination of DMS digital platform implementation with multidisciplinary team reorganization was associated with statistically significant improvements in clinical indicators among patients with arterial hypertension, manifested as a reduction in mean systolic blood pressure by 7 mmHg and diastolic

by 4 mmHg, as well as substantial changes in healthcare utilization: emergency visits significantly decreased, including home physician visits from 85% to 57% ($p < 0.0001$), emergency medical calls from 58% to 39% ($p < 0.0001$), and hospitalizations from 22% to 14% ($p < 0.001$). These results provided an empirical basis for practical recommendations aimed at institutionalizing effective DMP components.

The scientific novelty lies in the fact that for the first time in the conditions of the Republic of Kazakhstan:

The digital transformation of the Disease Management Program (DMP) has been conceptualized and empirically substantiated, integrating its architectural and process logic into the frameworks of medical information to ensure the manageability of patient trajectories in arterial hypertension (AH).

Using a quasi-experimental design, objective data were obtained confirming the effectiveness of a comprehensive organizational and digital intervention combined with the restructuring of the multidisciplinary team, which was reflected in improvements in both clinical and organizational indicators of patient management.

New evidence has been obtained regarding the critical role of the behavioral triad for the clinical effectiveness of the DMP.

Theoretical significance of the study:

The new empirical data obtained during the study deepen the theory of behavioral medicine and demonstrate the long-term effect of the isolated digital intervention MyTherapy on treatment adherence in a real-world clinical population.

The evolutionary approach, formalized and tested in the assessment of the operability of healthcare digital tools, links their architectural characteristics with organizational sustainability.

The digital platform can act as a catalyst for the transition from a nominal to a functionally integrated multidisciplinary team (MDT) through mechanisms of role visualization and consolidation.

Practical significance of the study:

The evidence base has been formed taking into account international experience with DMPs and the choice of the architectural model of the digital platform (autonomy, integration) when scaling the program in Kazakhstan.

The effectiveness and cost-efficiency of the mobile application for population-level improvement of therapy adherence are fully demonstrated and ready for implementation within the PHC system without increasing the workload of physicians.

A practical tool (IT checklist) has also been developed and tested for comparative evaluation and selection of DMP digital solutions by healthcare organization managers.

The model “DMS + restructured MDT + psychological support,” with confirmed improvements in clinical outcomes and optimization of service utilization, is ready for scaling and has been reflected in implementation acts and concrete recommendations for the Ministry of Health of the Republic of Kazakhstan, healthcare organization managers, and system developers.

Personal contribution of the author:

The author personally developed the concept and design, and conducted the full empirical study based on pilot healthcare institutions – city polyclinics No. 15 and No. 36 in Almaty. A systematic analysis of both international and domestic experience in disease management and digitalization was carried out, the results of which were formalized as a scientific work and registered with a certificate of state copyright (No. 66320 dated 15.01.2026, Appendix D). The author selected and adapted the following methods: conducting a randomized controlled trial using a mobile application; developing and testing an original methodology for interactive role mapping within the multidisciplinary team (MDT); and organizing a "pre-post" quasi-experiment to assess the DMS digital platform. Together with international trainers from the developer company, the author organized and conducted training for medical staff at the pilot sites on the implemented DMP model and the use of the DMS digital platform. Collected and verified all data, conducted statistical analyses, and formulated theoretical conclusions and practical recommendations. The full text of the dissertation, as well as the main scientific publications on the topic, were prepared independently by the author.

Approval of the work:

The main scientific results and provisions of the dissertation were presented and discussed at the extended meeting of the Scientific Committee in the field of Public Health at the S.D. Asfendiyarov Kazakh National Medical University as part of the preliminary defense procedure. Based on the discussion, the work was recommended for defense at the dissertation council (Scientific Committee Protocol No. 6 dated December 23, 2025).

Some of the research results were also presented at an internal scientific-practical seminar of the department.

On the topic of the dissertation, 6 printed works have been published, including:

I. Scientific publications in journals indexed by the Scopus database (1 article):

1. Nurakysh S., Kurakbayev K., Kosherbaeva L., Tazhiyeva A., Aimakhanova A., Kulkaeva G., Asykbaeva L., Ainabekov M., Fakhradiyev I., Tanabayeva S. Evaluation of the Effectiveness of the Mobile Application on Adherence of Patients with Arterial Hypertension. Acta Informatica Medica, 2022 Mar; 30(1):18-24, doi: 10.5455/aim.2022.30.18-24. ISSN:0353-8109, Scopus – 73 процентиль (Q2).

II. Publications in journals recommended by the Committee for Quality Assurance in Education and Science of the Republic of Kazakhstan (3 articles):

1. Nurakysh S., Iskakova B., Satkhozhina A., Saduakassova L., Dospayeva A., Abu Z., Qumar A. Digital behavior and self-rated health among adults in Kazakhstan: a cross-sectional survey. Central Asian Journal of Medical Hypotheses and Ethics Vol. 6 No. 3 (2025) doi:10.47316/cajmhe.2025.6.3.06, ISSN 2708-98002.

2. Нуракыш С., Кошербаева Л., Таукебаева Г., Куракбаев К., Серикбаев М., Мамырбекова С. Актуальность внедрения информационных технологий в программу управления заболеваниями. «Вестник КазНМУ» №1 – 2020 – С. 570–574, online ISSN 2524-0692, print ISSN 2524-0684

3. Ainabekov M., Uteuliev Y., Tazhiyeva A., Nurakysh S. Patient-centred Online Healthcare: The Way to Increase Access to Medical Care in Kazakhstan. «Вестник КазНМУ» №4 – 2020 – С. 391–393, online ISSN 2524-0692, print ISSN 2524-0684

III. Publications in other international scientific journals (2 articles):

1. Sharman A., Zhussupov B., Nurakysh S. Feasibility of mHealth Devices in Monitoring of Heart Rate, Physical Activity and Respiratory Function in Smokers with and without Respiratory Symptoms and COPD. Global Journal of Respiratory Care. 2020. 6, 1–15. https://doi.org/10.12974/2312-5470.2020.06.01

2. Saduakassova L., Satkhozhina A., Nurakysh S. The impact of self-management on the health status of patients with type 2 diabetes mellitus within the framework of a disease management program. International independent scientific journal, 74, 2025, C. 20-21, https://doi.org/10.5281/zenodo.15634022, ISSN 3547-2340

Implementation acts — 2:

1. SCE REM "City Polyclinic No. 15," Almaty — implementation of the automated DMS platform of the Disease Management Program for managing patients with arterial hypertension, chronic heart failure, and type 2 diabetes mellitus (Appendix A).

2. SCE REM "City Polyclinic No. 36," Almaty — implementation of the automated DMS platform of the Disease Management Program for managing patients with arterial hypertension, chronic heart failure, and type 2 diabetes mellitus (Appendix B).

The volume and structure of the dissertation: the dissertation is presented on 118 pages, consists of an introduction, main chapters, conclusions with conclusions and practical recommendations, a list of sources used (186 sources, 30 of them in Russian), contains 18 tables and 11 figures.