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FINANCIAL MECHANISM OF DIGITAL TRANSFORMATION OF THE HEALTHCARE SYSTEM IN THE FACE OF MODERN CHALLENGES

ABSTRACT

The article is devoted to the justification of the financial mechanism of digital transformation of the healthcare system in the face of modern challenges. The relevance of the study is due to the strengthening of budgetary constraints, the growth of the financial burden on households, the need for transparent allocation of resources, military risks, damage to medical infrastructure, and the need to ensure sustainable access of the population to medical services. In the work, the digital transformation of the healthcare system is considered not only as a technological update, but as a financial and institutional process that combines financing, electronic medical records, electronic prescriptions, electronic referrals, open analytical panels, control over the provision of services, and the use of data for management decisions. The article assesses the impact of financial and digital transformation of the health care system on the financial accessibility of medical services. To achieve this goal, a system of indicators was formed, which includes current healthcare expenditures as a percentage of gross domestic product, current expenditures per capita, out-of-pocket household expenditures, the share of Internet users, the growth rate of gross domestic product, and the author's assessment of the development of the electronic healthcare system.

As a result of the study, an integral index of the financial and digital transformation of the healthcare system and an index of financial accessibility of medical services were constructed. The correlation analysis showed the presence of a close positive relationship between financial and digital transformation and financial accessibility. Regression estimation confirmed the positive impact of the integral index on reducing the financial burden on households, although the statistical robustness of the results is limited by the small number of observations.

The results indicate that the effectiveness of the financial mechanism of digital transformation depends on the combina-tion of financing, development of digital infrastructure, institutional maturity of the e-health system, and macroeconomic stability.

Keywords: financial mechanism, digital transformation, health system, financial accessibility, e-health system, household expenditure, regression analysis, index approach, ANOVA testing

JEL Classification: I18, H51, O33, C22

INTRODUCTION

The healthcare system in modern conditions is under the influence of the simultaneous action of several groups of challenges. These include budget constraints, rising costs of medical services, demographic aging of the population, in-creased burden on public finances, war risks, migration processes, damage to medical infrastructure, shortage of personnel, and the need for rapid access of the population to quality medical care. Under such conditions, not only the volume of healthcare financing becomes of particular importance, but also the ability of the financial mechanism to ensure effective allocation of resources, transparency of contracting, control over the provision of services, reduction of the financial burden on households, and support for the sustainability of

medical institutions. The transformation of the healthcare system based on applied digital technologies is gradually emerging as one of the key areas of modernization of public services. It includes electronic medical records, electronic prescriptions, electronic referrals, electronic contracts, open analytical panels, medical service registries, mechanisms of electronic interaction between patients, doctors, medical institutions, and state authorities. At the same time, such a transformation is not a purely technological process. Its effectiveness largely depends on financial support, the model of payment for medical services, the capabilities of the state budget, the level of development of information infrastructure, and the ability of the management system to use data to make informed decisions.

Despite the significant practical interest in the development of the electronic health system, the scientific literature has not yet sufficiently addressed the issue of quantitative assessment of the relationship between financial provision, the development of digital infrastructure, and the financial accessibility of medical services. It is not uncommon for studies to focus either on the organizational aspects of electronic health care or on the general analysis of budget expenditures. At the same time, there is a lack of work in which financial and digital indicators are combined into a single econometric model that allows assessing the impact of digital transformation on the accessibility of medical services for the population. In our view, it is the combination of the index approach, correlation analysis, regression modeling, and ANOVA testing that allows us to form a more convincing empirical basis to improve the financial mechanism of the digital transformation of the health care system. This approach corresponds to the style of research, where the methodological emphasis is on building a system of indicators, substantiating the choice of variables, forming calculation tables, visualizing the results, and further economic interpretation of the obtained coefficients.

LITERATURE REVIEW

To deepen the interpretation of the obtained econometric results, a thematic keyword co-occurrence map was additionally structured for the research field related to the financial mechanism of digital transformation in healthcare. In methodological terms, this approach follows the logic of bibliometric visualization, where author keywords are grouped according to the density of links between concepts. The visualization makes it possible to identify the main intellectual areas that connect digital health technologies with economic evaluation, public spending, financial accessibility, institutional maturity, and patient-oriented outcomes. In contrast to purely technological interpretations of digital healthcare, the keyword structure demonstrates that the financial effect of digital transformation is mainly formed through the interaction between funding mechanisms, digital maturity, electronic medical records, telehealth, cost-effectiveness, patient experience, and governance (Figure 1).

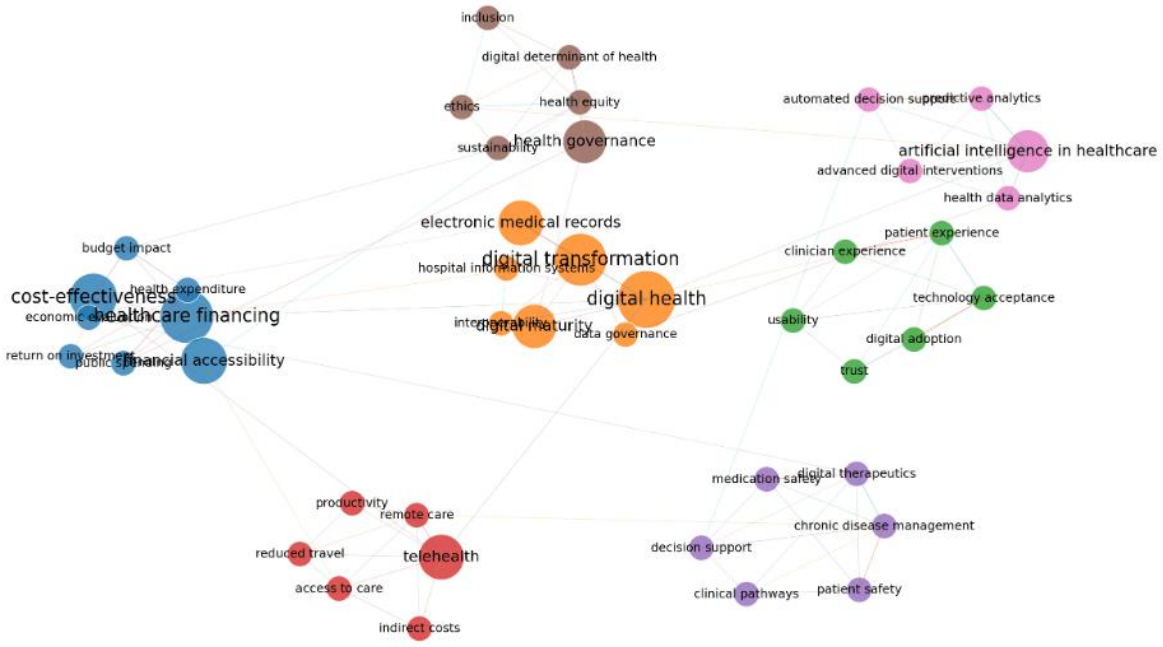

Figure 1. Author keyword co-occurrence network for "digital health and healthcare financing nd healthcare transformation."

Current research on digital transformation in healthcare shows that this process is no longer limited to the technical implementation of electronic tools, but is increasingly interpreted as a systemic change in service delivery, resource allocation, organizational maturity, and patient interaction.

The study of the financial mechanism of digital transformation of the healthcare system requires the analysis of three interconnected groups of scientific works. The first group concerns healthcare financing, financial protection of the population, and the transformation of public expenditure. The second group focuses on financial instruments for digital transformation of healthcare, including budget support, public-private partnership, grant financing, credit instruments, investment mechanisms and financing of digital infrastructure. The third group studies electronic healthcare, digital maturity, telemedicine, electronic medical records, and data-based governance. Such a structure of the literature review makes it possible to avoid reducing the topic only to the medical or technological effects of digitalization.

Ukrainian researchers pay considerable attention to the transformation of healthcare financing under modern conditions. Havrychenko et al. (2022) substantiate the need for financial changes in the healthcare system of Ukraine and analyses the financing mechanism through budget expenditures, subventions, primary healthcare financing, and reform-related financial risks. Their study is important for this article because it interprets healthcare financing as a mechanism that combines national and regional levels of management.

Krynychko and Motailo (2021) analyses new approaches to healthcare financing and emphasise the role of the Ministry of Health of Ukraine, the National Health Service of Ukraine, the Ministry of Finance of Ukraine and interdepartmental coordination in the implementation of financing reform. This approach is directly related to the present study, because digital transformation cannot be effective without coordination between financial, institutional and technological actors.

Sabetska (2021) focuses on problems and prospects of financial support for the healthcare sector of Ukraine and highlights the importance of state financing, the "money follows the patient" principle, insurance medicine and additional sources of funding. These findings support the view that the financial mechanism of healthcare transformation should include not only public expenditure, but also broader financial instruments.

The financial dimension of healthcare development is also analysed in works devoted to financial support of healthcare institutions. Volkova et al. (2024) examine modern approaches to financing healthcare institutions in Ukraine, analyses budget components, financial instruments, and the problems of financing at the local level. Their conclusions are important for the present article because they show that the accessibility and quality of medical services depend on the financing model of healthcare providers and on the ability of the system to combine public and private resources.

Shelemina (2023) compares Ukrainian and foreign experience of healthcare financing and argues that healthcare, as a strategic sector, should remain financially resilient under pandemics, natural disasters and war. This position is particularly relevant for the present study, since modern challenges include not only budgetary constraints, but also military risks, migration, damaged infrastructure and the need to maintain access to services under unstable conditions.

A separate contribution to the topic is made by works that directly connect healthcare digitalization with financial instruments. Kotenko and Bohnhardt (2021) analyses the financing of digital health projects and consider budget reimbursement, electronic health records, telemedicine, mobile medicine, artificial intelligence, big data, public-private partnership and venture financing. This source is especially relevant because it shifts the discussion from general digital health benefits to the problem of how digital health projects are financed.

Opanasiuk (2025) develops this direction by substantiating financial instruments of public administration for the digital transformation of healthcare in Ukraine. The author emphasises that healthcare digitalization includes changes in financing mechanisms, monitoring, data management, cybersecurity, digital maturity, and institutional coordination. This directly supports the interpretation used in the present article, according to which digital transformation is part of the financial mechanism of healthcare development, rather than a purely technological process.

International studies complement this discussion by explaining how digital health investments should be evaluated economically. Gentili et al. (2022) show that digital health interventions can be cost-effective, but their effect depends on the type of intervention, target population, implementation conditions, and the evaluation horizon.

Nguyen et al. (2022) analyses the economic evaluation of hospital-based electronic medical records and demonstrate that financial assessment should include costs, benefits, workflow changes and long-term organisational effects.

Woods et al. (2023) raise the question of how healthcare systems can justify public spending on digital health and argue that evaluation should cover not only direct budget costs, but also the value created through better coordination, reduced

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duplication, improved decision-making and more efficient use of clinical resources. These studies justify the inclusion of expenditure indicators and digital infrastructure indicators in one analytical model.

The institutional and managerial side of digital transformation is developed by Kraus et al. (2021), Stoumpos et al. (2023), Duncan et al. (2022), Canfell et al. (2024), Snoswell et al. (2020, 2022) and other authors. Their findings show that digital transformation depends on technology acceptance, digital maturity, clinical integration, telehealth capacity and organisational readiness. However, these studies mainly focus on health outcomes, organisational effects or technological adoption.

Thus, the reviewed literature shows that the financial mechanism of digital transformation of the healthcare system should be understood as a combination of financial resources, instruments, methods, institutional rules and digital tools that jointly influence the allocation of healthcare resources and the financial accessibility of medical services. At the same time, the literature also reveals a research gap. There are not enough studies that combine healthcare financing indicators, digital development indicators, and household financial burden into one empirical model.

AIMS AND OBJECTIVES

The purpose of the study is to clarify the concept of "financial mechanism of digital transformation of the healthcare system", develop and test an integrated diagnostic model for assessing how the combination of healthcare financing, general digital access, eHealth development and macroeconomic conditions is associated with the financial accessibility of medical services under modern challenges. To achieve this purpose, the following tasks are defined in the article:

1. To form a system of indicators that characterizes healthcare financing, digital infrastructure development, macroeconomic conditions, and the financial burden on households.
2. To calculate the FDHTI and the Financial Accessibility Index, FAI, for 2020–2024.
3. To analyse the statistical relationship between the Financial and Digital Healthcare Transformation Index, healthcare expenditure indicators, and the Financial Accessibility Index.
4. To substantiate the implications of the obtained results for improving the financial mechanism of digital transformation of the healthcare system.

METHODS

The methodological basis of the study is formed on the basis of a systems approach, index assessment, economic and mathematical modeling, correlation analysis, regression analysis, ANOVA testing, and graphical interpretation of the results. The choice of such methods is due to the need to combine financial, digital, and macroeconomic indicators into a single analytical system, which allows assessing not only individual trends, but also the cumulative impact of financial and digital transformation on the availability of medical services.

The research procedure includes three consecutive stages. At the preparatory stage, a research hypothesis was formed, according to which the increase in the level of financial and digital transformation of the healthcare system has a positive effect on the financial accessibility of medical services; however, the strength of such an impact depends on the amount of funding, the level of development of digital infrastructure, and macroeconomic conditions. Also at this stage, a system of indicators was defined, initial data were collected, their logical verification was carried out, and a table was prepared for further modeling. At the main stage, the indicators were normalized, an integral index of financial and digital transformation was constructed, the financial accessibility index was calculated, descriptive statistics, correlation analysis, and regression evaluation were carried out. It was at this stage that the density of the relationship between the indicators was determined and the direction of the influence of the integral index on the resulting variable was established.

At the final stage, the adequacy of the regression model was checked, the actual and model values of the financial accessibility index were compared, the results obtained were interpreted, and conclusions were formulated regarding the improvement of the financial mechanism of the digital transformation of the healthcare system.

RESULTS

The financial mechanism of the digital transformation of the healthcare system should be considered as a set of financial resources, methods of their distribution, instruments for payment for services, institutional rules, information flows, and

control tools that ensure the transition from fragmented financing to a more transparent, data-centric, and result-oriented model of the industry's functioning. In this aspect, the use of digital technologies not only simplifies administrative procedures, but also creates a basis for a more accurate assessment of the needs of the population, the volume of services actually provided, the level of financial accessibility and the efficiency of using budget funds.

To assess the impact of financial and digital factors on the accessibility of the healthcare system, a time series was generated for 2020–2024. Data on current healthcare expenditures as a % of gross domestic product are given in the World Bank DataBank for 2020–2024 as 7.4, 7.5, 7.1, 7.6, and 8.2, respectively. The empirical period of the study is limited to 2020-2024. Data for 2025 were not included because the model requires a complete and comparable annual set of indicators for the same year, including current healthcare expenditure as a percentage of gross domestic product, current healthcare expenditure per capita, out-of-pocket expenditure as a percentage of current healthcare expenditure, the share of Internet users, and gross domestic product growth. At the time of preparing the calculations, the comparable annual international statistical series used in the model were available up to 2024. In particular, health expenditure indicators in the World Development Indicators are based on the Global Health Expenditure Database and are published with a time lag, while macroeconomic and digital infrastructure indicators for the next year may be preliminary and subject to subsequent revision. For this reason, the inclusion of partial or operational data for 2025 would reduce the comparability of the index and could distort the regression estimates. Therefore, 2025 is deliberately excluded from the current empirical matrix and should be considered as a period for a future update of the model after the publication of complete annual data.

The indicator of Internet users, INT, requires a separate methodological clarification. This indicator does not measure the direct use of Internet services specifically in healthcare and is not interpreted in this study as a sector-specific eHealth usage indicator. It is used as a proxy for general digital access and technological readiness of the population, without which the practical use of electronic prescriptions, electronic referrals, patient portals, telemedicine tools, and digital communication with healthcare providers is limited. To avoid methodological substitution, the model also includes a separate sector-specific indicator, namely the author's assessment of eHealth development, DHEI. Thus, INT reflects the general digital environment of the population, while DHEI reflects the institutional and functional development of the electronic healthcare system. In future research, INT should be replaced or supplemented with more precise sectoral indicators, such as the number of electronic prescriptions, electronic referrals, electronic medical records, declarations in the electronic healthcare system, and users of digital health services, when comparable annual data become available.

The integral index of financial and digital transformation of the healthcare system was calculated using formula (1):

$$FDHTI_t = 100 \times (0.25CHEGDP_{norm,t} + 0.35CHEPC_{norm,t} + 0.25INT_{norm,t} + 0.15DHEI_t) \quad (1)$$

where $FDHTI_t$ is the integral index of the financial and digital transformation of the healthcare system in year t, $CHEGDP_{norm,t}$ is the normalized value of current healthcare expenditures as a percentage of gross domestic product, $CHEPC_{norm,t}$ is the normalized value of current healthcare expenditures per capita, $INT_{norm,t}$ is the normalized value of the share of Internet users, $DHEI_t$ is the author's assessment of the development of the electronic healthcare system, scaled from 0 to 1.

The outcome variable of the study was the health care affordability index. It was calculated based on the inverse relationship between household out-of-pocket expenditures and current health care expenditures (2):

$$FAI_t = 100 - OOP_t \quad (2)$$

where FAI_t is the index of financial accessibility of health services in year t, and OOP_t is the share of household out-of-pocket expenditures in current health care expenditures in year t.

The results of our calculations are presented in Table 1. Current healthcare expenditures per capita were USD 183.7, USD 217.7, USD 242.8, USD 265.1, and USD 369.9, respectively. Data on the share of people using the Internet are provided by the World Bank DataBank as 58.9% in 2020, 62.6% in 2021, 70.1% in 2022, 75.0% in 2023, and 79.2% in 2024. Additionally, the growth rate of gross domestic product was taken into account, which in 2020-2024 was 2.4%, 3.5%, 3.2%, -3.8%, and 3.4%. The share of household out-of-pocket expenditures in current healthcare expenditures is taken from the World Bank data, where the values for our country are given (Table 1).

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Table 1. Initial data for modelling the financial and digital transformation of the healthcare system. *(Source: compiled and calculated by the author based on World Bank, 2026)*

Year	Current health expenditure, % of gross domestic product, CHEGDP	Current health expenditure per capita, USD, CHEPC	Out-of-pocket expenditure, % of current health expenditure, OOP	Internet users, % of population, INT	Gross domestic product growth rate, %, GDPGR	Author's assessment of eHealth development, from 0 to 100, DHEI	Financial and Digital Healthcare Transformation Index, from 0 to 100, FDHTI	Financial Accessibility Index, from 0 to 100, FAI
2020	7.4	183.7	49.18	58.9	2.4	10.0	8.32	50.82
2021	7.5	217.7	50.66	62.6	3.5	35.0	25.29	49.34
2022	7.1	242.8	51.12	70.1	3.2	50.0	32.40	48.88
2023	7.6	265.1	47.86	75.0	-3.8	65.0	56.24	52.14
2024	8.2	369.9	45.29	79.2	3.4	80.0	97.00	54.71

Table 2 shows that the greatest weight in the integral index is given to current healthcare expenditures per capita (CHEPC), since this indicator directly characterizes the resource capacity of the financial mechanism. The share of Internet users (INT) and current healthcare expenditures as a percentage of gross domestic product (CHEGDP) have the same weight. The indicator INT is not interpreted as direct use of the Internet in healthcare, but as a general proxy for digital access and technological readiness of the population to use electronic services, including eHealth services. The indicator CHEGDP shows the macro-financial weight of healthcare within the national economy, because current healthcare expenditure as a percentage of gross domestic product reflects the share of aggregate economic resources directed to the healthcare system. The author's assessment of eHealth development (DHEI) reflects the sector-specific development of the electronic healthcare system, including electronic medical records, electronic prescriptions, electronic referrals, digital registers, and analytical tools.

Table 2. Weight coefficients used to construct the integral index.

Indicator	Direction of influence	Weight
Current health expenditure, % of gross domestic product (CHEGDP)	positive	0.25
Current health expenditure per capita (CHEPC)	positive	0.35
Share of internet users (INT)	positive	0.25
Author's assessment of eHealth development (DHEI)	positive	0.15
Total		1.00

Table 3 presents descriptive statistics for the model variables for 2020–2024. The standard deviation shows how strongly the annual values of each indicator differ from their average value during the analysed period. Therefore, it is not interpreted as a deviation from a target or normative level, but as a measure of time variability within the five-year empirical series. The Financial and Digital Healthcare Transformation Index (FDHTI) has the highest standard deviation, 34.34 points, because its value increased from 8.32 points in 2020 to 97.00 points in 2024. This indicates the uneven and accelerated growth of the combined financial and digital transformation indicator. The Financial Accessibility Index (FAI) has a much lower standard deviation, 2.36 points, which means that the reduction of the household financial burden was slower and more gradual than the expansion of financial and digital transformation prerequisites. These calculations are necessary to show that digital and financial transformation developed much faster than the improvement of financial accessibility for households.

Table 3. Descriptive statistics of the model variables.

Indicator	Mean	Standard deviation	Minimum	Maximum
Current health expenditure, % of gross domestic product (CHEGDP)	7.56	0.40	7.10	8.20
Current health expenditure per capita (CHEPC)	255.84	70.58	183.70	369.90
Out-of-pocket expenditure (OOP)	48.82	2.36	45.29	51.12
Internet users (INT)	69.16	8.43	58.90	79.20
Gross domestic product growth rate (GDPGR)	1.74	3.13	-3.80	3.50
Author's assessment of eHealth development (DHEI)	48.00	27.10	10.00	80.00
Financial and Digital Healthcare Transformation Index (FDHTI)	43.85	34.34	8.32	97.00
Financial Accessibility Index (FAI)	51.18	2.36	48.88	54.71

Figure 2 shows the comparative dynamics of the Financial and Digital Healthcare Transformation Index (FDHTI) and the Financial Accessibility Index (FAI). The FDHTI increased significantly faster than the FAI. This difference is methodologically important because the development of financing and digital infrastructure does not automatically lead to an immediate reduction in the financial burden on households. However, after 2022, both indicators begin to move upward, which may indicate a gradual strengthening of the relationship between healthcare financing, development of the electronic healthcare system, and reduction of household out-of-pocket expenditure.

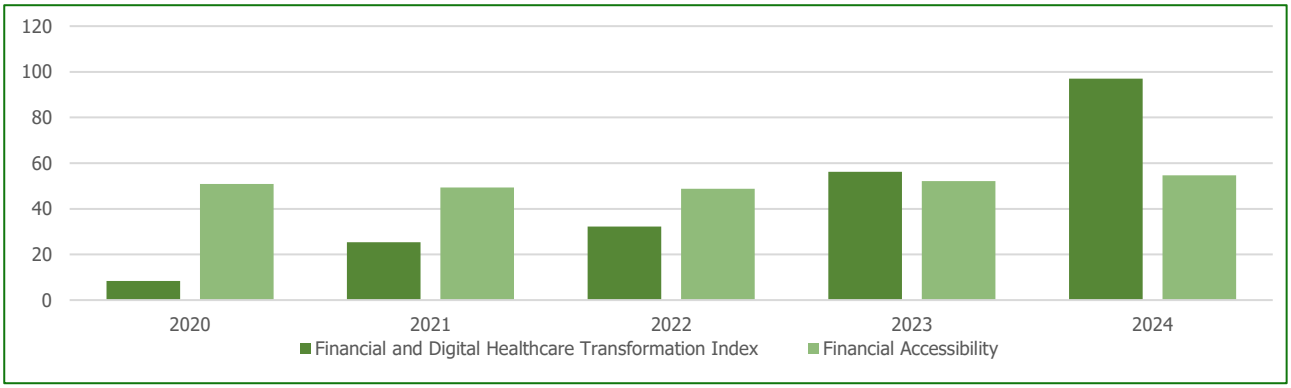

Figure 2. Dynamics of the Financial and Digital Healthcare Transformation Index (FDHTI) and the Financial Accessibility Index (FAI).

The strongest relationship of the Financial Accessibility Index (FAI)is observed with current healthcare expenditure as a % of gross domestic product, where the correlation is 0.926. A rather high relationship was also found between financial inclusion and current expenditure per capita, where the coefficient is 0.809. Thus, the preliminary results confirm that the reduction of the burden on households is associated not only with digitalization, but also with the scale of financial provision of the healthcare system.

Table 4. Correlation matrix of the model indicators.

Indicator	Financial Accessibility Index (FAI)	Financial and Digital Healthcare Transformation Index (FDHTI)	Current health expenditure, % of gross domestic product (CHEGDP)	Current health expenditure per capita (CHEPC)	Internet users (INT)	Gross domestic product growth rate (GDPGR)
Financial Accessibility Index (FAI)	1	0.843	0.926	0.809	0.688	-0.214
Financial and Digital Healthcare Transformation Index (FDHTI)	0.843	1	0.840	0.990	0.934	-0.124
Current healthcare expenditure, % of gross domestic product (CHEGDP)	0.926	0.840	1	0.818	0.607	-0.008
Current healthcare expenditure per capita (CHEPC)	0.809	0.990	0.818	1	0.915	0.005
Internet users, % of population (INT)	0.688	0.934	0.607	0.915	1	-0.310
Gross domestic product growth rate (GDPGR)	-0.214	-0.124	-0.008	0.005	-0.310	1

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In 2020–2021, despite the growth of the Financial and Digital Healthcare Transformation Index, financial accessibility declined, which can be explained by the high share of out-of-pocket expenditure in current health expenditure. After 2021, the situation changed, as the growth of both financial and digital components was accompanied by an increase in financial accessibility.

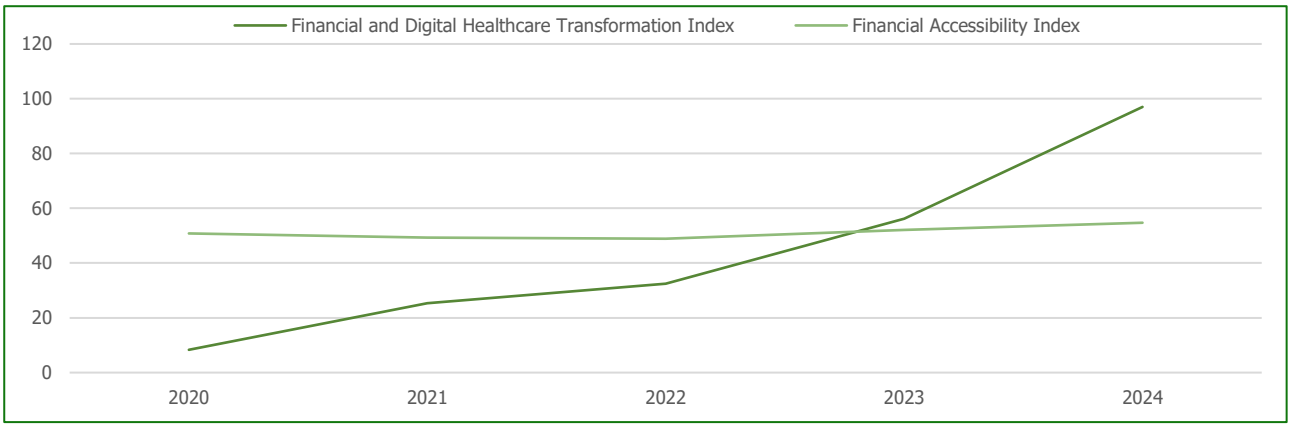

Figure 3. Comparative dynamics of the Financial and Digital Healthcare Transformation Index (FDHTI) and the Financial Accessibility Index (FAI).

Table 5 shows that the regression component explains most of the total variation in the Financial Accessibility Index (FAI), as the regression sum of squares is 16.045 out of a total of 22.188. However, the significance level of the F-statistic is 0.277, which does not give grounds to conclude that the model is highly statistically reliable by classical criteria.

Table 5. ANOVA for the regression model.

Source of variation	Sum of squares	Degrees of freedom	Mean square	F-statistic	Significance level
Regression	16.045	2	8.023	2.612	0.277
Residuals	6.142	2	3.071		
Total	22.188	4			

Table 6 shows that the largest deviation between the actual and model values was observed in 2020 and 2022. In 2022, the model overestimated financial accessibility, which may be due to the fact that the growth of digital and financial prerequisites has not yet translated into a real decrease in household out-of-pocket spending.

Table 6. Actual and modelled values of the Financial Accessibility Index (FAI).

Year	Actual value of the Financial Accessibility Index	Modelled value	Residual
2020	50.82	49.10	1.72
2021	49.34	49.98	-0.64
2022	48.88	50.41	-1.53
2023	52.14	52.35	-0.21
2024	54.71	54.06	0.65

The obtained results should be interpreted as evidence that the financial accessibility of healthcare services is associated with the combined development of financing capacity, digital infrastructure, and institutional maturity of the electronic healthcare system. The dynamics of the Financial and Digital Healthcare Transformation Index (FDHTI) show a sharp increase from 8.32 points in 2020 to 97.00 points in 2024. However, the Financial Accessibility Index (FAI) increased much more moderately, from 50.82 points in 2020 to 54.71 points in 2024. This difference is important because it shows that the expansion of digital tools does not automatically and immediately reduce the financial burden on households. Digital transformation becomes financially meaningful only when it is accompanied by sufficient healthcare expenditure, more transparent contracting, better control over service provision, and practical use of electronic data in the allocation of resources.

The correlation results confirm this interpretation. The relationship between the Financial and Digital Healthcare Transformation Index (FDHTI) and the Financial Accessibility Index (FAI) is positive and strong, with a correlation coefficient of 0.843. At the same time, the highest correlation with financial accessibility was recorded for current healthcare expenditure as a percentage of gross domestic product, where the coefficient is 0.926. Current healthcare expenditure per capita also has a high positive correlation with financial accessibility, with a coefficient of 0.809. Therefore, the results do not support a simplified conclusion that digitalization alone is sufficient to increase affordability. They indicate that the financial mechanism of digital transformation works through the joint effect of resource provision, technological readiness, and institutional capacity. In practical terms, electronic medical records, electronic prescriptions, electronic referrals and analytical dashboards can improve accessibility only when they are integrated into a financing model capable of reducing out-of-pocket payments and increasing the predictability of public coverage.

The obtained results have several policy implications. First, strengthening digital healthcare infrastructure should remain connected with the financial architecture of the healthcare system. Digital instruments can improve transparency and control, but they cannot replace sufficient financing. Second, the reduction of out-of-pocket expenditure requires not only new electronic services, but also stable public coverage, effective contracting of medical service providers, and better use of data for planning the Program of Medical Guarantees. Third, the increase in current healthcare expenditure per capita can strengthen the effect of digital transformation, because digital tools require human resources, institutional maintenance, cybersecurity, software support, and data quality management.

DISCUSSION

The findings are consistent with previous studies that emphasize the systemic nature of digital transformation in healthcare. Kraus et al. (2021) and Stoumpos et al. (2023) argue that digital transformation depends not only on technologies, but also on institutional change, organizational readiness and technology acceptance. The present study supports this position by showing that the growth of the digital transformation index is not fully reflected in financial accessibility unless it is combined with financing capacity. The results also correspond to the conclusions of Gentili et al. (2022), Nguyen et al. (2022) and Woods et al. (2023), who emphasize that digital health interventions require economic justification and that their effects depend on implementation conditions, costs, workflow changes and the broader financing model. The present findings add that, in the case of a healthcare system facing modern challenges, the financial effect of digital transformation should be evaluated through the reduction of household financial burden and not only through the availability of digital services.

The results are also comparable with studies focused on telehealth, electronic medical records and digital maturity. Snoswell et al. (2020, 2022) show that telehealth may reduce health system and household costs through lower travel needs, productivity gains and improved access. The present research is partly consistent with these findings, because financial accessibility improved in 2023-2024 together with the growth of digital and financial transformation. At the same time, this study uses out-of-pocket expenditure as the core outcome indicator, so it captures direct household payments rather than indirect benefits such as reduced travel time or productivity losses. This means that the actual socio-economic value of digital healthcare may be broader than the value reflected in the Financial Accessibility Index. The conclusions also correspond to Huter et al. (2022), Lewkowicz et al. (2022) and Insani et al. (2025), which show that the economic effect of digital health technologies depends on the quality of implementation, integration into care pathways and the capacity of organizations to prevent avoidable costs.

The study also has limitations that should be taken into account when interpreting the results. The first limitation is the short time series, which covers only 2020-2024 and contains five annual observations. This restricts the statistical robustness of the regression model and does not allow making strong causal conclusions. The second limitation concerns the exclusion of 2025, because a complete comparable annual set of all indicators was not available at the time of the calculations. The third limitation is related to the author's assessment of eHealth development. This indicator reflects the institutional progress of the electronic healthcare system, but it is an ordinal analytical estimate and not an official statistical indicator. The fourth limitation is the use of national-level annual data, which does not allow assessing regional differences, differences between population groups, or unequal access to digital services among urban and rural residents. The fifth limitation concerns the structure of the Financial Accessibility Index, which is based on out-of-pocket expenditure and therefore does not capture indirect costs of access to healthcare, such as travel expenses, waiting time, productivity losses, or informal payments. Finally, the model does not directly include the effects of war-related damage to medical infrastructure, forced migration, staff shortages and regional security risks. These factors may significantly influence both digital transformation and financial accessibility, and they should be included in future research when sufficiently comparable data become available.

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Thus, the discussion of the results shows that the financial mechanism of digital transformation of the healthcare system should not be interpreted as a purely technological process. The empirical findings confirm that digital transformation can support financial accessibility, but its effect depends on the scale of healthcare financing, institutional maturity, and the ability of the system to convert digital data into better contracting, planning, and expenditure control.

The comparison of actual and modelled values also provides an important interpretation. The model follows the general direction of the Financial Accessibility Index, but the ANOVA results show that the significance level of the F-statistic is 0.277. This means that the model should be treated as an exploratory analytical tool rather than as a statistically strong predictive model. The result is not a weakness of the research design alone, but also a consequence of the limited number of observations. With only five annual observations, even a logically consistent model cannot provide strong econometric robustness. Thus, the regression results should be interpreted as preliminary evidence of association between financial and digital transformation and financial accessibility, not as proof of direct causality.

CONCLUSIONS

The research showed that the financial mechanism of digital transformation of the healthcare system should not be interpreted only as the financing of technological renewal. It is a complex combination of financial resources, institutional rules, payment instruments, information flows, digital infrastructure, and control tools that influence the transparency, targeting, and effectiveness of healthcare financing. Therefore, digital transformation becomes part of the financial mechanism only when electronic medical records, electronic prescriptions, electronic referrals, analytical dashboards, and digital registers are connected with the allocation of financial resources and the reduction of the household financial burden.

The study confirmed that such instruments include budget financing, payment for medical services, contracting of healthcare providers, public control over service delivery, digital accounting of services, eHealth infrastructure, data-based planning and monitoring of expenditures. These instruments do not operate separately. Their effect appears when financing, digital infrastructure, and institutional coordination are combined into a single system of resource allocation and control. The selected indicators include current healthcare expenditure as a percentage of gross domestic product, CHEGDP; current healthcare expenditure per capita, CHEPC; out-of-pocket expenditure, OOP; Internet users, INT; gross domestic product growth rate, GDPGR, and the author's assessment of eHealth development, DHEI. The indicator INT was used only as a proxy for general digital access and not as a direct indicator of Internet use in healthcare. The sector-specific digital component was represented by DHEI. This approach made it possible to combine financial, digital, and macroeconomic indicators in one analytical model.

The calculations showed that FDHTI increased from 8.32 points in 2020 to 97.00 points in 2024, which reflects the rapid strengthening of financial and digital transformation prerequisites. At the same time, FAI increased more moderately, from 50.82 points in 2020 to 54.71 points in 2024. This difference indicates that the expansion of digital and financial prerequisites does not automatically lead to an immediate reduction in the financial burden on households.

The correlation analysis showed a strong positive relationship between FDHTI and FAI, with a correlation coefficient of 0.843. The strongest relationship with FAI was observed for current healthcare expenditure as a percentage of gross domestic product, CHEGDP, where the correlation coefficient was 0.926. Current healthcare expenditure per capita, CHEPC, also showed a high positive correlation with FAI, 0.809. Regression and ANOVA results confirmed the usefulness of the model as an exploratory analytical tool. However, because the empirical base includes only five annual observations, the results should be interpreted as preliminary evidence of association rather than proof of direct causality.

The results indicate that the improvement of financial accessibility requires not only the development of applied digital technologies, but also sufficient healthcare financing, transparent contracting, better use of eHealth data, stable public coverage and stronger control over out-of-pocket payments. In our opinion, further research should include more precise sectoral indicators, such as electronic prescriptions, electronic referrals, electronic medical records, the number of declarations, contracted medical institutions, and payments under the medical guarantee program. Such an expansion will make it possible to assess more accurately how solutions based on applied digital technologies affect the financial sustainability and accessibility of the healthcare system.

In our opinion, further research should include indicators of electronic prescriptions, electronic referrals, the number of declarations, the number of contracted medical institutions, and the volume of payments under the medical guarantee program. This direction will allow for a deeper assessment of how exactly solutions based on applied digital technologies affect the financial sustainability and accessibility of the healthcare system.

ADDITIONAL INFORMATION

AUTHOR CONTRIBUTIONS

All authors have contributed equally.

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CONFLICT OF INTEREST

The Authors declare that there is no conflict of interest.

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ФІНАНСОВИЙ МЕХАНІЗМ ЦИФРОВОЇ ТРАНСФОРМАЦІЇ СИСТЕМИ ОХОРОНИ ЗДОРОВ'Я В УМОВАХ СУЧАСНИХ ВИКЛИКІВ

Стаття присвячена обґрунтуванню фінансового механізму цифрової трансформації системи охорони здоров'я в умовах сучасних викликів. Актуальність дослідження зумовлена посиленням бюджетних обмежень, зростанням фінансового навантаження на домогосподарства, потребою в прозорому розподілі ресурсів, воєнними ризиками, пошкодженням медичної інфраструктури та необхідністю забезпечення сталого доступу населення до медичних послуг. Автори розглядають цифрову трансформацію системи охорони здоров'я не лише як технологічне оновлення, а й як фінансово-інституційний процес, що поєднує фінансування, електронні медичні записи, електронні рецепти, електронні направлення, відкриті аналітичні панелі, контроль за наданням послуг і використання даних для управлінських рішень. Здійснено оцінку впливу фінансово-цифрової трансформації системи охорони здоров'я на фінансову доступність медичних послуг. Для досягнення цієї мети сформовано систему показників, яка охоплює поточні видатки на охорону здоров'я у % до валового внутрішнього продукту, поточні видатки на одну особу, витрати домогосподарств із власної кишені, частку користувачів інтернету, темп зростання валового внутрішнього продукту й авторську оцінку розвитку електронної системи охорони здоров'я.

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У результаті дослідження побудовано інтегральний індекс фінансово-цифрової трансформації системи охорони здоров'я та індекс фінансової доступності медичних послуг. Кореляційний аналіз показав наявність тісного позитивного зв'язку між фінансово-цифровою трансформацією та фінансовою доступністю. Регресійне оцінювання підтвердило позитивний вплив інтегрального індексу на зниження фінансового навантаження на домогосподарства, хоча статистична стійкість результатів обмежується малою кількістю спостережень.

Отримані результати свідчать, що ефективність фінансового механізму цифрової трансформації залежить від поєднання фінансування, розвитку цифрової інфраструктури, інституційної зрілості електронної системи охорони здоров'я та макроекономічної стабільності.

Ключові слова: фінансовий механізм, цифрова трансформація, система охорони здоров'я, фінансова доступність, електронна система охорони здоров'я, витрати домогосподарств, регресійний аналіз, індексний підхід, ANOVA-тестування

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