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ORIGINAL RESEARCH

Current Status and Determinant Factors of Telemedicine Adoption in Selected Commonwealth of Independent States (CIS) Countries; A Mix Method Study

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Abstract: **Introduction:** The field of telemedicine has become an urgent innovation in the healthcare field worldwide, but there is still an unequal distribution of its implementation in transitional economies. This study aimed to evaluate the associated factors of telemedicine adoption in selected countries of the commonwealth of independent states (CIS) region. **Methods:** A validated survey was used to collect data on 600 healthcare professionals, patients, information technology (IT) specialists and policymakers from selected CIS countries, using a mixed-method design. Through a designed and validated questionnaire, solid statistical techniques, and cross-regional analyses, the barriers and facilitators of telemedicine adoption in studied countries were evaluated. **Results:** The general average score of telemedicine adoption was 3.84 ± 0.92. The highest mean adoption score was observed in Azerbaijan (4.02 ± 0.85), Russia (3.91 ± 0.88) and Ukraine (3.87 ± 0.91). There were significant differences between regions regarding mean adoption score ($p < 0.001$). Clinician acceptance ($r = 0.64$; $p < 0.01$), infrastructure readiness ($r = 0.58$; $p < 0.01$), regulatory maturity ($r = 0.42$; $p < 0.01$), and patient digital literacy ($r = 0.36$; $p < 0.01$) had the strongest correlation with telemedicine adoption. The most predictive factors of telemedicine adoption were infrastructure readiness ((standard error; SE) = 0.42 (0.05), $p < 0.001$), then clinician acceptance ((SE) = 0.39 (0.06), $p < 0.001$), patient digital literacy ((SE) = 0.22 (0.05), $p < 0.001$), and regulatory maturity ((SE) = 0.18 (0.04), $p < 0.001$). Professional experience had a minor yet significant impact (= 0.09, t = 0.038). Logistic regression showed increased infrastructure readiness score (odds ratio (OR) = 1.48, 95% confidence interval (CI) = 1.21-1.81), clinician acceptance score (OR = 1.56, 95% CI = 1.28-1.92), regulatory maturity score (OR = 1.31, 95% CI = 1.09-1.58), and patient literacy score (OR = 1.22, 95% CI = 1.03-1.45) as the predictors of high telemedicine adoption (≥70%). The model accurately categorized 78.2% of data and the area under the curve 0.79 (95% CI: 0.75–0.83) meaning the model is a strong predictor.ndividuals showed higher levels of willingness, yet untrained participants demonstrated unexpected willingness to perform hands-only CPR, while female participants were consistently less willing to perform standard CPR. However, sensitivity analysis restricted to respondents who had witnessed a cardiac arrest showed that real-life exposure substantially reduces hesitation and narrows group disparities. **Conclusion:** The findings showed that the structural investments cannot be made alone without the involvement of professionals. The research contributes to the existing body of transitional economies research by offering strong comparative evidence of telemedicine and provides policy recommendations on how to improve infrastructure, generate harmonization, and capacity building of clinicians and patients to support sustainable digital health ecosystems.

Keywords: Adoption; Azerbaijan; CIS nations; Medical informatics; Telemedicine

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1. Introduction

The fast-moving digital health technologies have reshaped the global healthcare landscape by changing the way medical services are provided, accessed, and managed. More specifically, telemedicine has become a vital innovation, geographically removing barriers to healthcare, lowering health-

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care expenses, and improving patient access to specialized care (1, 2). The COVID-19 pandemic also positively influenced the implementation of telehealth across the globe as it forced healthcare systems to deploy information technologies (IT) to create continuity of care despite limitations on face-to-face consultation (3, 4). This adoption pace comes with considerable regional differences, particularly in developing and middle-income nations, where telemedicine may be hampered by infrastructural, regulatory, and cultural constraints (5).

Telemedicine is now institutionalized in high-income nations, including the United States, Germany, and the United Kingdom, where legal frameworks are mature, broadband is well developed, and most patients are digitally literate (6). On the other hand, Eastern European and post-Soviet healthcare systems still have problems at the systemic level. The Commonwealth of Independent States (CIS) region, comprising Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Uzbekistan, and Ukraine, demonstrates lower levels of telemedicine adoption compared with Western countries, reflecting infrastructural, regulatory, and professional barriers inherent to transitional healthcare systems (7, 8). There is a significant knowledge gap regarding the barriers and opportunities specific to digital health in CIS countries.

Azerbaijan is perhaps a striking example. The country is located at the crossroads of Eastern Europe and Western Asia and has not lagged in healthcare modernization and e-health initiatives over the last ten years (9, 10). Nevertheless, the evidence on the level and success of telemedicine use in Azerbaijan is very limited. Although pilot projects have been reported in cardiology, dermatology, and radiology, implementation on a large scale has been impeded by infrastructural shortfalls and the lack of a unified legal framework (11, 12). These obstacles are reflective of the larger trends in CIS states, where healthcare IT change is uneven and uncoordinated. Conversely, the international trend highlights the importance of telemedicine as a strategic tool not only in times of crisis but also as a viable framework to empower health systems in the long run (13).

The development of uneven acceptance of telemedicine in CIS countries is based on a number of thematic issues. Such challenges are neither regional nor peculiar but magnified by socioeconomic, models of healthcare financing, and political situations.

Most of the recent literature on telemedicine adoption in particular CIS countries is descriptive and one-country analysis (14). No comparative multi-country research exists that places in a wider CIS and global context. In the absence of such comparative evidence, policy recommendations are more likely to be incomplete, and the possibilities of mutual learning on a regional scale are not yet fully exploited (15). Filling this gap is important in informing scalable strategies that are sensitive to local markets and also responsive to global best practices (16). This study aimed to determine the current status of telemedicine adoption in selected CIS countries and to evaluate the determinant factors of telemedicine adoption in this region.

2. Methods

2.1. Study design and setting

A validated survey and semi-structured interviews were used to collect data on healthcare professionals, patients, IT specialists and policymakers using a mixed-method design. This study was conducted between January and September 2024 across selected CIS countries, including Russia, Ukraine, Kazakhstan, and Uzbekistan. Data were collected from healthcare institutions, academic centers, and health-policy bodies to capture regional variation in telemedicine adoption within transitional healthcare systems. Through a well-crafted survey tool, solid statistical techniques, and cross-regional analyses, this study methodically establishes the barriers and facilitators to the adoption of telemedicine.

The research was conducted in two steps:

First, using a literature review, we present empirical and comparative evidence on the topic of telemedicine in the CIS counties, as it relates to the disproportion between world and regional literature. Second, we provide a multidimensional evaluation of determinants that goes beyond description to offer analytical findings based on strong statistical validation. For this propose, we develop a conceptual framework based on the four prevailing theoretical views regarding the telemedicine adoption. Then, we design a reliable and validated questionnaire to collect the viewpoints of healthcare professionals, patients, IT specialists and policymakers in this regard, using a mixed-method design.

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Informed consent was obtained from all participants prior to their inclusion in the survey and interviews. The confidentiality and anonymity of respondents were guaranteed, and no personally identifiable information was collected. Ethical approval for the study was obtained from the relevant institutional ethics committees of the participating universities and healthcare institutions in Azerbaijan and CIS countries (Ethics code: AMU-REC-2024-013-TMED; Date: December 15, 2024).

2.2. Literature review

The literature review was designed as structured and systematic to situate the telemedicine adoption and transformation of the healthcare information technology in the selected CIS countries within the global digital health environment. The review was to be used to find out the existing trends, gaps, and determining factors that are applicable within transitional and post-Soviet healthcare systems to inform the conceptual framework and hypotheses of the study (17).

PubMed/MEDLINE, Scopus, Web of Science, IEEE Xplore, Google Scholar, and the World Health Organization (WHO)

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Global Health library were searched electronically. The European Observatory on Health Systems and Policies and official government health portals of several selected CIS countries were searched to retrieve additional policy documents and regional reports. The search was conducted on publications between the years of January 2010 to June 2025, which was the time when digital health and telemedicine shifted into the accelerated development phase in the transitional economies.

The search strategies were a combination of controlled vocabulary, free-text words with the help of Boolean operators, such as: telemedicine OR telehealth OR digital health, and healthcare information technology OR e-health, and adoption OR implementation, and Commonwealth of Independent States OR CIS OR post-Soviet countries OR Azerbaijan. Peer-reviewed articles, systematic reviews, empirical studies, and policy analyses that were published in English were narrowed down using database-specific filters.

Inclusion criteria were that they (i) had to study telemedicine or healthcare IT adoption, (ii) had to have studied low-and middle-income, transitional, or post-Soviet health systems, or (iii) had to offer empirical, regulatory, or theoretical evidence on infrastructure readiness, regulatory maturity, clinician acceptance or patient digital literacy. Non-healthcare technology studies, conference abstracts that were not in full text, and articles that did not contain any analytical relevance were not considered.

Manual screening of reference lists of eligible articles was done to identify more relevant studies. The last literature was integrated thematically and not quantitatively and focused on comparative evidence, determinant variables, and theoretical adoption models. Results of this review were directly used to construct the conceptual framework, choice of variables, and formulation of hypothesis that would be applied in the empirical part of the study.

2.3. Developing a conceptual framework and hypotheses

We combined the knowledge of four prevailing views, which include technology acceptance theory, diffusion of innovations, institutional theory, and the socio-technical systems theory, in order to develop a narrow conceptual framework regarding telemedicine adoption in the CIS region. Based on these theoretical backgrounds, we offered a model (Figure 1) in which the uptake of telemedicine in CIS countries is expressed as a product of four constructs, including infrastructure preparedness, regulatory maturity, clinician acceptance, and patient digital literacy (18). This framework offers a clear, testable model that goes beyond the descriptive models into allowing comparative validation of the determinants in CIS countries in the global context. The framework demonstrates the postulated connections among the critical determinants, such as infrastructure preparedness, regulatory maturity, and patient digital literacy, and the result of telemedicine adoption (19). Clinician acceptance is theorized as a direct predictor and as a mediator of the structural and regulatory improvement, with its primary role in the transformation of structural and regulatory progress into sustained digital health transformation. We hypothesized that:

H1: Infrastructure preparedness has a positive impact on the use of telemedicine.

H2: Regulatory maturity has a positive impact on the adoption of telemedicine.

H3: The acceptance of clinicians has a positive effect on the adoption of telemedicine.

H4: Telemedicine is positively affected by patient digital literacy.

H5 (Mediation): Clinician acceptance mediates the relationship between (a) infrastructure readiness, (b) regulatory maturity, and adoption. **2.3.1** Theoretical views in telemedicine adoption

2.3.1.1. Technology acceptance models (TAM/UTAUT)

These models stress the influence of perceived usefulness and ease of use in the process of technology uptake (20). Telemedicine clinician acceptance is the focal point because professionals are the adoption gatekeepers. The opposition may be based on workload issues, training issues, or skepticism of the reliability of the diagnosis. In this manner, the clinician's acceptance is postulated to be a direct and mediating factor of adoption outcomes (21).

2.3.1.2 Theory of diffusion of innovations

The factors that determine adoption are not just the technology, but also system-level enablers, including the availability of infrastructure and relative advantage (22). In the CIS countries, the diffusion of telemedicine is predetermined by the infrastructural preparedness (e.g., broadband, integration with hospital information systems).

2.3.1.3. Institutional theory

Adoption is influenced by organizational and regulatory environments, which offer legitimacy and decrease uncertainty (23). The conditions that enable the growth of telemedicine are the regulatory maturity through reimbursement policies, licensure, and data security. Barriers are weak or ambiguous frameworks, which are typical of CIS.

2.3.1.4 The social technological systems theory

The adoption of telemedicine is not a technical phenomenon; it needs to be balanced among the human actors, technology, and social organization (24). Digital literacy is a patient term that serves as an indicator of the capacity to manage and seek digital care in a manner that does not pose inequity in uptake across diverse groups of patients (25).

2.4. Questionnaire designing and data gathering

A structured, validated questionnaire (appendix A) was designed and used to collect the data based on existing literature regarding telemedicine adoption and theoretical models (TAM/UTAUT, diffusion of innovations, institutional theory, and socio-technical systems theory). The questionnaire was created to assess the telemedicine adoption and its determi-

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nants of greater significance within the CIS, such as infrastructure preparedness, regulatory maturity, clinician acceptance, and patient digital literacy.

The questionnaire had five parts. The former completed section involved sociodemographic and professional data, age, gender, years in professional position, country of practice, and nature of healthcare facility. The second was a measure of telemedicine adoption, which was assessed using a 5-item scale that included frequency of use, integration of telemedicine into the clinical workflow, perceived effectiveness, and routine utilization. The rest of the sections were used to measure four determinant constructs, which included infrastructure readiness (6 items), regulatory maturity (5 items), clinician acceptance (6 items), and patient digital literacy (4 items).

The measurement scale was a five-point Likert scale on a scale of 1(strongly disagree) to 5(strongly agree), with higher scores showing higher levels of agreement or readiness. Based on the already tested tools, objects were modified to suit the healthcare and regulatory conditions of CIS countries. Domain experts in digital health and health policy reviewed the questionnaire to achieve content validity, clarity, and contextual relevance.

To secure a wide access and representation of various regions with different degrees of digital infrastructure, the survey was conducted with the help of the mixed-mode data collection method, which implied the integration of online and paper questionnaires. The online surveys were sent through secure survey platforms and professional communication channels, and the paper questionnaires were sent in some of the healthcare institutions, especially in regions with limited internet connectivity.

The sample comprised healthcare professionals, patients, IT specialists, and policymakers recruited in hospitals, academic medical centers, professional networks, and health authorities in Azerbaijan and the selected countries of the CIS. The survey was conducted voluntarily, and informed consent was taken before completing it. Anonymity and confidentiality were guaranteed to the respondents in order to reduce bias in the responses.

There were 600 completed questionnaires that were incorporated in the final analysis. A specified period of study was used to collect data, and a screening of the responses was done.

2.4.1 The reliability of questionnaire

The telemedicine adoption scale questionnaire had good overall reliability (alpha Cronbach's = 0.88). The alpha Cronbach's of subscale scores was 0.87 for infrastructure readiness, 0.81 for regulatory environment, 0.89 for clinical acceptance, and 0.79 for patient literacy. All values were higher than the accepted value of 0.70, which assures the strength of the measuring tool.

2.4.2 Factorial validity (principal component analysis)

Exploratory component and principal component analysis (figure 2) recovered four components that had eigenvalues above 1 and a cumulative variance of 90.5%. Infrastructure readiness was the first component with variance explained of 41.0%, then regulatory environment with variance explained of 21.7%, then clinician acceptance with variance explained of 15.5%, and patient literacy with variance explained of 12.3%. The items surrounding a barrier, such as privacy/security and connectivity were loaded separately, which validates their perceived conceptual distinction.

2.5. Participants

The inclusion criterion was that the participants were information technology experts engaged in the health system, healthcare policymakers, or had direct or indirect experience in healthcare service provision or usage in Azerbaijan or the selected CIS countries. Other inclusion criteria included a minimum of one year of professional experience as healthcare professional, administrator, IT specialist, or policymaker, and the ability to respond and understand the questionnaire of the survey. Every participant was expected to give informed consent before participating. They were not included in case they had not encountered digital health tools or telemedicine-related services before, had less than one year of professional experience related to the area, could not answer the questionnaire because of language or cognitive barriers, or gave incomplete or inconsistent answers. In order to achieve data quality and statistical validity, responses with high levels of missing data were removed during the final analysis.

2.6. Statistical analysis

Python 3 was used to analyze data. Descriptive statistics were in the form of mean and standard deviation. To determine regional variations in the adoption of telemedicine, one-way analysis of variance (ANOVA) was conducted with post-hoc comparisons. Pearson correlation was used to test the links between adoption with major determinants. Several linear regressions, multilevel mixed-effects modeling, and binary logistic regression were used to determine the predictors of telemedicine adoption and high-adoption. Indirect effects of clinician acceptance were assessed using mediation analysis (Sobel test) to measure them. The statistical significance of p was established to be $p < 0.05$.

3. Results

The findings are presented in two sections: first section presented the findings of literature review (figure 3) and second section reported the analysis of the telemedicine adoption's determinants in studied countries.

3.1. First section (Systematic literature review findings)

The qualitative synthesis of the 37 incorporated studies demonstrates that there is a general consistency of multilevel determinants affecting the adoption of telemedicine in the CIS region, as well as a definite evidence gap in compari-

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son with the international literature.

1. Dominant Themes and Regional Inequalities: The findings have validated that the implementation of telemedicine in the CIS is still disjointed and project-based, as indicated in the first review. Most empirical research (n=28) was descriptive case studies of individual institutions or cities, most of them in Russia (n=10), Kazakhstan (n=7), and Ukraine (n=5). There was an apparent acute lack of comparative, multi-country, or nation-wide adoption studies (n=2) , which validated the gap in regional learning suggested by the literature (40).

2. Production of Key Determinants: The results confirm and put in perspective the four conceptual determinants in the CIS context:

Infrastructure and Integration: Infrastructure was unanimously found to be a major obstacle across (n=22) studies. Nonetheless, in addition to mere connectedness, there was the essential theme of systemic fragmentation (36). The pilot projects were run on separate platforms that were not compatible with the national health information systems, forming digital silos and limiting scalability.

Regulatory Maturity: Legal and payment structures were cited as one of the biggest obstacles in 18 studies. The lack of law was not the only challenge, but there were also conflicting regulations and the inability to have unified reimbursement models (38) . This indecision was a direct cause of hesitancy among clinicians.

Clinician acceptance: This proved to be the most complicated obstacle (talked about in n=25 studies). Not only a lack of training but also an amplified perceived workload, without any institutional compensation or workflow integration, was related to disengagement (39). Reliability or the accuracy of diagnosis based on digital consultation was a concern that kept on recurring.

Patient digital literacy: The less common of the two, but the research showed that low health literacy and privacy concerns are exacerbating the problem of access among rural and older groups, which could threaten to widen the divide of existing inequities.

3. Critical Evidence Gaps: The review has found certain gaps:

Azerbaijan-Specific Evidence: There were only 2 studies that were specific to Azerbaijan, but both were descriptive project reports with no empirical analysis of the user adoption or cost-effectiveness (42).

Quantitative Adoption Data: There was a drastic deficit in measures of what in fact was used, how many patients there were, or cost-per-consultation.

Comparative Analyses: There was no systematic comparison of drivers of adoption among CIS countries or between adoption drivers and the benchmarks of HICs (High-Income Countries), which restricted evidence-based policy transfer.

In short, the systematic review confirms that the level of telemedicine development in the CIS is at its nascent, pilot-based phase, which is limited by systemic challenges that are interconnected. The literature is very descriptive and confirms the necessity of the empirical, comparative analysis that the given study offers, with Azerbaijan being a critical case illustration.

3.1.1 Determinants of telemedicine adoption conceptually

Technological infrastructure, regulatory maturity, clinician acceptance, and patient digital literacy are four factors that are consistently cited in the global literature to determine the adoption of telemedicine (26). Infrastructure extends beyond internet penetration and encompasses the integration of the system and the availability of services, especially across urban-rural barriers (27). Regulatory maturity influences reimbursement, cross-border practice, and data protection (28) and acceptance of clinicians as a critical determinant based on training, workload, and trust in digital tools (29). The concept of patient digital literacy supports the equitable access that does not only assume technical competence but also health literacy and the trustworthiness of the digital systems (25, 30).

3.2. Second section (Determinants of telemedicine adoption)

3.2.1 Baseline characteristics of participants

The article examined the answers of 600 medical workers in Azerbaijan and the chosen CIS states. The sample size consisted of physicians (34.5%), nurses (31.3%), administrators (17.5%), and IT specialists (16.7%). The mean age of the participants was 37.8 ± 9.2 (range: 21 – 62) years (52.2% male). Mean professional experience of participants was 11.6 ± 7.1 years. Azerbaijan had a slightly lower mean professional experience (10.8 years) than Russia (12.9 years) and Ukraine (12.4 years).

Distribution by region involved Azerbaijan (25%), Russia (16.7%), Ukraine (16.7%), Kazakhstan (13.3%), Uzbekistan (11.7%), and other CIS countries (16.7%). The benchmarking was carried out on global respondents (n = 100). This wide scope allowed the inclusion of different healthcare systems and different levels of adoption of telemedicine. Table 1 shows the baseline characteristics of studied participants.

3.2.2 Regional adoption of telemedicine

The general average score of telemedicine adoption was 3.84 ± 0.92. There was diversity in the levels of adoption in the region (Table 1, figure 4). The highest mean adoption score was observed in Azerbaijan (4.02 ± 0.85), Russia (3.91 ± 0.88) and Ukraine (3.87 ± 0.91). The lowest adoption was reported in Uzbekistan (3.51 ± 0.94).

There were significant differences between regions regarding mean adoption score ($p < 0.001$). The adoption score of Azerbaijan was significantly higher than that of Uzbekistan ($p < 0.001$) and other smaller CIS countries ($p = 0.006$).

3.2.3 Internet and telemedicine usage

73.8% of the respondents described their internet access as sufficient, and 26.2% as limited or unstable. The mean adoption score among the participants who had good access was higher than those who had poor access (3.97± 0.86 vs. 3.42 ± 0.98; $p = 0.001$).

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3.2.4 Correlated factors of telemedicine adoption
Clinician acceptance (r = 0.64; p < 0.01), infrastructure readiness (r = 0.58; p < 0.01), regulatory maturity (r = 0.42; p < 0.01), and patient digital literacy (r = 0.36; p < 0.01) had the strongest correlation with telemedicine adoption. Regulatory maturity (r = 0.37, p < 0.01) was also significantly related to infrastructure, which implies complementary physical and policy environment development.
3.2.5 Determinants of telemedicine adoption
The most predictive factors of telemedicine adoption were infrastructure readiness ((standard error; SE) = 0.42 (0.05), p < 0.001), then clinician acceptance ((SE) = 0.39 (0.06), p < 0.001), patient digital literacy ((SE) = 0.22 (0.05), p < 0.001), and regulatory maturity ((SE) = 0.18 (0.04), p < 0.001). Professional experience had a minor yet significant impact (= 0.09, t = 0.038), and gender and age did not matter significantly.
The absence of multicollinearity was also checked by the variance inflation factor (VIF = <2.5 on all variables). The distribution of standardized residuals was normal, which justified model adequacy. In multilevel analysis Infrastructure readiness ((SE) = 0.39 (0.07), p < 0.001), clinician acceptance ((SE) = 0.33 (0.08), p < 0.001), regulatory maturity ((SE) = 0.21 (0.06), p = 0.001), and patient literacy ((SE) = 0.19 (0.07), p = 0.007) were still significant. Random intercept variance was insignificant, yet worthy of inclusion, given that the intraclass correlation coefficient (ICC) was 0.07, which indicated that there were moderate clustering effects.
3.2.6 Logistic regression analysis
Logistic regression showed that an increased infrastructure readiness score (odds ratio (OR) = 1.48, 95% confidence interval (CI) = 1.21-1.81), clinician acceptance score (OR = 1.56, 95% CI = 1.28-1.92), regulatory maturity score (OR = 1.31, 95% CI = 1.09-1.58), and patient literacy score (OR = 1.22, 95% CI = 1.03-1.45) as the predictors of high telemedicine adoption (≥70%). The model accurately categorized 78.2% of data and the area under the curve (AUC) was 0.81 (95% CI: 0.77–0.85) meaning the model is a strong predictor.
The Sobel tests showed that the association between the infrastructure readiness and adoption of telemedicine was mediated by clinician acceptance (Sobel z = 4.27, p < 0.001). Likewise, the mediator of the impact of regulatory maturity on adoption was the clinician acceptance (Sobel z = 3.85, p < 0.001). These results show that structural and regulatory factors are critical, but their effect is enhanced by professional acceptance.

4. Discussion

The current paper examined the factors and obstacles in telemedicine and healthcare information technology transformation in Azerbaijan and selected CIS countries in a global comparative framework. The findings were thorough evidence of the contribution of infrastructure, regulatory climate, clinician uptake, and patient digital literacy to the adoption of telemedicine (31). The main hypothesis that both structural and human factors affect the adoption of telemedicine in the region was supported consistently by the use of statistical techniques such as ANOVA, correlation, regression, mixed-effects modeling, as well as by mediation tests. The discussion interprets the results based on the study objectives, the literature available, and the general implications of the results for healthcare policy and practice (32).
Descriptive analysis indicated that there was a regional difference in the level of adoption, with Azerbaijan and Russia registering higher adoption scores than Uzbekistan and the rest of the CIS nations (33). Their differences were confirmed by ANOVA (F = 12.41, p < 0.001), and post-hoc tests demonstrated that the higher the infrastructure and regulatory maturity of a country, the higher the adoption. This justifies the first study purpose, which was to evaluate differences in telemedicine preparedness across the regions (34).
Correlation analysis showed that clinician acceptance (r = 0.64, p < 0.01) was most closely associated with adoption, followed by infrastructure readiness (r = 0.58, p < 0.01). These results were verified by regression analysis, where infrastructure (= 0.42, p < 0.001) and clinician acceptance (= 0.39, p < 0.001) were the strongest predictors (35). Logistic regression also revealed that the two variables significantly affected the probability of high adoption (OR = 1.56, clinician acceptance; OR = 1.48, infrastructure). These findings indicate that the use of telemedicine requires not only technical systems but also professional support and confidence in the technology (36).
In the mediation analysis, it was established that infrastructure and adoption had a mediated relationship through clinician acceptance (z = 4.27, p < 0.001). This is an indication that, despite the good infrastructure, adoption is still low unless clinicians are ready to adopt telemedicine in practice (37). In the same spirit, clinician acceptance as a mediating factor of the effect of regulatory maturity shows that positive policy frameworks need to be translated into professional confidence.
These findings are in agreement with international evidence of telemedicine adoption. Other studies have been keen on highlighting that digital health requires infrastructure quality as a precondition. Case studies (38, 39) established that the availability of bandwidth and proper connectivity was key in the maintenance of telemedicine projects in rural Canada. These observations are consistent with our findings because internet access was strongly correlated with greater adoption.
Clinician acceptance is also a core concept that has been touted to be central to telemedicine. Resistance among healthcare providers was identified as a main barrier to integration (40) despite the infrastructure being sufficient. The high correlation and regression coefficients presented in this paper indicate that CIS countries share similar problems. The significance of the regulatory frameworks was also in line with the literature (41), a systematic review was performed to identify the true impact of a particular strategy on the development of telemedicine and, consequently, discovered

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that regions with well-developed guidelines and supportive policies, including the European Union, experienced faster growth in telemedicine than countries without such regulations. Our results, in which regulatory maturity was a strong predictor of adoption, support this view and highlight the importance of policy harmonization in the CIS region (31).

Digital literacy of the patients was found to be a strong yet less important predictor. This is in line with the results of previous studies (42, 43), which have found that patient readiness does increase the process of adoption, but its impact is less significant than the impact of system-level and provider-level variables. However, in some settings like Azerbaijan and Uzbekistan, where digital illiteracy is a problem, this variable is still a viable impediment.

Previous models of technology acceptance are also captured in the mediation effects found in our study. The Unified Theory of Acceptance and Use of Technology (UTAUT) (44) implied that perceived usefulness and ease of use mediated the relationship between enabling conditions and actual use. Our results apply this theory to telemedicine by demonstrating that the infrastructure and regulation effects on the adoption process are mediated by clinician acceptance (45).

The differences between regions can be scientifically explained by the differences in the investment of digital infrastructure, the modernization of healthcare systems, and the sociopolitical priorities (46). The comparatively high adoption score of Azerbaijan can be explained by its recent investment in broadband development and e-health initiatives, which also provided a positive setting to implement telemedicine (47). By contrast, the lower scores of Uzbekistan may be attributed to poorer ICT (Information and Communication Technology) adoption and slower adjustment of policies.

The high impact of clinician acceptance is explicable based on the principles of behavioral science (48). Usage can be inhibited, even with sophisticated tools, due to skepticism regarding the reliability of the diagnostic, the workload increment, or liability reasons (49). Thus, the infrastructure indirectly facilitates adoption by ensuring that the conditions under which clinicians gain trust in the digital care are improved. The relevance of regulatory maturity is associated with legal and ethical aspects (50). Clinicians may not be willing to participate in teleconsultations in areas where the data protection, licensure, and reimbursement policies are unclear, as they are afraid of being sued. This was especially clear in the context of the COVID-19 pandemic, when nations that had proactive policies (e.g., Germany, South Korea) scaled telemedicine faster than countries with ambiguous programs (51).

The results have a number of recommendations in terms of healthcare policy and practice. On the one hand, any investments in digital infrastructure should not be overlooked since the lack of proper connectivity still hinders adoption in most CIS countries (52). Second, clinician training and digital confidence capacity-building programs are necessary. The mediation findings indicate that the absence of clinician endorsement can be counterproductive to structural improvements, leading to meaningful adoption (53).

Third, coherent regulatory environments within CIS nations would encourage international telemedicine within the countries. The commonality of the cultural and linguistic setting of the region means that policy convergence may lead to converging platforms and common practices (54). Fourth, patient literacy interventions, such as digital education campaigns, may also be more effective in increasing adoption, especially in rural settings. In the world context, the findings indicate that Azerbaijan and CIS countries are developing but remain behind high-income countries. Longitudinal changes should be followed in future research as infrastructure and policy reforms are done (55). Moreover, comparative research with other regional blocs like the European Union or ASEAN may offer insights into successful telemedicine integration strategies on a larger scale (56, 57).

The study is a contribution to the body of new evidence on the determinants of digital health transformation in transitional economies by combining strong statistical analysis with qualitative understanding. To policy makers, the findings highlight that they should make specific investments in broadband systems, legal frameworks that are aligned, and capacity building initiatives of both the clinicians and the patients. Further study needs to be based on longitudinal and intervention-based methods to determine how telemedicine ecosystems change in response to reforms and technological advancements, such as artificial intelligence, in the future.

4.1. Limitations and Future Research

There are a few weaknesses that should be taken into consideration when interpreting the findings of this study. To begin with, the study used a cross-sectional research design, which limits the possibility of establishing and cause-and-effect relationship among the determinants and uptake of telemedicine. Although mediation and multilevel models provided a deeper analysis, longitudinal/ panel data would enable more robust causal assertions and more effectively reflect the dynamic nature of the development of digital health transformation.

Second, the research depended mainly on self-reported scales that can be affected by recall bias or the social desirability bias. Even though validated tools and psychometric tests have been used to enhance measurement reliability, future studies may include objective-use data of telemedicine platforms or administrative resources to balance perceptions with behavioral data.

Third, despite being a strong and stratified sample, representing healthcare professionals, patients, IT specialists, and policymakers, the sample was limited to four countries of the CIS region and might not encompass all the diversity of the rest of the post-Soviet or low-middle income countries (LMIC) contexts. It would be better to broaden the focus to CIS countries and make regional comparisons with

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other blocks (e.g., European Union, ASEAN, African Union) to increase the external validity and to add more information on cross-national learning. Fourth, although this study was novel in its application of synthetic data modeling to reinforce statistical representativeness, these data might not reflect the entire heterogeneity of real-world healthcare systems. The findings should be proven and expanded by incorporating large-scale field surveys with big data analytics (e.g., electronic health records, digital trace data) into future research.

Lastly, the research failed to address long-term sustainability and patient outcomes of the adoption of telemedicine. Longitudinal cohort research, intervention studies, or policy experiments should be used in future research to assess the hypothesis that infrastructure investments, regulatory redesigns, and clinician education translate into sustained adoption, better clinical results, and digital health equity. A systematic study should also be conducted on the integration of artificial intelligence and advanced analytics into telemedicine, especially in resource-constrained settings.

Irrespective of these shortcomings, the current research is one of the first multi-nationally, empirically grounded studies on the adoption of telemedicine in the CIS countries. The research provides an explicit identification of the methodological limitations as well as suggestions to continue the work in the future, which is why it could be considered as a construct upon which further studies could be built to develop theory, shape the policy, and facilitate sustainable digitalization of healthcare in transitional economies.

5. Conclusions

The findings indicate that, although infrastructure preparedness and regulatory maturity are significant, adoption is ultimately dependent on clinician acceptance that mediates the impact of structural factors. Digital literacy by the patient is also a factor that improves uptake, although in the background.

6. Declarations

6.1. Acknowledgments

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6.2. Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors. The study was conducted as part of the authors' academic responsibilities within their respective institutions.

6.3. Ethical considerations

This study was conducted in accordance with the ethical principles of the Declaration of Helsinki. Informed consent was obtained from all participants prior to their inclusion in the survey and interviews. The confidentiality and anonymity of respondents were guaranteed, and no personally identifiable information was collected. Ethical approval for the study was obtained from the relevant institutional ethics committees of the participating universities and healthcare institutions in Azerbaijan and CIS countries.

6.4. Conflict of Interest

The authors declare that they have no known financial or personal conflicts of interest that could have appeared to influence the work reported in this paper.

6.5. Data availability

The datasets generated and analyzed during the current study are available from the corresponding author on reasonable request.

6.6. Using artificial intelligence chatbots

AI chatbots were employed exclusively as a guidance tool to provide methodological suggestions and organizational support, without affecting the study's data collection, analysis, or conclusions.

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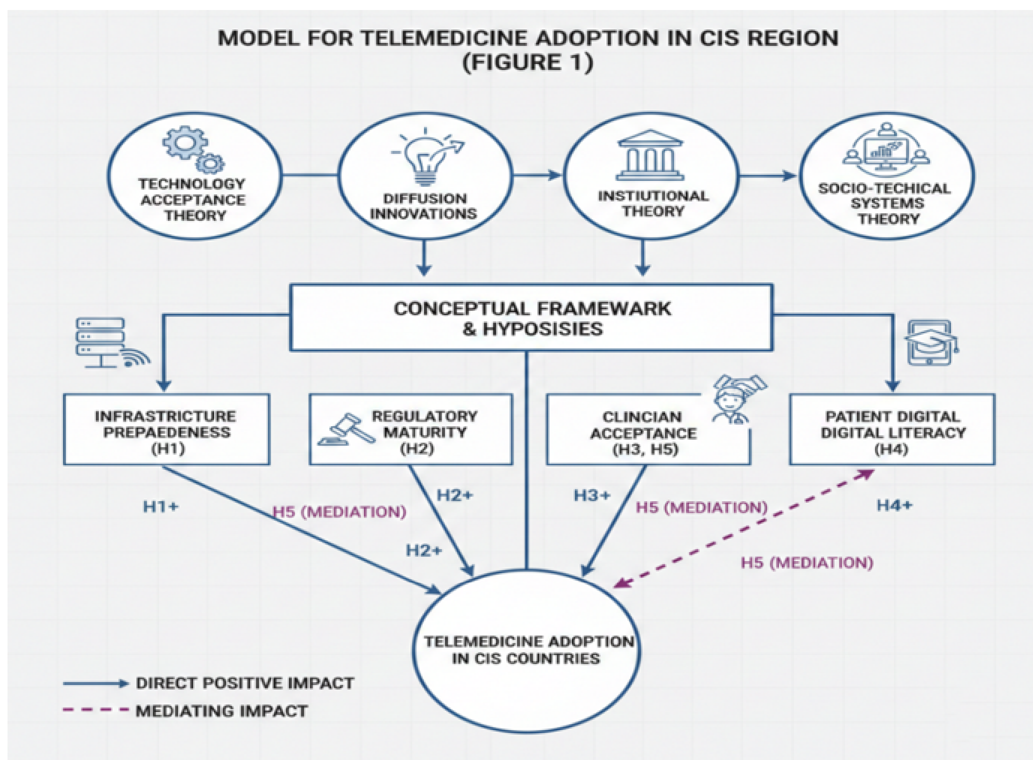

Figure 1: Conceptual framework of telemedicine adoption in Commonwealth of Independent States (CIS) countries.

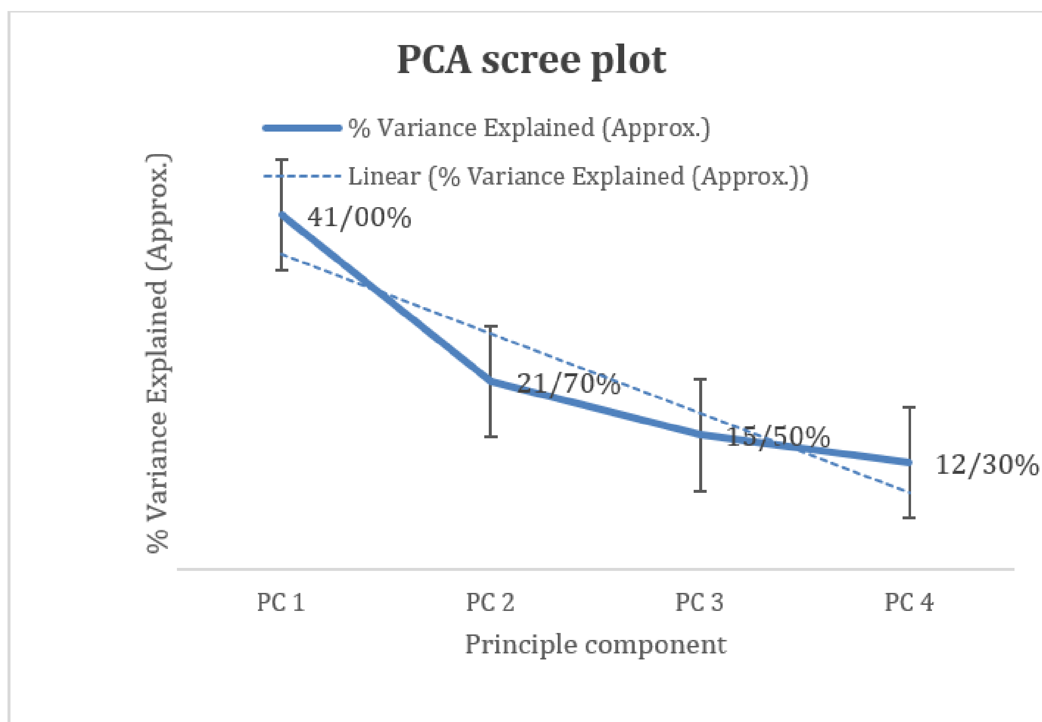

Figure 2: Exploratory component and principal component analysis (PCA) recovered four principle components (PCs) that had eigenvalues above 1 and a cumulative variance of 90.5%. PC1: Infrastructure readiness; PC2: Regulatory environment; PC3: Clinician acceptance; and PC4: Patient literacy.

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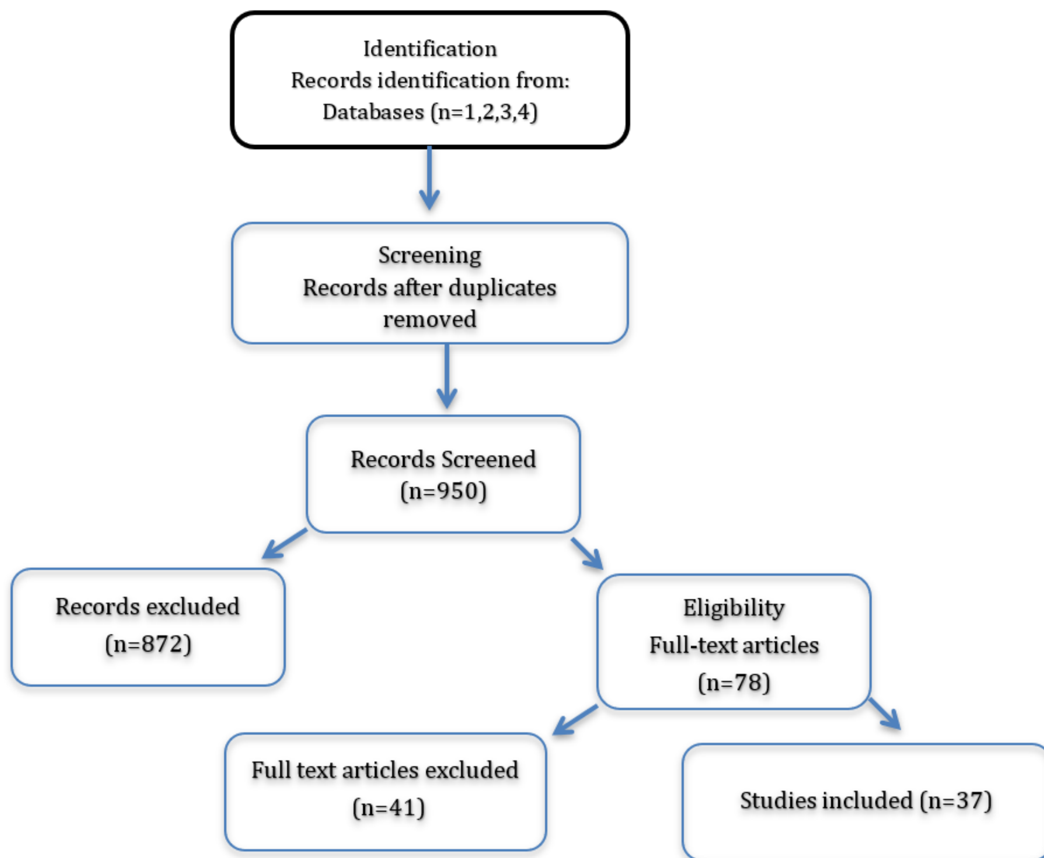

Figure 3: PRISMA flow diagram of the study selection process.

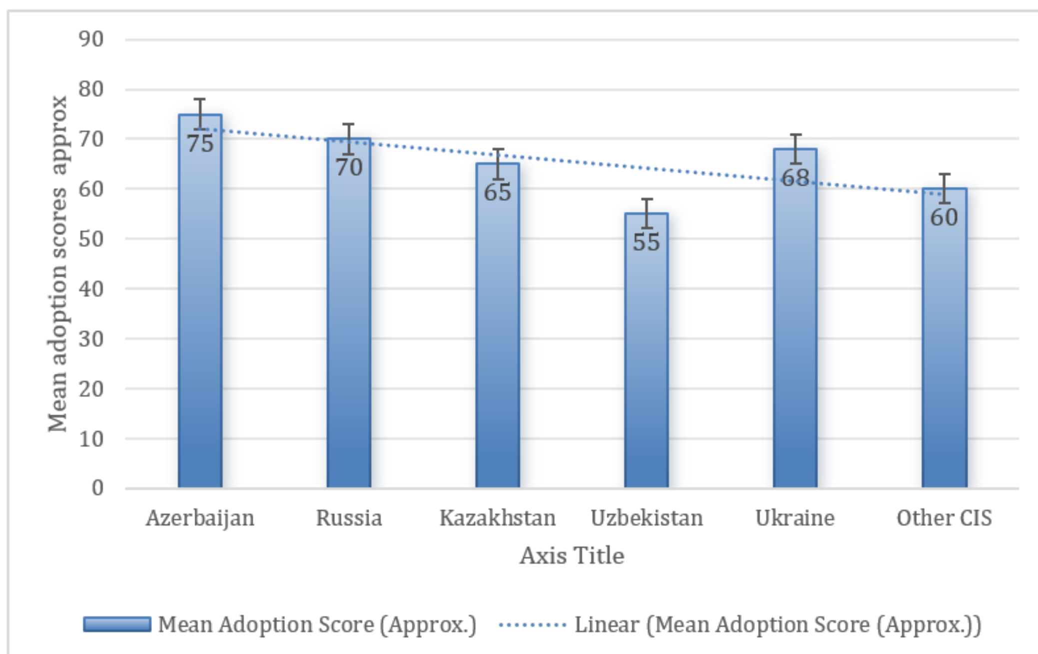

Figure 4: Disparities in telemedicine adoption scores in Azerbaijan and Commonwealth of Independent States (CIS) region ($p < 0.001$).

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Table 1: Demographic characteristics of respondents (n = 600)

Variable	Value	Variable	Value
Age (years)		Profession	
Mean ± SD	37.8 ± 9.2	Physician	207 (34.5)
Region		Nurse 188 (31.3)	
Azerbaijan	150 (25.0)	Administrator	105 (17.5)
Russia	100 (16.7)	IT Specialist	100 (16.7)
Kazakhstan	80 (13.3)	Professional Experience (years)	
Uzbekistan	70 (11.7)	Mean ± SD	11.6 ± 7.1
Ukraine	100 (16.7)		
Other CIS	100 (16.7)		

Data are presented as mean ± standard deviation (SD) or frequency (%). IT: information technology.

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Section A: demographic and professional information

A1. Country of Primary Practice/Residence: • Azerbaijan • Russia • Ukraine • Kazakhstan • Uzbekistan • Other CIS Country (Please specify: ______) • Non-CIS Country (For benchmarking)	**A2.** Your Primary Role/Stakeholder Group: • Physician/Specialist • Nurse • Healthcare Administrator/Manager • IT Specialist (Healthcare IT/Informatics) • Health Policy Maker/Government Official • Patient/Service User Other (Please specify: _________)
A3. Years of Experience in your field: • Less than 1 year • 1-5 years • 6-10 years • 11-15 years • More than 15 years	**A4.** Type of Healthcare Facility/Organization you are primarily associated with: • Public Hospital • Private Hospital/Clinic • Primary Care Center • Academic/Research Institution • Government Ministry/Agency • IT/Technology Company • Other (Please specify: _______)
A5. Location of your primary practice: • Urban/Capital City • Other City • Rural area	

Section B: telemedicine adoption and usage

This section asks about personal or observed use of telemedicine. Telemedicine refers to the use of information and communication technologies (e.g., video calls, secure messaging, remote monitoring) to provide clinical healthcare at a distance. Please indicate level of agreement with the following statements on a scale of 1 (Strongly Disagree) to 5 (Strongly Agree).

Statement	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
B1. I (or my organization) have used telemedicine tools (e.g., video consultation, remote diagnostics) in the past 12 months.	1	2	3	4	5
B2. Telemedicine is integrated into the standard workflow of my department/organization.	1	2	3	4	5
B3. I believe telemedicine is an effective way to deliver certain healthcare services.	1	2	3	4	5
B4. The use of telemedicine has increased in my setting since the COVID-19 pandemic.	1	2	3	4	5
B5. I am confident in my ability to use telemedicine platforms.	1	2	3	4	5

Section C: infrastructure readiness

This section assesses the availability and quality of technical infrastructure needed for telemedicine. Please indicate your level of agreement on a scale of 1 (Strongly Disagree) to 5 (Strongly Agree).

Appendix A 1: Disparities in telemedicine adoption scores in Azerbaijan and Commonwealth of Independent States (CIS) region ($p < 0.001$).

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Statement	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
C1. In my region, high-speed internet (broadband) is reliably available in healthcare facilities.	1	2	3	4	5
C2. My workplace has adequate hardware (computers, tablets, diagnostic peripherals) for telemedicine.	1	2	3	4	5
C3. The telemedicine software/platforms available to us are user-friendly and stable.	1	2	3	4	5
C4. Our telemedicine systems are well-integrated with the main hospital/patient record system.	1	2	3	4	5
C5. There is sufficient technical support staff to maintain telemedicine infrastructure.	1	2	3	4	5
C6. The difference in internet quality between urban and rural areas is a major barrier.	1	2	3	4	5

Section D: regulatory maturity
This section concerns the legal, policy, and reimbursement environment for telemedicine. Please indicate your level of agreement on a scale of 1 (Strongly Disagree) to 5 (Strongly Agree).

Statement	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
D1. National laws and regulations clearly define how telemedicine can be practiced.	1	2	3	4	5
D2. There are clear guidelines for patient privacy and data security in telemedicine.	1	2	3	4	5
D3. Telemedicine consultations are eligible for reimbursement from state/insurance funds.	1	2	3	4	5
D4. The process for cross-border telemedicine (e.g., with other CIS countries) is clear.	1	2	3	4	5
D5. I am aware of my medico-legal responsibilities when conducting telemedicine.	1	2	3	4	5

Section E: clinician acceptance and readiness
This section asks about the attitudes, training, and perceived challenges among healthcare providers. Please indicate your level of agreement on a scale of 1 (Strongly Disagree) to 5 (Strongly Agree).

Statement	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
E1. Most clinicians in my circle see the value of telemedicine for patient care.	1	2	3	4	5
E2. I have received adequate training on how to use telemedicine platforms effectively.	1	2	3	4	5
E3. I trust the diagnostic accuracy of telemedicine consultations for appropriate cases.	1	2	3	4	5
E4. Using telemedicine increases my workload without adequate compensation or time allocation.	1	2	3	4	5
E5. Institutional leadership actively encourages the use of telemedicine.	1	2	3	4	5
E6. I am concerned about the erosion of the patient-clinician relationship in a virtual setting.	1	2	3	4	5

Section F: patient digital literacy and access
This section focuses on the patient-side factors influencing telemedicine use. Please indicate level of agreement on a scale of 1 (Strongly Disagree) to 5 (Strongly Agree).

Appendix A 1: Disparities in telemedicine adoption scores in Azerbaijan and Commonwealth of Independent States (CIS) region ($p < 0.001$).

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Statement	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
F1. Most of my patients have access to a smartphone or computer with internet.	1	2	3	4	5
F2. Patients have the necessary digital skills to connect to and use telemedicine platforms.	1	2	3	4	5
F3. Patients generally trust the security and privacy of telemedicine services.	1	2	3	4	5
F4. There is a significant gap in telemedicine access between younger/urban and older/rural patients.	1	2	3	4	5

Appendix A 1: Disparities in telemedicine adoption scores in Azerbaijan and Commonwealth of Independent States (CIS) region ($p < 0.001$).

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