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Protocol of digital decision support system (DDSS) embedded within a tele-primary healthcare platform in Pakistan: an assessment of usability, acceptability, effectiveness and perceived quality of care in a resource-constrained setting

Hasan Nawaz Tahir ,[1,2] Shifa Habib,[1] Rawshan Jabeen ,[3] Anny Dhanwani,[1] Samrah Jawed,[1] Lorena Guerrero-Torres,[4] Sara Saeed Khurram,[5,6] Iffat Zafar Aga,[7] Mahek Karim ,[1,5] Abdul Momin Kazi ,[8] Shehla Zaidi [1,9]

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For numbered affiliations see end of article.

Correspondence to
Dr Hasan Nawaz Tahir;
hasan.nawaz@aku.edu

ABSTRACT

Background A digital decision support system in healthcare is a digital health intervention that assists healthcare professionals in decision-making by providing treatment recommendations and enhancing diagnostic accuracy and quality of care. This will be the first study in Pakistan to assess the system's usability, acceptability and effectiveness in improving healthcare outcomes while also evaluating the perceived quality of care. This comprehensive assessment will inform policy development in areas such as the scale-up of digital health interventions, data privacy and technology interoperability. Measures of effectiveness will include changes in clinical outcomes through a patient exit feedback survey. This study aims to evaluate the role of digital decision support systems in healthcare decision-making, which may be integrated into Pakistan's tele-primary healthcare system.

Methods The study will employ a multimethod approach. The data collection tools are adapted from the WHO's digital health intervention monitoring and evaluation framework and include a technology assessment, healthcare provider surveys, patient exit interviews and focus group discussions with healthcare providers. Purposive sampling will be used for qualitative interviews with providers (doctors) and patients. Government stakeholders, private sectors, multilateral, academia and policymakers will be engaged through a consultative meeting. We will also conduct a literature review, as well as a comprehensive analysis of existing studies, documents and data relevant to digital decision support systems and digital health interventions implemented globally, and assess the performance, challenges and opportunities.

Ethics and dissemination The study has been approved by the Ethics Review Committee at The Aga Khan University (2023-8514-26533). The dissemination of study findings through scientific publications and seminars will enable programme managers and policymakers to design tools to improve the quality of care provided through telemedicine platforms. This will contribute to efficient decision-making, access and quality of care for primary healthcare in low-income and middle-income countries. This study will also inform policy regarding the scale-up of decision support systems in primary care settings, data privacy and technology interoperability.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The protocol provides the approach and steps to assessing a digital decision support tool integrated within a large telehealth platform in a resource-constrained setting.
⇒ The novel conceptual framework used to design this study has been adapted from the WHO's digital health classification to highlight the health system's challenges in the context of a low-income and middle-income country.
⇒ The study's outcome will highlight the managers and policymakers to design tools to improve the quality of care provided through telemedicine platforms; however, only one telehealth organisation was involved.

INTRODUCTION

A digital health intervention (DHI) can be defined as the application of digital technologies to improve access, efficiency and quality of healthcare service delivery, strengthening health systems and improving population-level health outcomes.[1] These technologies include mobile health applications, electronic medical records and telemedicine services.[2] The significance of DHIs is especially pronounced in low-income and middle-income countries (LMICs) with weak health systems, high disease burden and poor healthcare indicators, where DHIs

present the potential to revolutionise traditional healthcare delivery models.[3] Telemedicine, a subset of DHIs, uses information and communication technologies to connect populations to healthcare services, bridging the gaps in health access and quality of care for remote and underserved populations.[4] However, significant implementation challenges, such as lack of infrastructure for DHI implementation, including the availability of smartphones, high-speed internet and computer devices, have been cited across literature.[5]

There is a growing body of evidence from LMICs in Asia and Africa that highlights the value of using DHIs and telemedicine platforms in primary care settings.[6] However, the implementation of evidence-based guidelines and the evidence on quality of care still need to be improved in LMICs, resulting in variations in patient-level outcomes.[7] At the policy level, while there are explicit digital health policies for many LMICs, these often need to be more focused on quality of care.[8] Evidence from the literature shows that the implementation of a digital decision support system (DDSS) can improve the implementation of standardised clinical guidelines; reduce clinical variations, duplications and errors; and improve clinical decision-making.[9] DDSS may also support other healthcare operations, such as supply chain, human resource management and organisational planning.[10]

Pakistan is an LMIC with the fifth largest population globally[11] and a Gross Domestic Product (GDP) per capita of US$1471 in 2023.[12] Pakistan has one of the highest rates of maternal and child mortality among other countries.[13 14] It has a budding Information Technology (IT) sector, with a broad base of technology-based start-ups in all sectors, including health. Health tech, such as *Sehat Kahani*, *doctHERS* and *Tibbi*, are digitising health service delivery by connecting health providers to communities through telemedicine platforms and DDSS.[15 16] Recent times have seen a proliferation of donor-funded DHIs; however, quality of service delivery through tech platforms remains insufficiently addressed.[15] Despite the evidence base supporting DDSS as an intervention for telehealth providers' users, there needs to be more evidence of its feasibility, usability, acceptability and effectiveness in improving the quality of care in a resource-constrained setting.

The proposed study will be the first in Pakistan to evaluate the effectiveness of a DDSS embedded within a large tech platform in addressing health system challenges related to quality of care in primary care settings. The evidence generated will enable programme managers and policymakers to design tools to improve the quality of care provided through these tech platforms. Our study will outline contextually appropriate strategies to optimise the effectiveness of DDSS in resource-constrained settings.

Other healthcare providers can use the recommendations from the study in LMIC settings to improve the quality of care, access, user-friendliness, interoperability and data security. The study will also inform policy development, focusing on decision support systems, data privacy and technology interoperability. Other e-health providers can use the recommendations appearing from the study.

Study aim

The study aims to assess the effectiveness of a DDSS embedded within a large telehealth platform in providing patient-centric care in a low-resource setting within the province of Sindh in Pakistan.

Objectives

- To determine the perceived feasibility, usability and acceptability of DDSS among primary healthcare (PHC) managers of Sehat Kahani's telehealth platform in Sindh, Pakistan.
- To ascertain the perceived quality of care for users of the telehealth platform supported by DDSS relative to non-users in Sindh, Pakistan.
- To make recommendations to enhance the overall effectiveness and robustness of the system, with a focus on strengthening its components and processes.

Conceptual framework

We applied the WHO's digital health classification (2.0) and WHO's DHI to our current study to identify the health system challenges addressed by the DHI under review (refer to table 1).

The conceptual framework for the study has been adapted from the WHO's tool for monitoring and evaluation of DHIs and the technology acceptance model (TAM).[17] The TAM, initiated from the domain of social science and psychology, is frequently used to understand and analyse the perspective of users in terms of behavioural intention. It has been used in many studies to understand the acceptance of new technology.[16 17] The perceived usefulness of technology is defined as the extent to which the performance of an individual improves as a result of using the technology. Likewise, the perceived ease of use highlights the extent of a user's belief of how much effort they must make to adopt that technology. The study will explore the perceptions of PHC managers of a telehealth platform with DDSS and the perceived quality of services provided by PHC managers, and measure the perceived quality of care and equity for telehealth platform users in improving care quality (figure 1).

METHODOLOGY

Study design

A mixed-method study design will be employed to achieve the stated study objective.

Study participants

The study sites were purposively selected and include 10 Sehat Kahani's electronic clinics (e-clinics) located in lower-income urban slums of Karachi and Interior Sindh, including Bilawal Goth Clinic, Labour Square Clinic and Korangi Zia Colony Clinic in Karachi, and Giddu Chowk

Table 1 WHO's digital health classification (2.0)

Health system challenge: need or problem to be addressed	DHI: digital functionality for addressing the health system challenges	Service and application types: digital system or service that delivers one or more of the DHI
Quality: 3.1: poor experience of health service users. 3.7: poor adherence to evidence-based standards, guidelines and protocols.	Healthcare provider decision support: 2.3.1: provide prompts and alerts according to protocol. 2.3.2: provide checklist according to protocol.	A3: decision support systems: 'Computer-based tools that combine medical information databases and algorithms with patient-specific data. They are intended to provide healthcare professionals and/or users with recommendations for diagnosis, prognosis, monitoring, and treatment of individual patients'.
Efficiency: 6.6: burden of manual processes.	Telemedicine: 2.4.1: consultations between remote health service users and healthcare provider. 2.4.2: remote monitoring of health service user's health or diagnostic data by provider. 2.4.3: transmission of medical data (eg, images, notes and videos) to the healthcare provider.	

DHI, digital health intervention.

Clinic, Al Shifa Clinic, Nasarpur Clinic, Jhan Mori Clinic, Tando Hyder Clinic, Moro Clinic and Larkana Clinic in Interior Sindh.

Sehat Kahani is an award-winning digital healthcare start-up that operates 65 e-clinics in low-income communities in Pakistan[18 19] and provided 3.1 million direct consultations from July 2017 to August 2023. These clinics are equipped with computers, video conferencing equipment and medical supplies. Patients access the e-clinics via the Sehat Kahani web and mobile or by visiting in person. They currently provide diagnosis protocols for febrile illnesses, where trained healthcare providers serve as intermediaries conducting needs assessments before connecting patients to qualified doctors through video consultations. The services menu includes PHC with specialised services, encompassing but not limited to maternal and child health, mental health and referrals to tertiary care facilities. The platform's telemedicine clinics have reduced the need for long-distance travel to receive healthcare.[20]

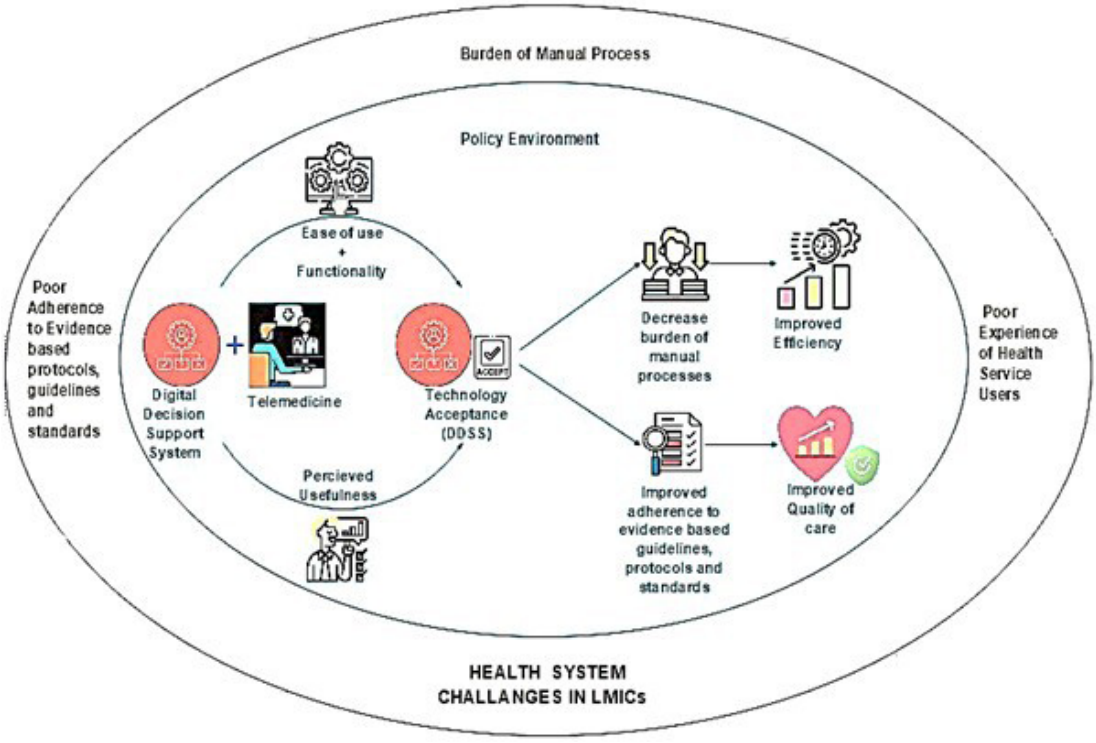

Figure 1 Conceptual framework for the study adapted from the WHO's tool for monitoring and evaluation of digital health interventions and the technology acceptance model. DDSS, digital decision support system; LMICs, low-income and middle-income countries.

Sehat Kahani's telehealth platform uses 'doctor brides' (which means doctors and housewives) to work remotely from home using digital technology to provide healthcare services and consultations to patients.[18] Sehat Kahani uses Microsoft's Azure cloud platform to store and analyse patient information, aligning with Microsoft's objective of empowering individuals and organisations through purpose-driven innovation. For instance, Microsoft cloud and artificial intelligence (AI) have been considered 'crucial for comparing healthcare demographics'.[21] In primary care settings, the DDSS pilot phase employs algorithms designed for quick detection of five febrile diseases: pneumonia, typhoid, malaria, dengue and urinary tract infection. These algorithms use patient data, symptoms and epidemiological information to aid in early detection and intervention. By incorporating advanced analytics, PHC professionals can rapidly identify incidents, allowing for prompt measures to prevent the spread of infectious diseases and improve patient outcomes. DDSS is a computer-based system that provides recommendations and ideas to healthcare providers based on patient data and different health information inputs,[22] and the DDSS uses a machine learning algorithm, that is, a decision tree, for diagnosing patients of five febrile diseases. The algorithm has been built using Python programming language and its scikit-learn library.[23 24] The Sehat Kahani DDSS is an innovative machine learning program that is connected with the electronic medical records system. The DDSS is designed to improve clinical decision-making by using disease protocols and algorithms to aid healthcare providers at various phases, such as diagnosis, treatment planning and continuous monitoring. The DDSS uses random forest technique, which is a type of machine learning algorithm. We used treatment protocol guidelines from the National Health Service (NHS) to build algorithm, for example, pneumonia,[25] typhoid,[26] malaria,[27] dengue[28] and urinary tract infections.[29] The initial algorithm training and testing followed a 70:30 ratio. The algorithm was trained using data of 1400 individuals and tested using data of 600 individuals. Model validation showed a sensitivity for febrile disease diagnosis of 0.87 and a specificity of 0.91. The Receiver Operating Characteristic (ROC) curve indicated following result: Area Under Curve (AUC) of 0.93 and the F1 score of 0.89. The system sends medic alerts on five febrile diseases—pneumonia, typhoid, malaria, dengue and urinary tract infections—as well as methods for managing these conditions.

Study settings

The study sites were purposively selected, which include 10 Sehat Kahani's e-clinics located in lower-income communities of six Karachi and other four districts in Sindh. We used the randomizer.org tool for random selection of intervention and control sites. Out of the total clinics (n=40), we randomly identified five clinics for intervention and five for control. We followed the following process of randomisation:

- The total number of clinic was initially arranged in alphabetical order, then each clinic was assigned a serial number. The serial number was then input into the randomizer.org tool.[30]
- Five random serial numbers were selected first and then the process was repeated to select five more.
- We then checked whether there was any overlap in the serial number of the first and second group. We did not find any overlap in the serial number of the first and second group.
- We assigned the first group of five sites as intervention and the second group of five sites as control.
- Once we identified the five clinics for interventions and five for control, we then developed a plan to implement intervention and control at these sites.

Thus, the intervention sites are Korangi Zia Clinic, Bilawal Goth Clinic, Giddu Chowk Clinic, Tando Hyder Clinic and Larkana Clinic. The control sites include Labour Square, Colony, Al Shifa, Nasarpur, Jhan Mori and Moro, respectively. The chosen study sites play a pivotal role in providing a comprehensive understanding of the effectiveness of the DDSS embedded within Sehat Kahani's telehealth platform and additional clinics in various locations within Interior Sindh, and the study aims to capture the diverse demographic and healthcare landscape of the province. These areas represent distinct populations facing unique health challenges associated with urban poverty, limited infrastructure and geographical remoteness. Additionally, the engagement of government stakeholders within the health department in the province of Sindh provides a crucial link to regional health policies, ensuring that the study's findings align with broader healthcare infrastructure and policy considerations.

Data collection tools

The tools for data collection (quantitative and qualitative) have been developed using the WHO's assessment framework for digital health.[17]

Quantitative assessment

Healthcare provider survey

The healthcare provider survey will assess the DDSS from a health provider's perspective. Data will be collected on various outcome measures shown in box 1[31 32] (refer to online supplemental appendix 1).

Box 1 Domains of perceived usefulness of DDSS

⇒ DDSS utilisation pattern.
⇒ Social influence.
⇒ Facilitating conditions.
⇒ Users' behavioural intentions towards DDSS.
⇒ Users' satisfaction with DDSS.
⇒ Ease of use.
⇒ Accuracy and completeness of disease protocol.

DDSS, digital decision support system.

Sampling strategy and size

We will have non-probability purposive sampling for the healthcare provider survey. The study sample consists of 10 e-clinics, of which 5 teleclinics are included in the intervention group with the DDSS system and 5 teleclinics in the control group, which are randomly selected. The inclusion criteria for the control group are teleclinics that exclusively use telemedicine. In contrast, the intervention group includes teleclinics where the DDSS has been implemented along with telemedicine. Each clinic, irrespective of the group, has 6 healthcare providers, resulting in 60 healthcare providers participating in the study, all of whom will be recruited for the survey and training will be provided. We anticipate response rates from both groups to enhance interpretation of the results. If needed, we will add more Sehat Kahani clinics to fulfil the sample size as a contingency plan. This approach ensures an adequate representation of the provider population and enhances the generalisability of the findings.

Inclusion and exclusion criteria

The inclusion criteria for the control group are teleclinics that exclusively use telemedicine. In contrast, the intervention group includes teleclinics where the DDSS has been implemented along with telemedicine. Healthcare workers who do not work in these sites or do not provide consent will be excluded.

Patient exit survey

The patient exit survey uses a previously developed and validated measurement scale in the Guinea[33] and Nouna districts of Burkina Faso.[34] The final instrument consisted of 27 items assessing perceived quality of care across six domains—quality of healthcare facility infrastructure, promptness of service, quality of healthcare provider conduct, quality of health provider communication, and financial and physical accessibility to care—on a five-level Likert scale ranging from very poor (1) to very good (5) (refer to online supplemental appendix 2). We selected these domains as relevant to DHIs as they impact both health care quality of care and digital technology. (see box 2).[35]

Sampling strategy and size

A non-probability purposive sampling technique will be employed at the end of the consultation to select patients for the patient exit survey, which has been translated into Urdu. The desired sample size for this study is 324 individuals, with patients from each clinic presenting with a complaint of fever. Half of the patients, totalling 162 individuals, are from e-clinics where DDSS is implemented and the other half are from e-clinics where DDSS is not implemented. The sample size determination considered assumptions such as an estimated population size of 100 000 individuals and an anticipated frequency of the outcome factor, in this case, the perceived quality of care, set at 70%. The chosen CI of 95% ensures high statistical precision and reliability.

Box 2 Domains of perceived quality of care

⇒ Perceived quality of healthcare facility infrastructure.
⇒ Perceived promptness of service.
⇒ Perceived quality of healthcare provider conduct.
⇒ Perceived quality of health provider communication.
⇒ Perceived quality of health service delivery.
⇒ Perceived financial and physical accessibility to care.

Inclusion criteria for the patients

The inclusion criteria for this survey are patients who visit the clinic with a new complaint of fever and are 18 years old or older; others will be excluded. This method allows for a deliberate and targeted selection of patients who have been exposed to telemedicine services based on specific criteria relevant to the research objectives.

Quantitative analysis

Data analysis will be performed using STATA V.17 statistical software, with initial descriptive statistics for sociodemographic, facility services and utility of decision support system, followed by inferential statistics for the outcome measure provided above. For instance, the primary endpoints would be feasibility (eg, ease of integration into current processes), acceptance (eg, providers' willingness to stick with the system) and usability (eg, user happiness with interface design). Further, the secondary endpoints would be an enquiry into DDSS-supported telehealth platform users' perceived quality of care being higher than that of non-users. Moreover, exploratory investigations can delve into possible relationships between provider demographics and DDSS usability perceptions, or examine variations in perceived quality of care across telehealth platform users according to patient attributes.

Outcomes for health provider survey

Data on the following outcome measures will be collected through the health provider survey:

- Per cent of PHC managers who have adopted (ie, became users of) the technology.
- Per cent of users who demonstrate proficiency in the use of the digital health system.
- Per cent of users who rate the digital health system as 'easy to use'.
- Per cent of users who rate the digital health system as 'transmits information as intended'.
- Per cent of users who report satisfaction with the content of health information received via the digital health system.
- Per cent of health workers who report adequate knowledge of specific patient management guidelines/protocols.
- Per cent of care standards relating to intervention X observed to be met using the DHI during a client–provider consultation.
- Per cent of providers observed to be using DHI during their patient consultations.

- Number of clients (average or total) attended by a health worker using the digital health system over the reference period.
- Whether all workers are similarly providing length, content and quality services (observation: checklist).

Client exit interviews

Data on the following outcome measures will be collected through client exit interviews:

- Per cent of clients satisfied with the quality of service.
- Per cent of clients satisfied with the waiting times before seeing the doctor.
- Per cent of clients satisfied with the time given by the doctor to see them.
- Per cent of clients satisfied with the medicines prescribed, including counselling on side effects.
- Per cent of clients satisfied with the cost of services.

χ^2 will be applied to compare categorical variables and t-test will be used to assess the mean scores for user acceptance, improvement in quality of perceived care and DDSS ease of use. Multivariate linear regression analysis will assess the impact of the decision support system on improving the quality of perceived care while adjusting for confounding variables such as education status, sex, language barrier, socioeconomic status and unknown confounders.

Qualitative assessment

Consultative meeting with stakeholders

We will engage stakeholders, including government health policymakers, private sector providers, health system experts and academics, in a consultative meeting to understand the health system barriers and facilitators for the implementation of decision support systems at public and private sector PHC facilities, as a broader solution for the identified health system challenges. The policymakers were preidentified by the research team through stakeholder mapping, a strategic tool for assessing and selecting stakeholders who can be involved in the project, initiative or decision-making process. We will also discuss the policy environment for implementing DHIs, including DDSS, in the public and private sectors, including data privacy and interoperability issues. It is a separate activity. A total of 35–40 stakeholders will be engaged by using purposive sampling techniques during this consultation, and during these sessions consent will be taken and data saved by using recorders (online supplemental appendix 3).

Indepth interviews with health policymakers

Indepth interviews will also be conducted with government policymakers to understand the needs of government essential health units/PHC centres for implementing DDSS and political commitments (online supplemental appendix 3).

Inclusion and exclusion criteria

The criteria for policymakers include expertise, decision-making authority, diverse perspectives and relevant experience in planning and development in the public sector. However, those who do not consent to participate or are unaware of the DDSS system will be excluded.

Sample size and strategy

The study will employ purposive and snowball sampling techniques to select participants who exhibit diversity in terms of age, sex and profession belonging to the government sector. The sample size is expected to be 15–20 participants based on the principle of data saturation. This entails continuing data collection until no new information or themes emerge from the data.

Focus group discussions with telemedicine service providers

Focus group discussions (FGDs) will be conducted with service providers of Sehat Kahani who have used the decision support system. They will select a purposive sampling technique from the Sehat Kahani teleconsultation clinics and understand their perceptions and barriers about service providers. The indepth interviews will be conducted with PHC managers, one per facility of Sehat Kahani (online supplemental appendix 4).

Sample size and strategy

A purposive sampling technique will be employed to select healthcare providers. This strategy will allow the selection of participants with direct experience and knowledge of using DDSS Sehat Kahani's e-clinics. There will be three FGDs, with 6–10 healthcare providers in each FGD.

Inclusion criteria

- Doctors in patient management and care affiliated with the decision support system.

Exclusion criteria

- Those who have joined for less than 3 months and are not directly involved in patient management and care.
- Doctors who do not give consent for an interview.

Qualitative analysis

The analysis plan will employ an exploratory approach using inductive data analysis. Transcripts of the interviews and discussions will first be coded, followed by generation of novel themes using coding criteria. These themes will be transformed into narratives, and the relationships between them will be analysed to gain an exploratory understanding of factors for the use and uptake of decision support systems. The analysis will be conducted systematically, ensuring accuracy and consistency. The findings will be validated and the process will be documented for transparency. The outcomes will be reported, summarising key themes and providing supporting evidence. The analysis will be performed using the NVivo software.

Technical assessment of DDSS

The research team, including AI and machine learning experts, will specifically assess the performance and stability of the software (ie, free of software bugs), user

interface design, legal compliance around restricted content and intellectual property, and prevention of deception. Sehat Kahani provided the platform of telehealth and DDSS as part of the research study. Our research team will review the software and hardware architecture of DDSS and its integration of the medical record. In this regard, we will gather data on software testing and implementation along with piloting and evidence of removal of software bugs. Sehat Kahani teams comprise software engineers, IT staff and operational managers in this evaluation (online supplemental appendix 5). Furthermore, a qualitative interview guide for DDSS for technical review form will be filled out (online supplemental appendix 6). Contingency plans have been developed to address potential variations in response rates to add more clinics.

Patient and public involvement

The study was developed after a detailed online literature search that involved a primary study that took input regarding decision support systems from patients. At the inception of the study idea, we conducted indepth interviews and round table discussions with health entrepreneurs and policymakers along with patient interviews to guide study development. The patients were not involved in recruitment but are involved in the conduct of the study as we performed client exit interviews with them. The results will be disseminated to study participants by conducting a seminar at the end of the study, by publication of study results and by report development as part of the requirement of the granting agency. The burden of intervention will be assessed by the study participants in the client exit interviews (see study teams in online supplemental appendix 7).

ETHICAL CONSIDERATIONS AND DISSEMINATION

This study was approved by the Ethical Review Board at The Aga Khan University. Patients participating in the study from April 2023 to May 2024 will be asked to provide informed written consent (refer to online supplemental appendix 8), which has been translated to Urdu. It will be emphasised that participation is voluntary. Interviews will be conducted in Urdu or the local language by local data collectors, conducted with privacy and while respecting local customs. The interviews will take place to maintain the privacy and confidentiality of the participants. It will be explained that information will be anonymised for confidentiality. Data will be anonymised for entry and analysis. Data will be encrypted and stored per The Aga Khan University's (AKU) Ethics Review Committee (ERC) policy, with anonymised data accessible only to study investigators and available for 7 years under encryption.

DISCUSSION

Telemedicine is a promising DHI aimed at delivering care to patients in flexible settings, potentially improving access to care, increasing patient engagement and reducing healthcare costs.[36] Pakistan as well as other LMICs have witnessed a proliferation of DHIs, including telehealth platforms, using the DDSS.[37] However, knowledge about its effectiveness in addressing health system challenges is needed. This is the first study in Pakistan that aims to evaluate the effectiveness of a DDSS embedded within a large tech platform such as Sehat Kahani in primary care settings. Our study will reveal how DDSS is positioned and creates change in a resource-constrained setting and will highlight its strengths and weaknesses in relation to the intended outcomes. Additionally, the study aims to ascertain the perceived quality of care and equity for users of the Sehat Kahani telehealth platform using DDSS, assess the needs and priorities of the health systems, and recommend strategies to optimise the effectiveness of DDSS.

Successful implementation of the DDSS within the telehealth platform requires careful consideration of several factors, including the availability and reliability of technology infrastructure, the training and support needs of healthcare providers, and the integration of the DDSS with existing clinical workflows. A careful assessment and optimisation of these factors is needed to ensure the effective and sustainable use of the DDSS within the telehealth platform.

However, the need for more reporting on the implementation and evaluation of DHIs in published literature poses a challenge for both research and practice, hindering the replication and immediate adoption of interventions in resource-constrained settings. Few studies have analysed intervention implementation using a contextually tailored approach,[16 38] which is necessary for successful adoption and replication. This research aims to provide such information to researchers and practitioners, which to our knowledge has yet to be achieved in Pakistan.

A notable strength of our study is its methodological rigour, characterised by the adoption of a multimethod approach with a cross-sectional design, enabling the researchers to collect both quantitative and qualitative data. This approach allows for a more comprehensive understanding of the factors that influence the effectiveness of the DDSS within the telehealth platform, as well as the impact on quality of care and patient satisfaction. Moreover, the cross-sectional design allows us to capture a snapshot of the current state of the telehealth platform, providing valuable insights into the real-time dynamics of its implementation. This temporal dimension is crucial in assessing the sustainability and adaptability of the DDSS within the ever-evolving landscape of digital health.

Strengths and limitations

The study adapts the conceptual framework from the WHO's tool for monitoring and evaluation of DHIs and the TAM to assess the perceived usefulness and ease of use of DDSS. The WHO's tool for monitoring and evaluation of DHIs provides a standardised framework, allowing for consistent data collection and analysis, making it easier to compare results across different interventions and settings. This tool has previously been employed in

other studies.[39 40] In addition, to understand the acceptability of DDSS among the users, our data collection tools will draw from the TAM. This allows for a comprehensive understanding of the factors that influence technology adoption, allowing for addressing facilitators and barriers to its use. The evaluation of DDSS in Pakistan involves challenges such as data quality, infrastructure restrictions and insufficient resources. The decision support system has only been applied to febrile diseases, and comorbidities associated with these diseases need to be explored further. The algorithm was trained on a limited set of individuals; more comprehensive testing will have to be done to enhance the generalisability of the algorithm, taking into account sociodemographic factors at work. The sociocultural backgrounds and ethical considerations add complexity. More studies are needed, especially since this is one of the first studies conducted in Pakistan. It is suggested that DDSS be integrated to a large extent to provide societal benefits beyond hospital settings, including public and private sectors.

The study also has the potential to stir policy dialogue among policymakers in Pakistan towards deploying DDSS to improve the quality of care for rural and underserved communities with gaps in the health workforce. This study hopes to better align the public health and digital technology research agendas and identify common knowledge gaps and intersections where the expertise from these two sectors can complement each other. The proposed work would lay the basis for scale-up grant applications focused on the development and implementation of an AI-based DDSS and the development of metrics for quality-of-care assessment for telemedicine and digital health platforms.

CONCLUSION

The study will provide valuable insights into the use of DHIs in LMICs and identify strategies to optimise the effectiveness of these interventions. The results of the study can be used to inform policy development and implementation and promote the adoption of evidence-based guidelines enabled by DDSS for patient management in LMICs. Additionally, the study will provide insights into the barriers and facilitators for implementing DHIs in LMICs, which can be used to inform future research and implementation efforts. Overall, the study has the potential to contribute to the development of a more equitable, accessible and effective digital healthcare system in Pakistan and other LMICs.

OPERATIONAL DEFINITIONS

- Effectiveness of DDSS: Measures of effectiveness will include changes in clinical outcomes through patient exit feedback survey.
- Feasibility of DDSS: Feasibility means, in the context where DHI is being implemented, whether it is possible to do successful implementation. This includes electricity, internet, hardware availability, human resource capacity and patient acceptance.
- DDSS: DDSS is a computer-based system that provides recommendations to healthcare providers based on patient symptoms data and various different health information inputs. Large amounts of data, including patient records, treatment results and medical literature, can be analysed using machine learning algorithms to find patterns and insights that conventional rule-based approaches would miss.

Author affiliations
[1]Department of Community Health Sciences, The Aga Khan University, Karachi, Pakistan
[2]Community Medicine, Shaqra University, Shaqra, Saudi Arabia
[3]Department of Paediatrics and Child Health, The Aga Khan University, Karachi, Pakistan
[4]Alliance for Health Policy and Systems Research, WHO, Geneva, Switzerland
[5]Public Health and Digital Health, Sehat Kahani C/O Community Innovation Hub, Karachi, Pakistan
[6]Health Policy and Management, The Aga Khan University, Karachi, Pakistan
[7]Public Health, Sehat Kahani, Karachi, Pakistan
[8]The Aga Khan University, Karachi, Pakistan
[9]Global Business School for Health, University College London, London, UK

X Rawshan Jabeen @Jabeen R and Lorena Guerrero-Torres @lorenagroo

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ORCID iDs
Hasan Nawaz Tahir http://orcid.org/0000-0002-8710-3314
Rawshan Jabeen http://orcid.org/0000-0003-1543-8657
Mahek Karim http://orcid.org/0009-0003-8300-9210
Abdul Momin Kazi http://orcid.org/0000-0001-8253-1777
Shehla Zaidi http://orcid.org/0000-0001-7620-9247

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