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Formative qualitative research on the potential for digital solutions to address diabetes care gaps in Tanzania and Sri Lanka

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ABSTRACT

Objectives Diabetes care remains unavailable and unaffordable for many people. Adapting models of care to low-income and middle-income country contexts is a priority. Digital technology offers substantial potential yet must surmount health system, technological and acceptability issues. This formative research aimed to identify the potential for a digital technology solution (Diabetes Compass) to address diabetes care gaps in primary healthcare.

Design Qualitative research was conducted in selected districts of Sri Lanka and Tanzania with practitioners, patients and family members. In-depth interviews assessed how digital solutions may improve diabetes care, acceptability and usability; contextual and clinical observations identified practitioner clinical competencies, strengths and weaknesses, and the influence of the care environment on service delivery; and workshop discussions explored strategies to encourage digital solution uptake and sustain use.

Setting The research was undertaken in 2022 at nine health facilities in Sri Lanka's Southern Province (Galle), and 16 health facilities in Tanzania's Lindi and Pwani Regions.

Participants Participants included primary and secondary care practitioners, facility managers, patients and family members.

Results There was striking concordance in the diabetes care gaps and potential for digital solutions in the two countries, and between practitioners, patients and family members. Five main gaps were practitioner training; health information systems and data; service delivery; infrastructure, equipment and medication; and community awareness and knowledge. Practitioners, patients and family members saw strong potential for digital solutions to improve early detection, diagnosis, secondary prevention of complications and improve patients' and families' experience of living with diabetes. They identified specific design and implementation considerations to enable the Diabetes Compass to realistically meet these needs and overcome challenges.

Conclusion There was a strong appetite among practitioners, patients and family members for a digital solution to strengthen diabetes care. Their experience of challenges and practical recommendations informed the Diabetes Compass design.

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This study takes a system approach, across the continuum of care and a multidimensional perspective, including practitioners, patients and family members.
- ⇒ Practitioners, patients and family members in other regions and countries may identify different or additional issues or perspectives.
- ⇒ Using this study's deep, qualitative insights to develop and conduct a quantitative survey to understand the extent the needs, experiences and preferences are shared or differ within practitioner and patient populations more widely would benefit digital service planning.

INTRODUCTION

Diabetes is the ninth largest cause of death globally,[1] with prevalence growing most rapidly among low-income and middle-income country (LMIC) populations, where 80% of the global population with the condition live.[2] Moreover, the unavailability and unaffordability of diabetes care in many LMICs have contributed to a 10% higher mortality rate among LMIC populations compared with high-income countries.[3] To improve coverage of appropriate services and make efficient use of limited resources, the WHO recommends integration of diagnosis, screening, treatment and disease management within primary care settings.[4] However, health systems in LMICs often face critical gaps including limited awareness and training among health staff, an insufficient number of endocrinologists, and a lack of laboratory equipment, facilities, medications and medical supplies, alongside low community awareness and prevalent misapprehensions about the condition.[2] Therefore, adapting models of care to LMIC contexts and identifying ways to surmount these obstacles is a priority.

Models of care that have been piloted in LMICs have included an emphasis on early diagnosis, training practitioners to manage common diabetic complications at the primary healthcare (PHC) level, prevention among at-risk individuals and peer-to-peer learning among community members.[2] However, despite rapid developments in recent decades in applying digital technologies to improve diagnosis; clinical decision-making and treatment; self-management and monitoring and supporting continuity of care for various health issues,[5] the potential to develop feasible and effective models of diabetes care in LMICs remains largely unexplored. To date, most digital interventions for diabetes have focused on patient support, such as health promotion messaging, clinic appointment reminders, support for self-care practices and remote monitoring via wireless or wearable sensors.[6 7] Relatively few interventions have provided technical support to practitioners or strengthened aspects of the health system, such as referrals or prescribing.[8] Therefore, given the body of evidence that digital technology can cost-effectively impact time between diagnosis and receiving care, attendance, medication adherence, clinical outcomes and quality of life,[9–11] there appears to be an important opportunity to harness this potential to upscale and enhance diabetes care in LMICs.

This paper presents the findings of formative research to inform the design of the World Diabetes Foundation's Diabetes Compass initiative to develop digital technology solutions to enhance the delivery and experience of care for people with type 2 diabetes in LMICs.[12] This formative research is meant to inform a needs-based approach that develops a deep understanding of existing needs and considers how technology can address those needs in the early phases of product development. Rather than starting with a specific technology and looking for problems to solve with that technology, Diabetes Compass aims to understand the needs and capabilities of practitioners and patients for using customised digital health solutions to ultimately improve diabetes care in the public PHC system.

METHODOLOGY

Study design and setting

Qualitative research, guided by grounded theory, was undertaken in 2022 in Tanzania and Sri Lanka—two of the Diabetes Compass pilot countries. These countries were selected based on the national prevalence of type 2 diabetes and government interest in collaboration. Diabetes prevalence in Sri Lanka increased from 3.0% to 11.3% between 1990 and 2019, at which point it was responsible for 9.8% of deaths and 8.6% of disability-adjusted life-years (DALYs). Tanzania has the highest diabetes age-adjusted prevalence in Africa, estimated at 12.3% in 2019 and responsible for 2.4% of deaths and 1.3% of DALYs.[13 14]

The aim of this study was to provide insight into current gaps and unmet needs related to diabetes care and to identify the potential role for Diabetes Compass to address critical gaps and enhance care. This information was intended to inform a user-centred design process. The research was undertaken at nine health facilities in Sri Lanka's Southern Province (Galle), and 16 health facilities in Tanzania's Lindi Region (Lindi Municipal Council and Kilwa District Council) and Pwani Region (Kisarawe and Rufiji District Councils). Sites were purposively selected in consultation with the Ministry of Health, and the Ministry of Health, Community Development, Gender, Elderly and Children in Sri Lanka and the President's Office Regional and Local Government in Tanzania.

Participants

Study participants included PHC practitioners (doctors, nurses and—less commonly—ancillary practitioners, such as a nutritionist); facility managers or medical officers-in-charge (MOIC); secondary and tertiary care practitioners (doctors and nurses); patients with diabetes in PHC facilities; patients with diabetes in secondary and tertiary care facilities; and family members of patients with diabetes. Participants were purposively selected to reflect a range of specific characteristics known to potentially affect the delivery and experience of healthcare, including gender, age, location (rural and urban), practitioner role and patient socioeconomic characteristics. Patients with diabetes were recruited at PHC diabetes clinics; practitioners were invited to participate in liaison with facility managers or MOIC.

The sample sizes for this research were selected based on the anticipated number of participants required to reach saturation in the selected qualitative methodologies described below (in-depth interviews, contextual and clinical observations, and workshops). According to standard approaches in grounded theory, the aim of reaching conceptual density and saturation is to not be fully exhaustive but to reach a sufficient depth of understanding that enables researchers to develop a theory to characterise the given population or phenomena.[15] Participants were recruited specifically for each research activity and there were no preexisting relationships between researchers and participants.

Data collection

Researchers with training in qualitative research collected data via three activities in Tanzania and Sri Lanka: in-depth interviews regarding digital readiness, clinical and contextual observations, and workshops on motivating and supporting use of a Diabetes Compass digital

Table 1 Formative research participants

Activity	Participants (n)		Country
Digital readiness in-depth interviews	8 practitioners Clinical officers=4 Nurses=2 Medical officer=1 Doctor=1	8 Patients	Tanzania
	6 practitioners Medical officers=4 Doctor=1 District medical officer=1	6 Patients	Sri Lanka
Clinical and contextual observations	4 practitioners (3 facilities) Doctors (n=2) Clinical officer (n=1) Nutritionist (n=1)		Tanzania
	4 practitioners (4 facilities) Medical officers (n=2) MOIC (n=2)		Sri Lanka
Workshops on motivating and supporting diabetes compass uptake and sustained use	1 workshop Patients=7 Family members=3	1 workshop Doctors=5 Nurses=4	Tanzania
	1 workshop Patients=8 Family members=2	1 workshop Medical officers=5 MOIC=2 Nursing officer=3	Sri Lanka

MOIC, medical officers-in-charge.

solution. All activities were conducted in person and in local languages. Table 1 specifies the number of participants per research activity.

Digital readiness in-depth interviews were conducted with PHC practitioners (Tanzania, n=8; Sri Lanka, n=6) and PHC patients with diabetes (Tanzania, n=8; Sri Lanka, n=6). Semistructured interviews explored interviewees' perceptions of how digital solutions may improve diabetes care, impacts of past and current digital health initiatives, and the acceptability and usability of digital solutions. Interview guides were developed and used to conduct interviews with both practitioners and patients with diabetes. The interview guide contained questions related to what types of technology are used, level of comfort using different types of technology, data and privacy concerns, history of contact with the health system through technology and app usage. The interview guides are available in online supplemental materials.

Contextual and clinical observations (Tanzania n=4; Sri Lanka n=4) provided insight into practitioners' clinical competencies, strengths and weaknesses, and how the care environment can influence service delivery. Two researchers shadowed each participating practitioner for a full shift, including at least three clinical consultations with patients with diabetes and tasks not directly involving patients such as referrals, data entry and liaising with colleagues. One researcher (trained clinician) observed clinical competencies and skills using a validated tool[16]; the second researcher observed practitioners' environment, duties and relationships. Field notes were recorded using a structured observation guide and a brief semistructured interview was conducted at the end of the session.

Workshops on motivating and supporting Diabetes Compass use were conducted with PHC practitioners (Tanzania, n=8; Sri Lanka, n=9), facility managers (Sri Lanka, n=2), patients with diabetes (Tanzania, n=7; Sri Lanka, n=8) and diabetes patients' family members (Tanzania, n=3; Sri Lanka, n=2). The aim was to identify and consider advantages and challenges of potential methods to encourage uptake and sustain Diabetes Compass use among practitioners and patients. Topic guides were developed for the workshop facilitators and are available in online supplemental materials.

Data analysis

Sessions were audio recorded and subsequently transcribed, translated into English for analysis and back-translated to check translation quality. The guiding questions developed for each activity were used to develop code books. Two coders extracted and analysed the data using deductive coding. Themes were identified by analysing similarities and differences across responses, and frequency of agreed on similarities and differences was used to create hierarchies of identified themes. Themes were validated by in-country team members.

Patient and public involvement

Patients and practitioners were involved as participants in the study and contributed via various qualitative methods to enable patients' own experiences and perspectives to be at the forefront. Research questions were informed by prior review of published studies on patient and practitioner perspectives of healthcare in LMICs, and by stakeholder workshops held in each country by the World Diabetes Foundation.

RESULTS

Five main gaps related to diabetes care were identified in relation to (1) practitioner training, (2) PHC service delivery, (3) health information systems and data, (4) infrastructure, equipment and medication and (5) community awareness and knowledge.

Practitioner training

PHC practitioners in both countries highlighted the lack of in-service opportunities to enhance their diabetes knowledge and skills. Although sporadic in-service training was offered, for example, by the Tanzania Diabetes Society, participation was said to be restricted to more senior personnel and most practitioners were unable to access this. This was compounded by a lack of information sharing by attenders with non-participant colleagues. In Sri Lanka, although Regional Health Service Directors organised occasional training, practitioners had to forgo income to attend in lieu of service delivery, and this was a deterrent.

The practitioner training gap was identified as significant in relation to clinical decision-making and complications management, particularly as practitioners reported that their existing knowledge was already limited to their basic preservice training in NCDs. Moreover, it was reported that awareness of national clinical guidelines was low, and they were rarely followed. Practitioners resorted to peer support, personal experience and the internet to address their questions. According to one practitioner, 'We don't have any training. We are just using our experience and knowledge', while another reported that, 'For something I don't know, I normally Google'. In practice, the knowledge gap was reported to limit primary care service delivery to diagnosis and patient education, requiring complications management to be undertaken in secondary or tertiary care.

Although practitioners generally used some form of digital technology in everyday life (personal smartphones or tablet computers) and used the internet to address clinical questions, a lack of training in Health Information System and digital technology use was identified as a problem. This gap was indicated to adversely impact practitioners' ability to accurately produce and use data for clinical decision-making and delay prescriptions. Whereas Tanzanian practitioners sometimes received basic introductory HIS training on joining facilities, they and their Sri Lankan counterparts primarily relied on peer support and on-the-job experience.

Patients and family members also discussed PHC practitioner training. Although they universally desired better access to quality diabetes care locally, they currently perceive that better care is available at secondary/tertiary level. They said that they would only seek local care if their faith in PHC services was bolstered, part of which entailed confidence that local practitioners have received training in diabetes care. This applied also to their views about the potential for community health workers or volunteers to undertake diabetes screening and advice using digital solutions. A priority consideration was to have confidence that personnel had received adequate training in diabetes.

PHC service delivery

Practitioners and patients and their family members in Sri Lanka and Tanzania highlighted the gap in the range and quality of services available at community level. It was commonly perceived that this relates primarily to a lack of practitioners with specialised diabetes training, resulting in primary care delivery focusing almost exclusively on screening and diagnosis. However, sometimes lack of testing equipment and supplies could impede even these basic functions and required patients to be referred to higher-level facilities, which entailed significant out-of-pocket travel costs and may prove inaccessible for some owing to work or family commitments. As one practitioner noted, 'I don't think many health centers have clinical chemistry machines. Diabetic patients need to be monitored monthly…so we fail to do some basic examinations since [there are] no supportive facilities'. Patients requiring complications management or additional services would generally be referred to secondary or tertiary facilities, and follow-up thereafter was perceived to be weak, partly because travel time and cost often encouraged patients to resort to complementary medicine for treatment. Patients and practitioners reported long waiting times at clinics, with delays being fuelled by the gaps in practitioner knowledge (and needing, eg, to ask colleagues' advice), and HIS and other data-related delays.

Although not a majority experience, some patients indicated that they had experienced or been aware of community-level diabetes screening events. These were described as ad hoc and links to follow-up care at clinics were perceived to have been poor. Thus, whereas patients and family members welcomed diabetes care being available locally, they preferred a less 'one-off' model, ongoing engagement with diabetes practitioners and for community screening better linked into the health system.

Health information systems and data

Health information system management was identified as a critical current weakness, leading to patient data loss and impeding quality care. Currently, across Sri Lanka and Tanzania, paper-based systems are concurrently used alongside the (digital) Health Information Systems. This is perceived as duplicative, undermines data quality and reduces available time for service delivery. Fundamentally, however, many lower-level facilities in both countries lack HIS access and rely on paper records that delay and impede continuity of care between PHC and secondary/tertiary facilities. According to one practitioner, 'We have a paper-based system to enter patient data. Due to heavy number of patients for clinics, the practitioners do not have time to enter real time data', while another noted that, 'We definitely have to change this system. So, moving from a paper-based to a digital system is better'.

Facilities in both countries are required to share data with their respective Ministries of Health and to develop reports describing the local diabetes epidemiological profile including the disease burden. Practitioners who used HIS identified data gaps and uncertainties, for example, gender and age are not included in monthly reports in Tanzania, whereas in Sri Lanka rural practitioners were unsure if their data was included in reports to MOH. In particular, practitioners expressed concerns about poor data quality related to dual or paper-based systems, their lack of training, limited time and an absence of data quality checks and feedback or even confirmation of receipt for data submitted.

Patients and family members were aware that data system weaknesses could affect the quality of care they received. They reported delays obtaining prescriptions due to data loss, and due to delayed data entry by practitioners. Also, patients perceived that PHC level practitioners sometimes lacked accurate information relating to their care, for example, due to delayed data record updates related to prior consultations, or in secondary/tertiary care. This was a common component of patients' rationale for seeking care at tertiary or secondary level.

Infrastructure, equipment and medication

Specific systemic weaknesses impeded primary care practitioners' abilities to provide care. In infrastructure terms, practitioners in both countries said they regularly experience power outages and unstable internet connections. 'No point in having these machines as long as we do not have internet', noted one practitioner. These systemic weaknesses limit the ability to view or upload patient data and the option of using the internet to support clinical decision-making, as well as making data entry more time-consuming. Although mitigation strategies exist, including back-up generators and advice from regional technical or senior staff, these were not always accessible and proved to be time-consuming.

Access to diagnostic equipment and medications at primary care level was an issue in both countries. The former results in delays and patient referral to secondary or tertiary care for testing, greater out-of-pocket costs for patients and their families due to additional travel and sometimes lost wages, and practitioners believed it contributed to the number of patients lost to follow-up. Lack of available medication was highlighted by practitioners, patients and family members as an ongoing difficulty. In Tanzania, this was related to frequent stock-outs and poor public system supply. In Sri Lanka, practitioners reported that delayed data input (due to outages or workload) delayed prescriptions. In both countries, patients said they sometimes left facilities without prescriptions, and either incurred greater expense seeking medication in the private sector, or where this was not an option, they resorted to sharing pills, complementary medicine or prioritising medication for some family members over others.

Community awareness and self-management knowledge

Practitioners and patients in Tanzania and Sri Lanka concurred in perceiving that diabetes received far less public attention and priority compared with other diseases and is not considered to be as prevalent or as problematic. 'For me, I think this disease has not been given that much attention, [for other issues] they do have their clean clinics but for us, it is not like that. The government has announced that this is also a special disease but when you are coming into the grassroots the implementation is not as intended', noted one patient.

The lack of public attention and priority was indicated as a factor that deterred people from perceiving diabetes screening as important. Weak community awareness about available screening and management services was seen to contribute to the sizeable number of people who only seek care for late-stage disease and complications. Country-specific factors were also at play: in Sri Lanka diabetes is stigmatised, and fear of the social implications of a positive diagnosis was said to deter patients from screening or seeking care; whereas in Tanzania, patients' greater familiarity with infectious diseases was said to result in diabetes symptoms being mistakenly attributed to more familiar diseases, such as malaria.[17]

Low community awareness was also described as limiting diagnosed people's capacity to self-manage. Although patients in both countries received diet and physical activity advice when diagnosed, this was sporadic and was said to generally fail to reflect everyday realities and thus be difficult to implement. Reflecting on the advice they had received, one patient stated, 'When you wake up in the morning, don't eat pancakes, don't drink tea, don't eat rice, don't eat everything! In other words, diabetes has tormented us'. Patients and family members said that they had received insufficient information about self-management and how to prevent, identify and manage complications as reflected by one patient's observation that, 'Until today we still do not know the symptoms of diabetes…because we get services but we don't get the chance to get the lessons—to be taught'.

The potential for digital solutions to address the identified diabetes care gaps

Practitioners: perceived benefits and utility, and functionality requirements

Practitioners in both countries universally welcomed the potential for digital solutions to enhance their diabetes care capacities. Their existing foundation of basic digital literacy due to using personal digital technology in their everyday lives was commonly mentioned. A key caveat was the requirement for digital solutions to be user-friendly (simple to use and accessible). Priority areas for support included complication screening and management (specifically wound and foot care, renal care and neurovascular care), symptom identification, data capture, and monitoring, and medication prescription management. Additionally, the potential for digital asynchronous training was universally welcomed, to enable practitioners to receive training at convenient times and without impeding service provision.

Practitioners perceived that a digital solution could address data gaps and enhance decision-making, procurement and budgeting, resulting in improved patient and facility management. Automatic data cross-checks and storage were proposed as important functions. Foremost, practitioners emphasised the need for a digital solution to be integrated with each country's existing national HIS to avoid duplication of effort and because using national HIS (where available) is a requirement rather than optional. Practitioners identified the potential to streamline data entry to replace the dual entry process (paper and digital) and to prevent patient data loss. They suggested practical features to ensure a digital solution could be useful and functional in their context. Offline functionality was recommended to enable use during power or internet outages. In Tanzania, a portable solution that may be used in the field was identified as useful, possibly combined with GPS to identify a patient's location. In Sri Lanka, automatic troubleshooting was proposed to avoid time-consuming delays and limit reliance on the stretched regional technical support, as well as laboratory results being automatically entered into a digital solution.

Nonetheless, whereas practitioners identified various ways that a digital solution could enhance their capacity to deliver quality diabetes care and identified their own priorities for usability, a caveat was raised in both countries. Practitioners suggested that data entry into a digital solution could potentially be performed by administrative personnel (based on the experience of some national programmes having dedicated data clerks) and said this would further enable them to prioritise clinical delivery. While such administrative capacity for diabetes does not currently exist and the model of practitioner data entry may be unlikely to change, the point does highlight the critical need for a diabetes digital solution to be user-friendly and relieve practitioners' existing burden.

Patients and family members: perceived benefits and utility, access needs, and preferences

This openness to digital solutions to improve locally available diabetes care was found also among patients and family members. This willingness was conditional on an assurance of a similar quality of care and services to those available at higher-level facilities, continuity of care, one-off activities and enhanced provision of lifestyle and treatment advice. A further important point was the need for a digital solution to be compatible with the button phones that most patients had access to, rather than smartphones and to recognise that some patients shared a family mobile phone.

Patients perceived that a digital solution for their own use could facilitate care-seeking and help address self-management issues at an earlier stage, particularly regarding complication development, and when patients were unable to attend a clinic. They believed that digital solutions could potentially help them identify where to access services and obtain medicines and provide between-appointment support, such as SMS messages containing specific health promotion information and advice. A communication channel for asking questions and seeking advice was also proposed, again particularly regarding diabetic complications and lifestyle management.

Table 2 summarises the potential for digital solutions to address identified diabetes care gaps.

DISCUSSION

Prior studies on diabetes care in Tanzania and Sri Lanka and more widely across LMICs have tended to range from the 'skyscraper view' of national system surveys relating to service delivery and readiness studies of the experience or knowledge, skills and practices of people living with diabetes or, less frequently, among practitioners.[18–21] This study took a multidimensional perspective to generate detailed insight into the delivery and experience of diabetes care and the potential for digital solutions from a system perspective, across the care continuum from prevention to condition management.

Notably, there was striking concordance between the two diverse countries and also in the perceptions of practitioners, patients and family members relating to the gaps in diabetes care and the potential for digital solutions. Although, several country-specific features and needs were identified, these were relatively few and less significant in comparison to the similarities. The identified major themes related to the gaps in diabetes care at the PHC level (practitioner training; health information systems and data; PHC service delivery; infrastructure, equipment and medication; and community awareness and self-management knowledge) broadly reflect the 'big picture' seen in the available LMIC and country-specific data and literature.[2 22] For example, practitioners, patients and family members in both countries each independently highlighted the need for further training for PHC practitioners to be able to enhance diabetes care provision; that the most difficult aspects of condition management for patients are complications and lifestyle, particularly diet; and that the strong linkage between the current health information ecosystem and the related issues and patient outcomes including access to treatment or medication, medication compliance, complication management.

The study's findings provide new insight regarding the potential for digital solutions to enhance diabetes

Table 2 Summary of the potential for digital solutions to address identified diabetes care gaps

Identified gaps in diabetes care	The potential role of digital solutions in addressing diabetes care gaps
Practitioner training	► Asynchronous training, accessible per practitioner availability ► Easy access to information and guidance on diabetes care, including complication screening and management, medication and treatment options ► Training and mentorship for potential CHW/CHV involvement in diabetes care
Health information systems and data	► Simplified and streamlined data entry ► Information centralisation, improving referral and reducing patients 'lost to follow-up' ► Easier access to time-critical data to inform clinical decision-making, procurement and budgeting ► Reduce prescription delays for patients
Primary healthcare (PHC) service delivery	► Enhance capacity to screen and undertake diagnosis at PHC level ► Address delays and waiting times due to data issues
Infrastructure, equipment and medication	► Offline options to address infrastructure constraints in power, internet and technical support availability ► Guide patients and family members regarding sites with available medication ► Improve prescription management
Community awareness and self-management knowledge	► Information on available services ► Information and advice to guide self-management, particularly for complications and lifestyle modification ► Enhance communication with practitioners between appointments

CHV, Community Health Volunteer; CHW, community health worker.

care from the dual perspectives of practitioners involved in service delivery and people in need of care. Most of the prior digital technology research and pilot projects for diabetes care in LMICs have focused exclusively on patient information and communication.[7,10] Far fewer studies related to supporting practitioners and undertaking health system strengthening, and these tended to be hospital based or focused on specific aspects of care delivery.

The Diabetes Compass initiative set out to understand and address both the supply (provider) side and the demand (service user) side of diabetes care by including the needs of practitioners as well as patients and their families and the formative research provided insight from this holistic perspective. On the PHC practitioner side, the findings indicated the considerable appetite in both countries regarding the potential for digital solutions to enhance their knowledge and skills and help address the major issues they experienced with diabetes data and HIS and related core functions. Nonetheless, practitioners, whether they had HIS access or not, were acutely aware of the need for a digital solution to be integrated with national HIS, recognising the importance of centralised data and the potential to better use and communicate data between different levels of the health system. Like many countries, Tanzania and Sri Lanka have developed and are implementing digital health strategies,[23] and although roll-out is gradual and technical and capacity challenges exist, a proportion of PHC diabetes practitioners have HIS access. The findings suggest that digital solutions could widen access to digital patient data and HIS for those currently without access, as well as address some of current users' challenges related to connectivity, duplicate systems, poor data quality and linking to critical functions such as referrals and prescriptions.

Patients and family members shared practitioners' sense of the potential for digital solutions and were keen to consider how they could use such technology to improve their ability to access diabetes diagnosis and care, source medication more easily and to receive advice regarding self-management. Their vision thereby comprised almost the full breadth of functions that various digital diabetes technology pilot projects have previously explored (apart from glucose monitoring),[7,8,24] and some of which are already in use among patients and families in high-income countries. They qualified this by indicating that the technology needed to match what they had access to without significant expense, which for most people meant button mobile phones (rather than smartphones), that could also be shared with other family members. This caveat reflects a wider picture across many LMICs where, although mobile phone penetration is now vast and over 90% of the world's population has access to a phone, access to internet-capable devices is far lower and constrained by connectivity as well as device and data costs.[25] For example, in Sri Lanka, internet-capable devices are above the global average with 94.9 active mobile-broadband subscriptions per 100 people, whereas in Tanzania there are only 28.6 subscriptions per 100 people.[26] This difference likely reflects that broadband services are part of a universal access scheme in Sri Lanka.[26]

It was perhaps unsurprising that patients and family members identified tangible ways that a digital solution available to them personally could be beneficial, yet more notable was their perception of the benefit of digital solutions for practitioners. Patients and family members were acutely aware that some of the deficiencies in their experience of diabetes care, such as long waiting times, and delays in obtaining prescriptions, and sometimes having to be referred to higher-level facilities, could be directly caused or exacerbated by practitioners' difficulties with data systems and inadequate access to information. This finding appears less common in the wider literature, possibly because most studies have focused on patient or practitioners needs, adding a new dimension to understanding the potential significance of digital solutions to address the needs of provider, patient and community needs.

The study identified gaps in diabetes care that might be categorised as systemic challenges within LMIC health systems more widely in relation to noncommunicable diseases (NCDs): access to medications, medical supplies and equipment, and workforce capacity,[2 22] alongside the broader societal challenges of reliable power supply, access to information technology and connectivity.[24] Clearly, a digital solution, such as the Diabetes Compass, cannot provide a panacea for structural issues requiring multifaceted and multisectoral solutions, yet the findings identified highly specific ways that a digital solution could be designed to help patients and practitioners navigate such challenges. For example, practitioners recommended offline functionality, linking to wider Health Information Systems (HIS) referral and prescription systems, digitally available training, and information and guidance to enhance their clinical practice. In parallel, patients and family members identified the possibility to use button rather than smartphones for signposting to available services and medication availability (while not guaranteeing supply, at least making them aware of where supplies may be obtained).

This formative research was undertaken in selected districts of two countries and sampling was purposive rather than cross-sectional. It is possible that different or additional issues or perspectives may be identified by practitioners, patients and family members in other regions and in other countries. However, the purposive sample included various dimensions of diversity indicated in the literature to be important in relation to healthcare, and moreover, there was strong concordance in the findings between two different countries, between districts, and between practitioners, patients and family members. This suggests that the findings may reasonably be expected to resonate more widely in the two countries and in other LMICs. Nonetheless, future implementation and scale up in other regions and countries should include pilot testing to identify the degree that needs are different or similar.

CONCLUSION

This study investigated experiences and needs in relation to diabetes care across the continuum from prevention to condition management from the dual perspectives of service delivery (practitioners) and care needs (service users) and identified the potential for digital solutions to address current challenges and gaps. There was notable concordance regarding the aspects of diabetes care where improvements could be made both from the service delivery and the service user perspectives and between the two LMICs. Commonly defined needs were articulated in relation to: practitioner training, health information systems and data, PHC service delivery, infrastructure, equipment, and medication, and community awareness and self-management knowledge. Practitioners, patients and family members shared the view that digital solutions offer considerable potential to help address many of the specific needs and recommended how digital solutions could be most feasible and acceptable in their contexts.

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Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by the Sri Lanka Medical Association on 25 April 2022 and the Tanzania National Institute for Medical Research on 7 June 2022 (NIMR/HQ/R.8a/Vol.IX/4011). Participants gave informed consent to participate in the study before taking part.

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Data availability statement Data are available on reasonable request.

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