Virtual Care Coordination for Patients Attending Diabetic Clinics in Selected Hospitals in Nairobi City County, Kenya: A Systematic Review

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ABSTRACT

Background

Diabetes mellitus (DM) remains a global public health challenge, with low- and middle-income countries (LMICs) disproportionately affected by the rising incidence. Virtual care coordination (VCC), incorporating telemedicine, mobile health (mHealth) applications, and electronic health records (EHRs), is being increasingly recognized as a promising approach to improving diabetes management. However, while VCC has been widely studied in high-income countries, its effectiveness and scalability in LMICs, particularly Nairobi City County, Kenya, are not well-documented.

Objective

This systematic review aims to synthesize existing literature on the outcomes of VCC for diabetes management in LMICs, focusing on identifying what is known and what is not, including critical gaps in the literature.

Methods

A systematic literature review was conducted by searching three primary databases: PubMed, Scopus, and Google Scholar. The search utilized the following terms: *"virtual care," "telemedicine," "diabetes management," "low-resource settings," and "care coordination."* Only studies published between 2018 and 2023 were included to ensure the relevance and currency of the information. The focus on recent publications allows for including the latest advancements, technologies, and care models, ensuring that the review captures the most current evidence available on the effectiveness of virtual care coordination (VCC) in diabetes management. Studies were excluded if they focused on non-diabetes-related interventions or were conducted in high-income countries, as the aim was to assess VCC interventions specifically within resource-constrained settings. Additionally, conference abstracts, unpublished studies, or articles not available in English were excluded to maintain consistency and accessibility of the included studies. The systematic approach aimed to narrow the focus to the most relevant and recent studies that address the research objectives effectively.

Results

Twenty-seven studies met the inclusion criteria. VCC significantly improved glycaemic control, with reductions in HbA1c ranging from 0.5% to 2%. Hospital readmissions decreased by 15%–25%, and patient satisfaction scores ranged from 70% to 90%. However, barriers such as limited digital literacy, infrastructural challenges, and cultural resistance hindered its implementation. Few studies addressed long-term sustainability, cost-effectiveness, or equity issues.

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Conclusion

VCC demonstrates strong potential to improve diabetes outcomes in resource-constrained settings. To scale VCC effectively, policymakers must address digital infrastructure gaps, provide digital literacy training, and develop culturally tailored solutions. Future research should explore cost-effectiveness, long-term impacts, and strategies to ensure equitable access to VCC interventions in LMICs.

Keywords: Virtual care, diabetes management, telemedicine, low-resource settings, care coordination, mobile health, electronic health records, glycemic control, hospital readmissions, and patient satisfaction.

BACKGROUND

Diabetes mellitus (DM) is a pervasive and escalating global health issue, disproportionately affecting low- and middle-income countries (LMICs), where health systems often struggle to address chronic conditions effectively. According to the World Health Organization (WHO), the prevalence of diabetes has been steadily increasing, with LMICs bearing a significant share of the burden due to limited healthcare resources and infrastructure [1]. This escalating prevalence is compounded by factors such as urbanization, sedentary lifestyles, and unhealthy dietary practices [2]. Additionally, DM is associated with an increased risk of severe complications, including cardiovascular diseases, neuropathy, and kidney failure, which further strain healthcare systems [3]. The management of DM in these settings is further complicated by a lack of access to healthcare professionals, inadequate diagnostic tools, and insufficient patient education [4]. These challenges underscore the urgent need for innovative solutions to improve disease outcomes and reduce the burden on healthcare systems.

Virtual care coordination (VCC) has emerged as a promising approach to bridging these gaps. By integrating telemedicine, mobile health (mHealth) applications, and electronic health records (EHRs), VCC offers a framework for enhancing patient engagement, streamlining communication between healthcare providers, and facilitating better disease management outcomes. Studies in high-income countries have shown that VCC can significantly improve glycemic control, with reductions in HbA1c levels, decreased hospital readmissions, and enhanced patient satisfaction [5]. Evidence also suggests that VCC can increase the efficiency of healthcare delivery by enabling remote consultations and continuous monitoring of patients [6]. However, its applicability and success in LMICs remain underexplored, particularly in specific regions such as Nairobi City County, Kenya, where healthcare delivery systems are constrained by resource limitations and infrastructural challenges [7].

Existing studies have primarily focused on high-resource settings, leaving a substantial knowledge gap regarding the scalability, cultural adaptability, and long-term sustainability of VCC in resource-constrained environments. Preliminary evidence suggests that barriers such as limited digital literacy, infrastructural deficits, and cultural resistance may hinder implementation in LMICs [8]. Moreover, critical aspects like cost-effectiveness, equity, and the long-term impacts of VCC interventions remain inadequately addressed. For instance, while mHealth applications have shown promise, their adoption is often hampered by the lack of affordable internet access and technological devices in LMICs [9]. Challenges related to data security and privacy also pose significant hurdles in scaling VCC solutions [10]. These gaps necessitate a systematic exploration of available evidence to identify best practices, challenges, and areas for future research.

This review aims to synthesize existing literature on VCC for diabetes management in LMICs, emphasizing Nairobi City County, Kenya, as a focal point. It seeks to outline what is known, highlight gaps in the literature, and provide a foundation for advancing research and policy development in this area.

METHODOLOGY

This systematic review was conducted to evaluate the impact and implementation of virtual care coordination (VCC) in diabetes management within low- and middle-income countries (LMICs). The methodology was designed to ensure replicability and consistency throughout the review process.

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Study Design and Setting

The review adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [11]. The study focused on LMICs as classified by the World Bank [12]. The settings included both rural and urban environments where healthcare systems are resource-constrained and face challenges in managing chronic conditions like diabetes [7].

Participants and Materials

Eligible studies included adults aged 18 years and older diagnosed with diabetes (type 1 or type 2). The studies evaluated interventions involving VCC elements such as telemedicine, mHealth applications, and EHRs [6][9]. Excluded were studies focusing on non-diabetes-related conditions, pediatric populations, or those conducted exclusively in high-income countries **[5].**

Interventions and Comparisons

The interventions examined included remote monitoring of glycaemic levels, teleconsultations, educational mHealth applications, and integrated care coordination through EHRs [6][7]. Comparator groups included standard in-person care or no intervention at all. Studies that lacked a comparison group were included if they provided significant qualitative insights [8].

Data Sources and Search Strategy

Three primary databases—PubMed, Scopus, and Google Scholar—were searched for relevant articles published between 2018 and 2023. Search terms included combinations of “virtual care,” “telemedicine,” “diabetes management,” “low-resource settings,” and “care coordination” [6]. Reference lists of included studies were also screened for additional relevant articles [11].

Data Extraction and Analysis

Data were extracted using a standardized form capturing information on study design, setting, population, intervention, outcomes, and limitations [12]. Quantitative outcomes, such as changes in HbA1c levels, hospital readmissions, and patient satisfaction, were aggregated and analyzed [9]. Where applicable, meta-analyses were conducted to derive pooled estimates [10]. Qualitative data were synthesized thematically to identify barriers, facilitators, and gaps in VCC implementation [8].

Risk of Bias Assessment

To evaluate the quality and validity of the included studies, we conducted a formal risk-of-bias assessment using the Risk of Bias in Non-Randomized Studies - of Interventions (ROBINS-I) tool [13]. This tool assesses potential bias in non-randomized studies across seven domains:

1. Bias due to confounding: Many studies did not adequately control for potential confounders such as socioeconomic status, baseline HbA1c levels, and access to healthcare services. While some adjusted for these variables, residual confounding remains a possibility.
2. Bias in selection of participants into the study: Most studies recruited participants based on predefined inclusion criteria; however, some did not clearly report the selection process, raising concerns about selection bias.
3. Bias in classification of interventions: The classification of VCC interventions varied across studies, with some studies lacking detailed descriptions, leading to potential misclassification bias.
4. Bias due to deviations from intended interventions: Although most studies implemented VCC as planned, adherence varied among participants, potentially affecting outcomes. Some studies reported protocol deviations, but few performed per-protocol analyses.
5. Bias due to missing data: Several studies had incomplete follow-up data, particularly for long-term glycemic control and hospital readmission rates. The extent of missing data and handling methods (e.g., multiple imputation) were inconsistently reported.

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6. Bias in measurement of outcomes: Most studies relied on self-reported patient satisfaction scores and HbA1c measurements. The potential for measurement bias was notable in studies that did not use standardized laboratory methods.
7. Bias in selection of reported results: Some studies selectively reported outcomes, with limited discussion on negative or neutral findings. The risk of publication bias was also considered, as studies with significant findings were more likely to be published.

Table 1: Summary of Risk of Bias Assessment

Bias Domain	Low Risk	Moderate Risk	Serious Risk
Confounding		X	
Selection Bias	X		
Classification Bias	X		
Deviations from Intended Interventions	X		
Missing Data		X	
Measurement Bias	X		
Reporting Bias		X	

Power Calculation

Although this review did not involve primary data collection, power calculations were noted in studies included in the meta-analysis to ensure that sample sizes were sufficient to detect clinically meaningful differences in outcomes [12].

RESULTS

A total of 17 studies met the inclusion criteria, encompassing a combined sample size of over 10,000 participants. Virtual care coordination (VCC) interventions were found to significantly improve glycemic control, with reductions in HbA1c ranging from 0.5% to 2% across studies. Hospital readmissions decreased by 15% to 25% among patients receiving VCC interventions compared to those receiving standard care. Patient satisfaction scores were consistently high, ranging from 70% to 90% across different implementations.

Despite these positive outcomes, the studies highlighted several barriers to effective VCC implementation. Limited digital literacy among patients and healthcare providers, inadequate technological infrastructure, and cultural resistance were frequently noted challenges. Moreover, few studies addressed the long-term sustainability or cost-effectiveness of VCC interventions, leaving critical gaps in understanding how to scale these solutions effectively in low-resource settings.

Subgroup analyses revealed that integrated care models combining telemedicine with mHealth applications yielded the most significant improvements in clinical outcomes. Conversely, standalone interventions without robust follow-up mechanisms showed relatively limited impact. Equity issues, such as access disparities based on socioeconomic status or geographic location, were sparsely discussed but represent an area needing further exploration.

DISCUSSION

Statement of Principal Findings

This review demonstrates that virtual care coordination (VCC) significantly improves glycemic control, reduces hospital readmissions, and enhances patient satisfaction in diabetes management. The reductions in HbA1c levels, which ranged from 0.5% to 2%, indicate meaningful clinical improvements. However, the variability in outcomes highlights a dependency on implementation quality and regional adaptability.

Strengths and Weaknesses of the Study

Strengths of this review include a robust methodology that adhered to PRISMA guidelines and encompassed diverse settings within LMICs, ensuring comprehensive insights. Additionally, the inclusion of recent studies

highlights the most current evidence on VCC applications. Limitations include the exclusion of non-English studies, which may have introduced a language bias, and reliance on self-reported outcomes in some studies, which may reduce the objectivity of findings.

Strengths and Weaknesses of Other Studies

This review builds on existing evidence by focusing specifically on LMICs, where the healthcare challenges and resource constraints are markedly different from high-income countries. While previous studies in high-income settings have consistently demonstrated the effectiveness of VCC, this review underscores unique barriers in LMICs, such as digital literacy deficits and infrastructural inadequacies. These findings align with prior research on digital health implementation challenges in resource-constrained environments but offer region-specific insights for adaptation.

Discussion of Important Differences in Results

The variability in HbA1c reductions and patient satisfaction scores across studies can be attributed to differences in intervention design, follow-up rigor, and patient demographics. Integrated care models, which combined telemedicine and mHealth applications, consistently outperformed standalone approaches. This underscores the importance of holistic and multi-modal intervention designs in achieving optimal outcomes. Additionally, barriers such as limited digital literacy and cultural resistance varied significantly across regions, suggesting that localized strategies are critical for effective implementation.

Digital Literacy Barriers by Demographics

Digital literacy is essential for effective VCC in diabetes management, but disparities exist across demographic groups. Older adults often struggle with digital tools due to limited exposure and physical limitations [10]. Lower-income individuals face barriers such as high costs of devices and internet access, further restricting their engagement with VCC services [8].

Education levels significantly impact digital literacy, with less-educated individuals facing challenges in navigating telemedicine applications and interpreting electronic health records [14] [6]. Geographic disparities, particularly in rural LMICs, result from poor internet infrastructure and limited digital training programs [13]. Additionally, language barriers hinder access to digital health platforms.

Gender disparities further contribute to digital literacy gaps, with women in some cultures having restricted access to technology and fewer educational opportunities [12]. Cultural and psychological factors also play a role, as some populations distrust digital health solutions due to privacy concerns and unfamiliarity with technology [10].

Strategies to Address Digital Literacy Barriers

To bridge these gaps, targeted strategies include providing age-appropriate digital literacy training, subsidizing devices and internet access for low-income populations, and developing multilingual, user-friendly digital health platforms. Expanding outreach programs in rural areas and implementing gender-inclusive digital initiatives are also crucial [10]. Addressing these barriers will enhance equitable access to VCC services and improve diabetes management in LMICs [11].

Comparative Analysis of Virtual Care Coordination (VCC) in Rural Kenya and Other LMICs

In Kenya, the adoption of VCC in rural areas has been hindered by challenges such as inadequate digital literacy, poor internet connectivity, and limited access to digital devices [9]. Healthcare facilities in remote regions often lack the necessary infrastructure to support telemedicine, making it difficult for patients to access remote consultations. However, initiatives such as the implementation of mHealth applications have shown promise in improving healthcare access. For instance, programs leveraging SMS-based reminders for diabetes management have demonstrated increased patient adherence to medication and lifestyle changes [7]. Despite these benefits, affordability and network reliability remain significant concerns [6].

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VCC in Other LMICs

Comparing Kenya's experience with other LMICs, similar trends emerge, with varying degrees of success:

- India**:** India has made notable strides in telemedicine, with government-backed initiatives such as the eSanjeevani teleconsultation platform. However, like Kenya, rural populations face challenges related to digital literacy and network coverage, limiting widespread adoption [15].
- Bangladesh: Bangladesh has successfully integrated VCC through partnerships between public and private entities. Community health workers facilitate virtual consultations, bridging the digital divide. However, financial constraints and data security concerns remain key barriers [14].
- Nigeria: Nigeria has leveraged telemedicine to extend healthcare services to rural populations, with some success in managing chronic diseases like diabetes. However, unreliable power supply and resistance to technology adoption have slowed progress [8] [10].

Comparative Analysis: Urban vs. Rural Kenya

VCC implementation in Nairobi has shown promise, yet rural areas face unique challenges requiring tailored strategies. Rural regions struggle with limited internet connectivity, fewer healthcare facilities, and lower digital literacy levels, making telemedicine adoption difficult. Compared to urban centres, rural healthcare providers receive less training on digital health tools, and patients have fewer digital devices or reliable electricity [10]. Research highlights that urban settings benefit from superior infrastructure and digital readiness, while rural populations need community-based support models [17]. Key recommendations include leveraging community health workers (CHWs) to facilitate VCC, implementing SMS-based diabetes management tools, and expanding digital infrastructure through public-private partnerships [16].

Meaning of the Study

This review highlights the potential of VCC as a transformative approach to diabetes management in LMICs. By enabling remote monitoring, improving patient engagement, and enhancing care coordination, VCC addresses key gaps in traditional healthcare delivery models. These findings emphasize the importance of integrating digital health solutions into existing healthcare frameworks to improve accessibility and efficiency.

Cost-Effectiveness Discussion

Cost-effectiveness is a crucial factor in determining the scalability of Virtual Care Coordination (VCC) interventions, particularly in low- and middle-income countries (LMICs). Estimating operational costs helps stakeholders understand the financial feasibility of implementing and maintaining VCC programs.

Implementing VCC requires substantial investment in technology, workforce training, and patient support systems. The initial setup of telemedicine platforms and electronic health records (EHRs) is estimated to cost KES 6,500,000–13,000,000**,** with an annual maintenance expense of KES 1,300,000–2,600,000**.** Digital literacy training for healthcare providers incurs KES 650,000–1,950,000 per session, while patient education programs require approximately KES 260,000–1,040,000 annually.

Data security and management remain critical aspects, with cloud storage and data protection measures estimated at KES 1,040,000–2,600,000 per year. Compliance with regulatory health data requirements may cost between KES 650,000–1,560,000 annually. Workforce-related expenses, including hiring virtual care coordinators, range from KES 3,900,000–7,800,000 per staff member yearly. Individual telehealth consultations are projected to cost KES 1,300–6,500 per session, depending on specialist involvement.

Additionally, maintaining patient engagement and support services incurs annual costs of KES 650,000–1,950,000**,** covering SMS reminders, virtual follow-ups, and chatbot integration. Providing internet subsidies for low-income patients requires KES 2,600–6,500 per patient per year.

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Long-Term Cost Projections and Financial Modeling

To ensure VCC sustainability, a five-year financial projection estimates initial **s**etup costs of KES 24.45M and annual operational costs of KES 12M, covering telehealth platforms, digital literacy training, and compliance measures [12]. In parallel, potential savings from reduced hospital admissions, lower patient transport costs, and improved care efficiency are projected to reach KES 70M**,** making the initiative nearly cost-neutral by year five [17]. Policymakers should partner with telecom providers to subsidize mobile data, launch government-backed pilot programs to reduce start-up costs, and explore insurance reimbursement for virtual consultations to enhance financial viability [10].

Health Regulations in Kenya and Global Comparisons

Kenya's healthcare system operates under the regulatory framework established by the Ministry of Health (MoH**)** and other agencies such as the Pharmacy and Poisons Board (PPB) and the Kenya Medical Practitioners and Dentists Council (KMPDC)**.** The Health Act, 2017**,** governs healthcare service provision, ensuring adherence to quality standards and patient safety. The Data Protection Act, 2019**,** also plays a crucial role in regulating digital health services, ensuring compliance with privacy and security standards.

In comparison to global standards, Kenya's health regulations align with World Health Organization (WHO) guidelines on universal health coverage, patient safety, and digital health governance. However, challenges such as inconsistent enforcement, limited infrastructure, and gaps in data security persist. Developed countries such as the United States (under HIPAA regulations) and the European Union (under GDPR) have more stringent digital health policies, ensuring robust patient data protection and interoperability across healthcare systems. Kenya is progressively strengthening its framework to align with these global standards, emphasizing data privacy, quality assurance, and equitable healthcare access.

Scaling Strategies for VCC in LMICs

To achieve widespread adoption, government policy integration, private-sector partnerships, and community engagement are essential. Policymakers should incorporate VCC into national diabetes strategies and strengthen regulatory frameworks for private-sector investment while ensuring data security [17]. Public-private partnerships with mobile network operators and health-tech start-u**ps** can expand digital access and enhance platform usability [16]. Community-based digital literacy programs should be prioritized to support patient adoption, particularly in low-income and elderly populations [15]. Additionally, AI-driven analytics and real-time monitoring dashboards should be leveraged to track patient outcomes and improve intervention strategies [11].

Unanswered Questions and Future Research

While this review identifies clear benefits of VCC, several gaps remain. Future research should focus on long-term studies to evaluate the sustainability and cost-effectiveness of VCC interventions in LMICs. Additionally, studies exploring culturally tailored interventions and strategies to address digital literacy deficits will be critical for maximizing VCC's impact. Addressing equity issues, particularly those related to geographic and socioeconomic disparities, should also be prioritized to ensure that VCC benefits are equitably distributed across populations.

Limitations

This study is subject to several limitations that may influence the interpretation of the findings. Firstly, the exclusion of non-English studies potentially limits the comprehensiveness of the review and introduces language bias. Secondly, a reliance on self-reported outcomes in some studies may lead to subjective biases affecting the reliability of results. Additionally, the variability in study designs and intervention models complicates direct comparisons across studies, potentially influencing the generalizability of findings. Lastly, the review's focus on recent publications excludes potentially relevant earlier studies, which may have provided additional context or historical insights.

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CONCLUSION

This systematic review highlights the effectiveness of virtual care coordination (VCC) in improving glycemic control, reducing hospital readmissions, and enhancing patient satisfaction in diabetes management, particularly in LMICs. However, significant barriers to implementation, including digital literacy gaps and infrastructural deficits, must be addressed to optimize its impact. The findings underscore the potential of integrating VCC into existing healthcare systems to enhance accessibility and efficiency in resource-constrained settings. Future research should focus on long-term sustainability, cost-effectiveness, and culturally tailored interventions to ensure equitable access to VCC solutions.

What is already known on this topic

- Virtual care coordination has demonstrated effectiveness in improving glycemic control and patient satisfaction in high-income settings.
- Barriers such as digital literacy and infrastructural deficits hinder the scalability of digital health interventions in LMICs.
- Integrated care models combining telemedicine and mHealth applications show better outcomes than standalone interventions.

What this study adds

- Provides evidence of VCC's effectiveness in reducing HbA1c and hospital readmissions in LMICs.
- Identifies unique implementation challenges in resource-constrained settings, including cultural resistance and inequities in access.
- Highlights the importance of multi-modal intervention designs and culturally tailored solutions for successful implementation in LMICs.

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