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Digital Health Interventions for Gestational Diabetes Management in Low-Resource Settings

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ABSTRACT

Gestational diabetes mellitus (GDM) is a rising public health concern in low-resource settings, where limited infrastructure and workforce shortages hinder effective screening, diagnosis, and management. Poorly controlled GDM increased risks of maternal complications, neonatal morbidity, and long-term metabolic disease. Digital health interventions, including mobile health (mHealth) applications, telemedicine, decision-support systems, and wearable technologies, have emerged as innovative strategies to improve GDM management by enhancing access to care, supporting patient self-monitoring, and enabling remote clinician engagement. The purpose of this review was to synthesize evidence on the clinical efficacy and implementation of digital health interventions for GDM in low-resource settings. A narrative synthesis was conducted by searching PubMed, Scopus, and Web of Science for articles published between 2012 and 2025, focusing on randomized controlled trials, implementation studies, and high-quality reviews relevant to digital health and GDM. Findings indicated that mobile platforms for glucose monitoring and lifestyle counseling improve glycemic control, with reported mean reductions in fasting blood glucose of 0.4–0.8 mmol/L and HbA1c reductions of up to 0.5% compared with standard care. Telemedicine and community-based digital tools also improved adherence to medical nutrition therapy and facilitated timely insulin initiation. Challenges included limited connectivity, device affordability, literacy barriers, and lack of tailored content for local populations. Evidence supports the potential of digital health interventions to mitigate structural gaps in GDM management, provided they are integrated into broader health system strengthening initiatives.

Keywords: Gestational diabetes, Digital health, Low-resource settings, Telemedicine, Mobile health

INTRODUCTION

Gestational diabetes mellitus (GDM) affects approximately 14% of pregnancies globally, representing over 18 million cases annually, with the highest prevalence reported in low- and middle-income countries [1,3]. Sub-Saharan Africa and South Asia face a disproportionate burden due to increasing maternal obesity, sedentary lifestyles, and limited access to screening services [4]. Poorly controlled GDM is associated with a two- to three-fold increased risk of preeclampsia, cesarean delivery, and macrosomia, while offspring face a higher likelihood of neonatal hypoglycemia, obesity, and type 2 diabetes later in life [5]. Alarmingly, most women with GDM progress to type 2 diabetes within 10 years postpartum [6].

In low-resource settings, barriers to optimal GDM management include inadequate laboratory capacity, shortages of skilled clinicians, and sociocultural obstacles to dietary counseling and adherence [7]. Daily glucose monitoring and frequent antenatal visits are often unattainable. Consequently, innovative solutions are required to address gaps in care. Digital health interventions offer a promising pathway, leveraging mobile health (mHealth) applications, teleconsultations, remote monitoring, and decision-support platforms to expand access to screening, treatment, and education [8]. This review first examines the role of mobile and telemedicine platforms in improving GDM detection and monitoring, then discusses their effects on maternal and neonatal outcomes, and finally considers barriers, implementation challenges, and future directions. The purpose of this synthesis is to critically appraise evidence on digital health interventions for GDM in low-resource settings, highlighting both opportunities and limitations to guide clinicians, policymakers, and researchers.

Mobile Health Applications for GDM Management

Mobile health (mHealth) applications enable pregnant women to self-monitor glucose levels, record dietary intake, and receive lifestyle counseling. Randomized trials in low-resource settings demonstrate significant improvements

in fasting blood glucose control, with mean reductions of 0.4–0.8 mmol/L compared to standard care [9]. HbA1c reductions of 0.3–0.5% have also been reported [10]. Applications incorporating culturally adapted dietary guidance enhanced patient adherence to medical nutrition therapy, resulting in lower postprandial glucose excursions [11].

SMS-based reminders improve appointment attendance and medication adherence by 20–30% in resource-limited populations [12]. Digital tools also facilitate communication between patients and midwives, reducing delays in clinical decision-making [13]. However, device affordability and digital literacy remain major challenges.

Telemedicine and Remote Monitoring

Telemedicine platforms bridge geographical gaps by connecting individuals in rural areas with specialist care. Studies report that remote consultations reduce missed clinic visits by 35% and improve timely initiation of insulin therapy when indicated [14]. Real-time transmission of glucose data through Bluetooth-enabled glucometers improves clinician oversight, allowing rapid dose adjustments [15].

Remote monitoring also enhances maternal satisfaction and reduces travel costs, an important consideration in low-resource environments [16]. In trials conducted in India and Kenya, telemedicine reduced rates of macrosomia by 18% and neonatal intensive care admissions by 22% [17,18]. These findings highlight the potential of digital tools to improve both maternal and infant outcomes.

Decision-Support Systems and Artificial Intelligence

Clinical decision-support systems (CDSS) integrated into antenatal clinics provide algorithms for risk stratification and personalized treatment. Artificial intelligence (AI) models using machine learning predict the need for pharmacotherapy with accuracy exceeding 80% [19]. Such tools reduce clinician workload and standardize care delivery in environments with limited endocrinology expertise [20].

However, validation in diverse populations is essential, as predictive models trained in high-income countries may underperform in resource-limited contexts [21]. Integration into national electronic health records remains another key challenge.

Impact on Maternal and Neonatal Outcomes

Digital health interventions are consistently associated with improved maternal outcomes. Mean fasting blood glucose decreased by 0.5 mmol/L, and insulin initiation occurred earlier in intervention groups compared with usual care [22]. Reductions in gestational hypertension and cesarean section rates have also been observed [23].

For neonates, interventions lowered the incidence of macrosomia by 15–20% and neonatal hypoglycemia by 12% [24]. Exclusive breastfeeding rates improved when digital platforms incorporated postnatal education [25]. These findings suggest that digital health interventions can directly improve perinatal health outcomes in resource-constrained settings.

Implementation Challenges in Low-Resource Settings

Despite promising outcomes, several barriers limit widespread adoption. Internet penetration in sub-Saharan Africa remains below 40%, and smartphone ownership among women of reproductive age is often under 30% [26]. Digital health literacy gaps hinder effective use, particularly in rural areas [27]. Moreover, costs associated with devices, data plans, and software licensing limit scalability [28].

Sociocultural barriers, including mistrust of digital platforms and gender-based restrictions on mobile phone use, further restrict utilization [29]. Data privacy and security concerns also require regulatory frameworks, which are often lacking in low-resource environments [30].

Future Directions and Research Priorities

Future research should focus on hybrid models combining digital interventions with community health workers to address literacy barriers [31]. Development of offline-compatible tools and use of low-cost SMS platforms may improve reach [32]. Rigorous cost-effectiveness analyses are necessary to guide policymakers in scaling interventions [33].

Emerging technologies such as continuous glucose monitoring integrated with mHealth apps hold promise, but affordability and sustainability must be addressed before large-scale implementation [34]. Collaborative frameworks between governments, private sector, and international organizations will be essential for equitable deployment [35].

CONCLUSION

Digital health interventions provide an innovative pathway to strengthen gestational diabetes management in low-resource settings. Evidence supports their efficacy in improving glycemic control, maternal adherence, and neonatal outcomes. Mobile health applications, telemedicine platforms, and decision-support systems can mitigate gaps in specialist availability, reduce healthcare costs, and enhance patient engagement. However, significant challenges remain, including limited digital infrastructure, affordability, literacy barriers, and sociocultural obstacles. Addressing these constraints requires multidisciplinary collaboration and health system integration. Future research should emphasize context-specific adaptation, long-term sustainability, and rigorous evaluation of cost-

effectiveness. Clinicians and policymakers should prioritize the integration of culturally adapted, affordable digital health interventions into antenatal care systems for gestational diabetes in low-resource settings.

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