REVIEW ARTICLE

Effectiveness of Smartphone Applications in Achieving Glycemic Control Among Adult Diabetic Patients: A Meta-Analysis

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Background: Diabetes Mellitus Type 2 is a significant global health issue with a high prevalence in the Philippines. Managing this condition effectively is crucial, and digital technologies, particularly smartphone (mHealth) applications, have emerged as a potential tool in diabetes self-management.

Objective: This study evaluated the effectiveness of smartphone (mHealth) application use in achieving glycemic control among adults with Type 2 Diabetes Mellitus, focusing on HbA1c levels and medication adherence.

Method: This systematic review and meta-analysis, adhering to PRISMA guidelines, analyzed randomized controlled trials from databases like PubMed and Embase, comparing interventions using mHealth applications with standard care. The primary measures were HbA1c levels and medication adherence.

Results: Ten studies involving 20,984 participants were included in the meta-analysis. Using mHealth applications led to an average HbA1c reduction of 0.36%, indicating improved glycemic control. There was considerable heterogeneity ($I^2 = 91\%$) because of the clinical and methodological diversity of the included studies. Subgroup analysis showed that the younger and older age groups, shorter and longer T2DM duration, and lower and higher HbA1c baseline benefited from its use. Sensitivity analysis still showed high heterogeneity (95%-97%), reflecting clinical diversity. A narrative analysis of two studies highlighted the utility of mHealth applications in tracking diet, physical activity, and vital stats, aiding medication adherence through reminders and data sharing with healthcare providers.

Conclusion/Recommendations: This systematic review and meta-analysis showed the effectiveness of mHealth application use in achieving glycemic control among adults with Type 2 Diabetes Mellitus by improving HbA1c levels and medication adherence. Integrating mHealth applications as adjuncts in family and community medicine as part of personalized care for managing type 2 diabetes in the Philippines can help achieve glycemic control and medication adherence. Future studies should focus on longitudinal assessments, exploring cultural and linguistic factors in the Filipino context to optimize diabetes care within this specialized medical framework.

Key words: Mobile applications, blood glucose self-monitoring, diabetes mellitus, type 2

Introduction

Diabetes Mellitus Type 2, characterized by insulin resistance and a declining insulin secretion capability, is a significant global health issue, affecting about 537 million adults worldwide.[1] Its prevalence in the Philippines stands at 7.1%, with a notable portion of cases undetected, leading to a considerable mortality rate among those under 60 years old.[2] The economic impact of undiagnosed diabetes is substantial, encompassing direct healthcare costs and indirect expenses like lost productivity and disability. This condition also adversely affects mental health and daily life. Management strategies focus on achieving reasonable glycemic control, ideally an A1c below 7% for non-pregnant adults, through lifestyle changes, medication, and education.[3] The rise of digital technology, particularly mobile health (mHealth)

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applications, represents a significant evolution in self-management for chronic diseases like diabetes.[4-5] Defined as using mobile devices for medical and public health practices, mHealth, offers innovative health information transfer between patients and practitioners and includes tools for tracking patient data, providing lifestyle education, and facilitating more accessible methods like automated carbohydrate counting.[6-9]

Recent research emphasizes integrating information technology, specifically mHealth applications, in diabetes management. Studies collectively highlight the effectiveness of mHealth applications in fostering proactive patient behaviors crucial for effective diabetes management and increasing user satisfaction, suggesting their potential role in national health systems to improve healthcare delivery through timely assessments and remote monitoring, particularly in resource-limited and hard-to-reach areas.[10-12] The American Association of Diabetes (2023) underscored the critical role of mHealth in improving diabetic care.[13]

However, the previous studies also reveal significant gaps, particularly regarding the effectiveness of mHealth applications on vital health metrics, specifically hemoglobin A1c (HbA1c) levels, a crucial indicator for glycemic control. This gap is pronounced in exploring the performance of these tools across diverse community settings characterized by varying levels of technological access and health literacy.[14] Another notable deficiency is in the educational aspects of mHealth applications. Despite their proven effectiveness in managing basic tasks, there's a discernible gap in features that enable comprehensive glucose monitoring, tracking of hypoglycemic episodes, and logging detailed dietary histories – components integral to a more inclusive and effective diabetes management approach. This paper investigates the effectiveness of mHealth application use in achieving glycemic control among diabetic patients. This paper likewise addresses the pressing need for effective management of Diabetes Mellitus Type 2 by providing baseline data for educational aspects of mHealth applications through accessible, patient-centric information technology solutions, particularly in the Filipino context. Hopefully, this will pave the way for future collaboration with local software developers to integrate educational aspects tailor-made for Filipino diabetic patients, and automate glucose level monitoring and dietary intake, thereby contributing to advancing patient-centered care strategies and public health policy in the Philippines.

The objective was to evaluate the effectiveness of smartphone (mHealth) application use in achieving glycemic control among patients with type 2 Diabetes Mellitus.

Methods

Study Design

This systematic review and meta-analysis, compliant with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines[15], aimed to evaluate the effectiveness of mHealth applications in enhancing glycemic control among adults with type 2 diabetes mellitus (T2DM). The objective was to evaluate the effectiveness of mHealth applications in achieving glycemic control against standard care without app support, and medication among patients with type 2 Diabetes Mellitus. A comprehensive literature search was conducted in databases including PubMed, Embase, Central, Cochrane, Web of Science, Proquest, and Scopus, encompassing publications in English up to May 2023. Inclusion criteria specified clinical or randomized control trials. Data extraction followed a standardized protocol, utilizing Comprehensive Meta-Analysis V.3 for statistical analysis. The approach centered on pairwise comparisons using standard mean differences (SMDs) and mean differences (MDs), presented with 95% confidence intervals to determine the efficacy. To ensure a comprehensive evaluation, the analysis was extended to include subgroup (exploring variations across demographics, disease duration, and baseline HbA1c) and sensitivity analyses (assessing result stability under various conditions). The quality of studies was assessed using the Cochrane Risk of Bias Tool, and publication bias was examined with funnel plots and Egger's regression test, providing a thorough and multifaceted assessment of mHealth applications in T2DM management.

Literature Search

In this systematic review and meta-analysis, the clinical question evaluated the effectiveness of mHealth application use on glycemic control and medication adherence among adults with type 2 diabetes mellitus (T2DM). Studies included were English-only peer-reviewed studies published from 2017 to 2023 involving adult patients (18 years and older) in randomized control trials, comparing those managed with and without mHealth applications and focusing on glycemic control. Exclusions encompassed studies on hospitalized patients, diabetic emergencies, or those where Relative Risk could not be derived. The literature search, conducted from June 1 to July 15, 2023, spanned databases like PubMed, Embase, Central, Cochrane, Web of Science, Proquest, and Scopus, supplemented by manual searches of organizational websites and scrutiny of reference lists from relevant articles. The targeted search strategy involved keywords related to T2DM and within the glycemic control domain, applying stringent filters to remove duplicates and non-English studies, and ensuring a comprehensive synthesis of pertinent literature up to May 2023.

Study Selection and Assessment of Quality

The study selection process began with two independent reviewers (EACT and JJGA) screening titles and abstracts against predefined inclusion criteria, ensuring relevance to the research objectives. In instances of disagreement or ambiguity about a study's eligibility, a third reviewer (MRAE) was involved to achieve consensus before proceeding to a full-text review. The full texts of preliminarily selected studies were independently assessed against the inclusion criteria. Conflicts in opinions during this stage were resolved through collaborative discussions or, if necessary, with the intervention of a third reviewer for adjudication. To evaluate the methodological quality and risk of bias in the included studies, the Cochrane Risk of Bias Tool for Randomized Controlled Trials V.2.0 was used.[16] Each study was independently assessed by team members, covering critical areas such as the randomization process and management of missing outcome

data. Divergences in risk of bias assessments were reconciled through detailed consultations among reviewers, ensuring a consistent and unbiased evaluation and upholding the integrity of this systematic review.

Data Extraction

Data extraction was performed by two independent reviewers. Detailed data and outcomes extracted from each study encompassed changes in HbA1c levels and medication adherence rates pertinent to diabetes management. These outcomes were clearly defined beforehand and included specific time points of measurement. Interventions were systematically categorized and defined based on the type and functionality of the mHealth application used, including features like glucose tracking, medication reminders, and dietary advice. The interventions were juxtaposed for comparative analysis with control groups that did not utilize mHealth applications. The comparison groups were defined based on similar parameters but without the intervention of mHealth applications. Additionally, variables such as potential conflicts of interest and funding sources were noted for each study. The reviewers used a standardized data extraction form to compile the information from full-text articles. Any disagreements regarding data extraction were resolved through discussion or, if necessary, by consulting a third reviewer. Assumptions regarding missing or unclear data were minimized by contacting study authors for clarification when possible, and all such instances were documented to ensure transparency in the data synthesis process.

Statistical Analysis

Comparisons were drawn between the use of mHealth applications as adjuncts and standard care in managing glycemic control among patients with type 2 diabetes, with outcomes such as HbA1c levels and medication adherence being the focal points. The inclusion or exclusion of studies in these comparisons was based on the predefined eligibility criteria detailed earlier. In this meta-analysis, a random-effects model was employed to calculate standard mean differences (SMDs) for continuous data, allowing for the pooling of effect sizes even in the presence of between-study variance. The Comprehensive Meta-Analysis V.3 software was used to facilitate this process, which included the assessment of statistical heterogeneity through the I^2 statistic: expressed as low (less than 25%), moderate (26%–74%), or high (more than 75%), and, importantly, interpreted according to its general context. Effect measures and the assessment of the quality of studies were graphically presented using forest plots, and publication bias was evaluated using funnel plots and Egger's regression test. Detailed subgroup analyses were done to explore heterogeneity causes across patient demographics, diabetes duration, and baseline HbA1c, and sensitivity analyses were conducted by excluding studies with high-bias risks or outdated data. This meticulous approach underpinned the soundness of the conclusions. Ethical approval for this study was granted by the hospital's Institutional Ethics Review Board (IERB), and registered with PROSPERO with an identification code of CRD42023487920.

Results

The systematic search yielded 2160 articles, from which 305 duplicates or non-English publications were removed. After an initial review of 2080 papers for eligibility based on title and abstract, full texts for 37 articles were retrieved. Of these, 25 were excluded due to ineligible populations, interventions, research designs, or outcomes. Consequently, two studies were included in the narrative analysis, while 10 were included in the final analysis. The studies, conducted across Asia and Europe, comprised a review population of 20,984 participants, with disease durations ranging from 6 months to 18 years. These were randomized controlled trials (RCTs), primarily single-blind, open-label, and exploratory. Most studies took place in primary healthcare settings, with interventions spanning from 6 weeks to 6 months, focusing on daily self-management support, with two also providing education.

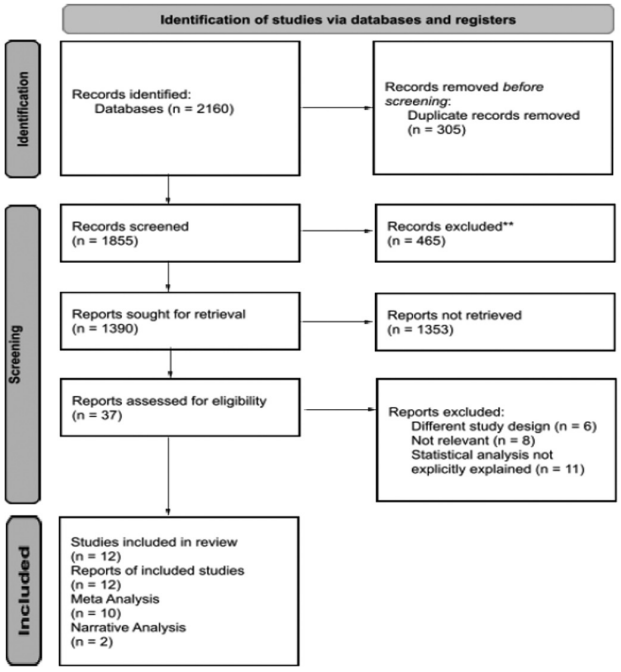

Figure 1. PRISMA flow diagram.

The meta-analysis comprehensively evaluated ten studies, all centered around mHealth applications as adjuncts in diabetes management but varied in setting and approach. Most were conducted in primary healthcare (PHC) settings, with one study in a tertiary clinic. These studies, diverse in methodologies and patient demographics, including age, gender, chronicity of diabetes, comorbidities, and medication regimens, had intervention periods ranging from 6 weeks to 6 months. The daily interventions primarily focused on self-management support, with two studies offering self-management support and education. The quality of these studies was stringently evaluated using the Cochrane Risk of Bias tool, resulting in four studies categorized as low risk[17,18,19,20] indicating high quality, four with moderate concerns[21,22,24] and two rated as high risk[25,26] suggesting lower quality. Studies excluded from the analysis typically did not align

with the set criteria concerning population, intervention, design, or outcomes. Specifically, those not employing mHealth applications or failing to report on glycemic control, thereby refining the focus and enhancing the quality of this review.

Table 1. Characteristics of included studies.

Study	Study Title	Study Design	Sample size	Population characteristics	Intervention Details	Comparison	Outcome Measures	Duration of Follow Up	Key Findings	Country of Study
Eva Hilmarsdóttir et al., 2021	A Digital Lifestyle Program in Outpatient Treatment of Type 2 Diabetes: A Randomized Controlled Study	Randomized Controlled Study	30	Patients with Type 2 Diabete, Average age 51.2 ± 10.6 years	Use of the Side kick Health smartphone application along with standard care	Standard care only	Body weight, HbA1c, blood lipids, distress related to diabetes, quality of life, depression, anxiety	6 months	Significant decrease in HbA1c, disease-specific distress, and anxiety symptoms in the intervention group	Iceland
Turki Alanzi et al., 2018	Evaluation of the effectiveness of mobile diabetes management system with social networking and cognitive behavioural therapy (CBT) for T2D	Randomized Controlled Trial (RCT)	19	Patients with Type 2 Diabetes from Saudi Arabia-Dammam	Use of the SANAD system along with conventional diabetes treatment	Conventional diabetes treatment only	HbA1c, Diabetes Knowledge Test (DKT), Self-efficacy Scale (SES)	Not specified	Significant decrease in HbA1c, increase in diabetes knowledge and self-efficacy scores	Saudi Arabia
Weiping Jia et al., 2021	Evaluation of an mHealth-enabled hierarchical diabetes management intervention in primary care in China (ROADMAP): A cluster randomized trial	Cluster Randomized Controlled Trial (cRCT)	17554	Registered patients with type 2 diabetes in primary care, China	mHealth-mediated service package, monthly blood glucose monitoring, capacity building, and quarterly performance review	Usual care	Control of HbA1c, blood pressure, LDL-C, changes in FBG and body weight, episodes of hypoglycemia	12 months	Significant improvement in HbA1c control rate and composite ABC control rate, no difference in hypoglycemia and weight gain	China
Nora J Kleinman et al., 2017	Improved Medication Adherence & Frequency of Blood Glucose Self-Testing Using an m-Health Platform Versus Usual Care in a Multisite Randomized Clinical Trial Among People with Type 2 DM in India	Randomized Clinical Trial	91	People with Type 2 Diabetes, aged 18-65, India	m-Health app and mobile phone data stipend along with free visits, lab tests, transportation, and diabetes management supplies	Usual care with free visits, lab tests, transportation, and diabetes management supplies	A1c change, medication adherence, frequency of BG self-testing, patient and provider satisfaction, app usage	6 months	Increased medication adherence and frequency of BG testing in the intervention group, high app usage and satisfaction	India
Jun Yang Lee et al., 2017	Telemonitoring in fasting individuals with Type 2 Diabetes Mellitus during Ramadan: A prospective, randomised controlled study	Randomised Controlled Study	85	Patients with Type 2 Diabetes fasting during Ramadan	Remote blood glucose telemonitoring program with feedback during Ramadan	Conventional self-monitoring	Incidence of hypoglycaemia during Ramadan, glycated haemoglobin levels	12 weeks	Lower incidence of hypoglycaemia and reduction in HbA1c levels in the telemonitoring group	Malaysia
Da Young Lee et al., 2020	Effect of Voluntary Participation on Mobile Health Care in Diabetes Management: Randomized Controlled Open-Label Trial	Randomized Controlled Open-Label Trial	72	Patients with Type 2 Diabetes	mHealth-based diabetes self-management education through a mobile app, individualized feedback from healthcare professionals	Previous diabetes management strategies	HbA1c level, BMI, blood pressure, lipid profile, various questionnaire scores	6 months	Improvement in glycemic control, diabetes self-management skills, and lowering of diabetes-related distress	South Korea

Study	Study Title	Study Design	Sample size	Popula-tion characteristics	Intervention Details	Comparison	Outcome Measures	Duration of Follow Up	Key Findings	Country of Study
Su Lin Lim et al., 2021	Effect of a Smartphone App on Weight Change and Metabolic Outcomes in Asian Adults With Type 2 Diabetes: A Randomized Clinical Trial	Randomized Clinical Trial	305	Asian adults with Type 2 Diabetes and BMI ≥ 23	Smartphone app to track weight, diet, physical activity, and blood glucose, communicati on with dietitians for 6 months	Diet and physical activity advice from a dietitian	Change in body weight, HbA1c, fasting blood glucose, blood pressure, lipids, diet	6 months	Greater reductions in weight and HbA1c levels in the intervention group, with a greater proportion having a reduction in diabetes medications	Singapore
Yanmei Wang et al., 2019	Effects of continuous care for patients with type 2 diabetes using mobile health application: A randomised controlled trial	Randomized Controlled Trial	120	Patients with Type 2 Diabetes	Continuous care based on mobile phone application	Conventional care	Glycemic Haemoglobin levels, blood glucose levels, self-care abilities, disease cognition abilities, number of readmissions	Not specified	Improvements in disease awareness, self-management abilities, GH levels, blood glucose levels, and reduced rehospitalisatio n frequency	China
Yeoree Yang et al., 2020	Effect of a Mobile Phone – Based Glucose-Monitoring and Feedback System for Type 2 Diabetes Management in Multiple Primary Care Clinic Settings: Cluster Randomized Controlled Trial	Cluster Randomized Controlled Trial	247	Patients with Type 2 Diabetes in primary care clinics	Mobile phone-based glucose-monitoring and feedback system	Face-to-face physicians' consultation	HbA1c, fasting plasma glucose, blood pressure, treatment satisfaction and compliance	3 months	More improvement in HbA1c, fasting plasma glucose, blood pressure, treatment satisfaction and motivation in the intervention group	South Korea
Yuan Yu et al., 2019	Effects of mobile phone application combined with or without self-monitoring of blood glucose on glycemic control in patients with diabetes: A randomized controlled trial	Randomized Controlled Trial	185	Patients with Diabetes	Mobile phone application (MPA) combined with or without self-monitoring of blood glucose (SMBG)	Groups with no MPA and no SMBG, SMBG only, MPA only	HbA1c, fasting plasma glucose, 1,5-anhydroglucit ol	24 weeks	Significant improvement in HbA1c levels, especially in groups with MPA, no significant effect on HbA1c change for SMBG intervention	China

The Forrest plot evaluated the efficacy of using mHealth applications as adjuncts versus standard care for managing type 2 diabetes mellitus (T2DM). It demonstrated a statistically significant pooled MD in HbA1c levels, favoring mHealth applications with a decrease of 0.36% (95% CI: -0.46% to -0.27%), indicating improved glycemic control through mHealth application use. The heterogeneity across studies was notable ($I^2 = 91\%$), likely stemming from variations in methodology, patient populations, and intervention lengths. To tackle the notable heterogeneity ($I^2 = 91\%$) seen in the forest plot, subgroup analyses were performed: younger versus older age group, shorter versus longer DM duration, and lower versus higher HbA1c baseline. There was no significant difference between the younger (MD -0.34) and older (MD -0.35) age groups (I^2=0%, p=0.99, total MD -0.36)); shorter (MD -0.51) versus longer (MD -0. 52) T2DM duration (I^2=0%, p=0.95, total MD -0.51)); and lower (MD -0.34) versus higher (MD -0.36) HbA1c baseline (I^2=0%, p=0.94, total MD -0.33)).

Variations in the risk of bias were noted among the individual studies, including deviations from intended interventions and inconsistencies in HbA1c outcome measurements (Figures 3 - 5). Potential reporting or publication biases, as indicated by the funnel plot (Figure 6), displayed an asymmetrical distribution with sparse data points on the right side, suggesting an underrepresentation of smaller studies or those with less favorable HbA1c outcomes. Sensitivity analyses, aimed at assessing the robustness of results, involved excluding studies stepwise to identify causes of heterogeneity, indicated by an I^2 statistic remaining high (95%-97%). This suggested clinical heterogeneity.

A narrative approach was used to evaluate medication adherence, complementing the quantitative analysis of HbA1c outcomes. This was due to the diverse nature of the interventions and the varying metrics used to measure adherence. The studies by Yang[25] and Kleinman[21] illuminated the versatility of mobile applications in diabetes self-management, showcasing their utility in monitoring dietary intake, physical activity, and vital clinical statistics, including blood pressure and glucose levels. These applications further aided patients in managing their medication regimens by providing tracking, scheduling, and the capacity to share data with healthcare providers alongside automated reminders. Participants were equipped with glucose monitors and test

strips to support accurate clinical data collection. Provider portals emerged as a prevalent cointervention, offering a channel for physicians to access patient data and deliver feedback, enhancing the interactive component of diabetes management. Additional reminders in some studies added another layer of support. The narrative synthesis of these disparate and complex interventions against the backdrop of routine care provided by control groups highlights the enriched, multifaceted support mHealth applications offer physicians managing diabetes, emphasizing their significant role in contemporary family medicine practice.

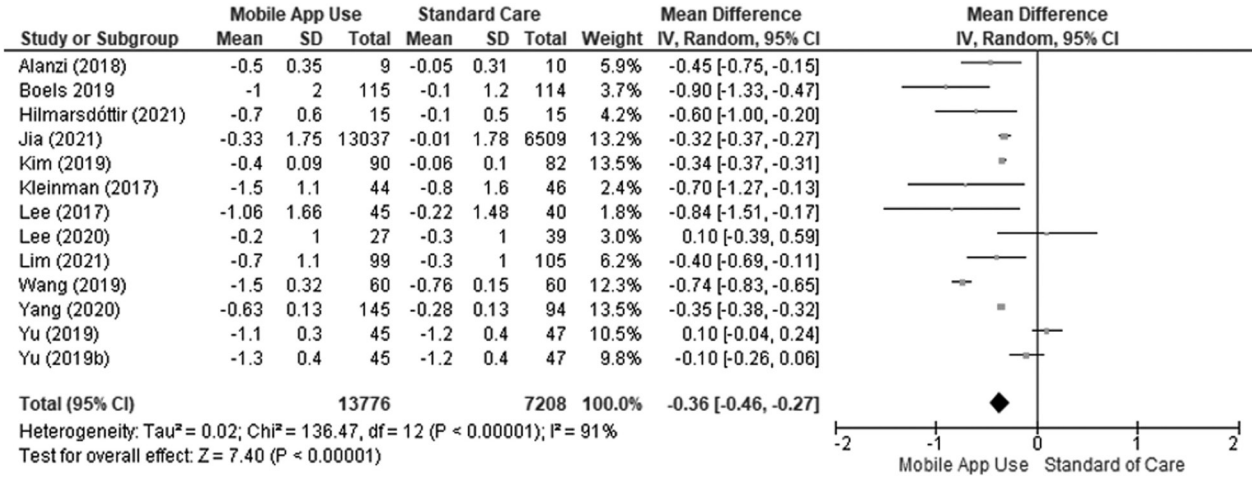

Figure 2. Forest plot illustrating comparative efficacy of mobile application usage versus standard care in glycemic management for type 2 diabetes mellitus patients.

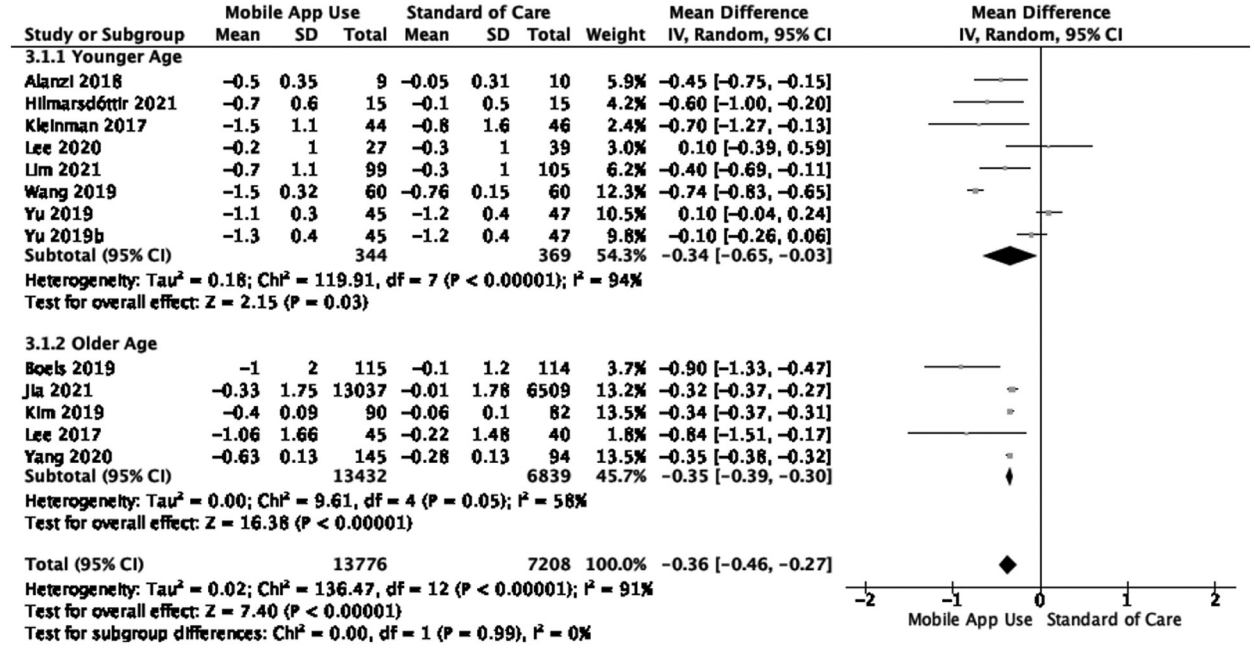

Figure 3a. Forest plot displaying subgroup analysis of glycemic control in younger vs. older patients with type 2 diabetes mellitus: comparative efficacy of mobile application use versus standard care.

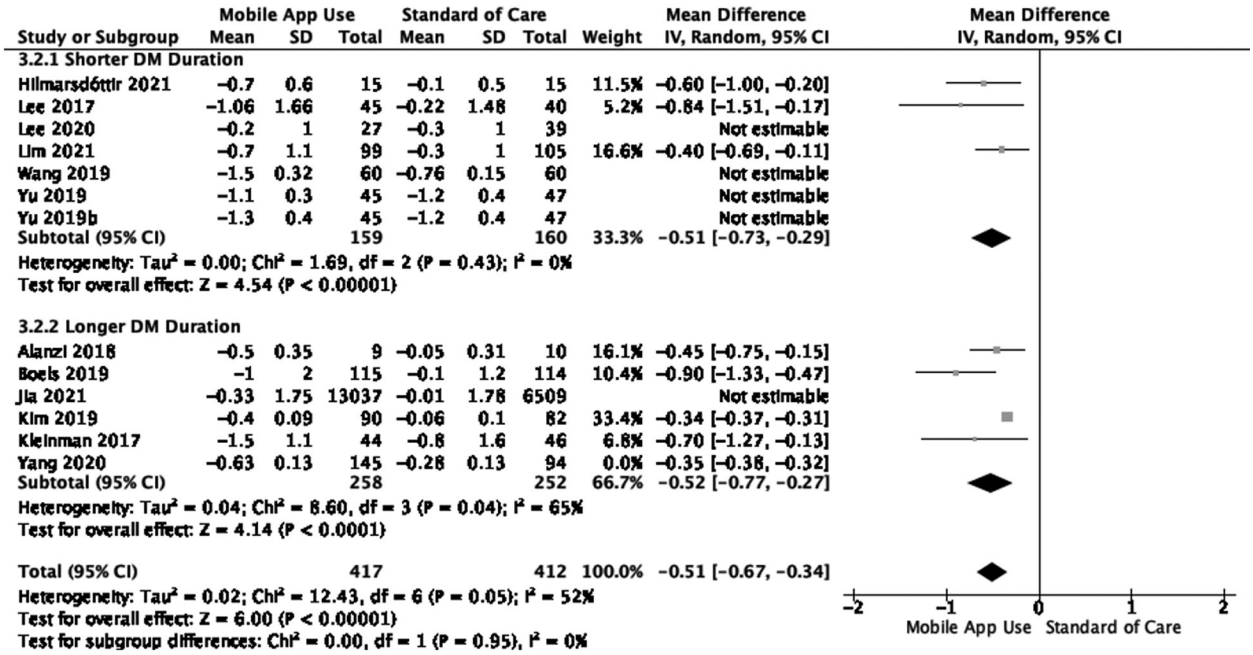

Figure 3b. Forest plot displaying subgroup analysis of glycemic control in shorter vs. longer DM duration: comparative efficacy of mobile application use versus standard care.

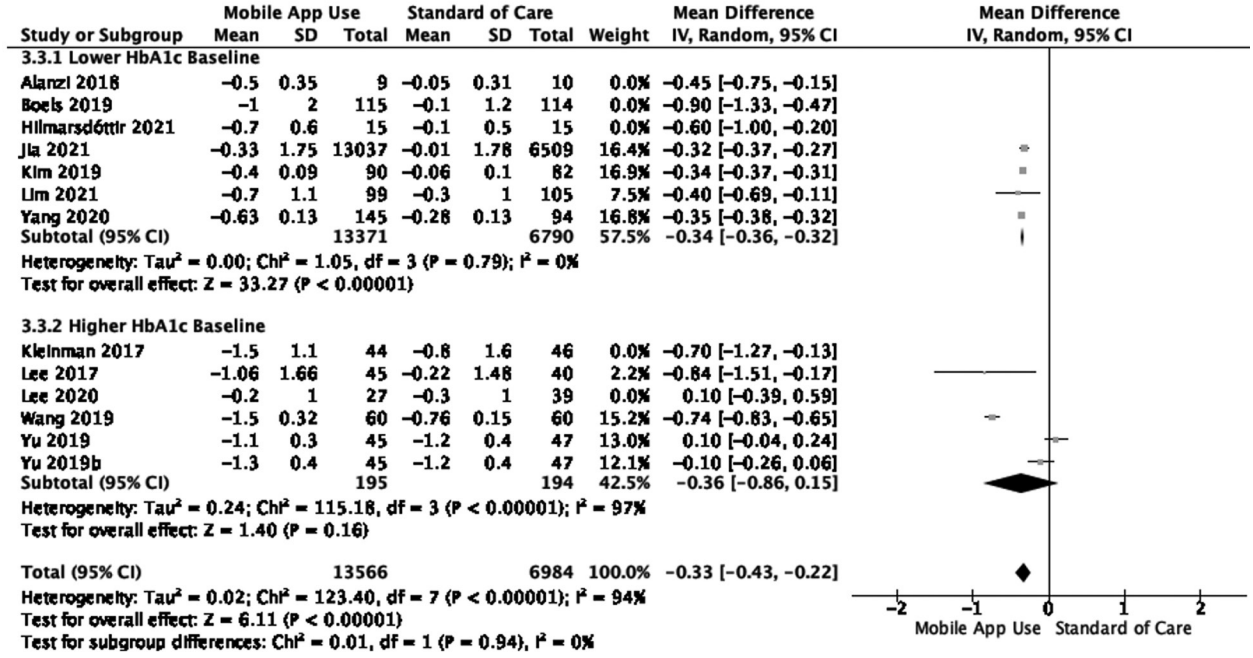

Figure 3c. Forest plot displaying subgroup analysis of glycemic control in lower vs. higher baseline hba1c: comparative efficacy of mobile application use versus standard care.

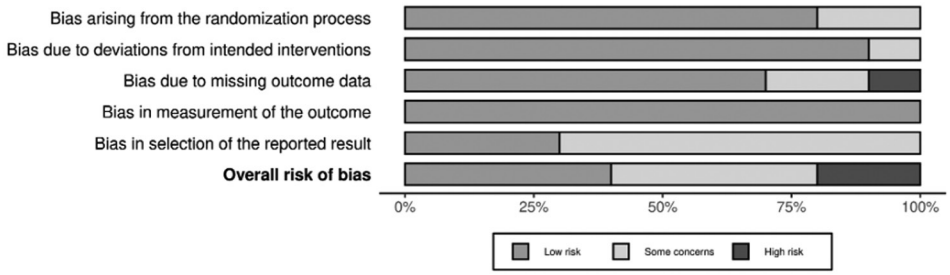

Figure 4. Risk of bias summary for randomized controlled trials comparing mobile application usage with standard care.

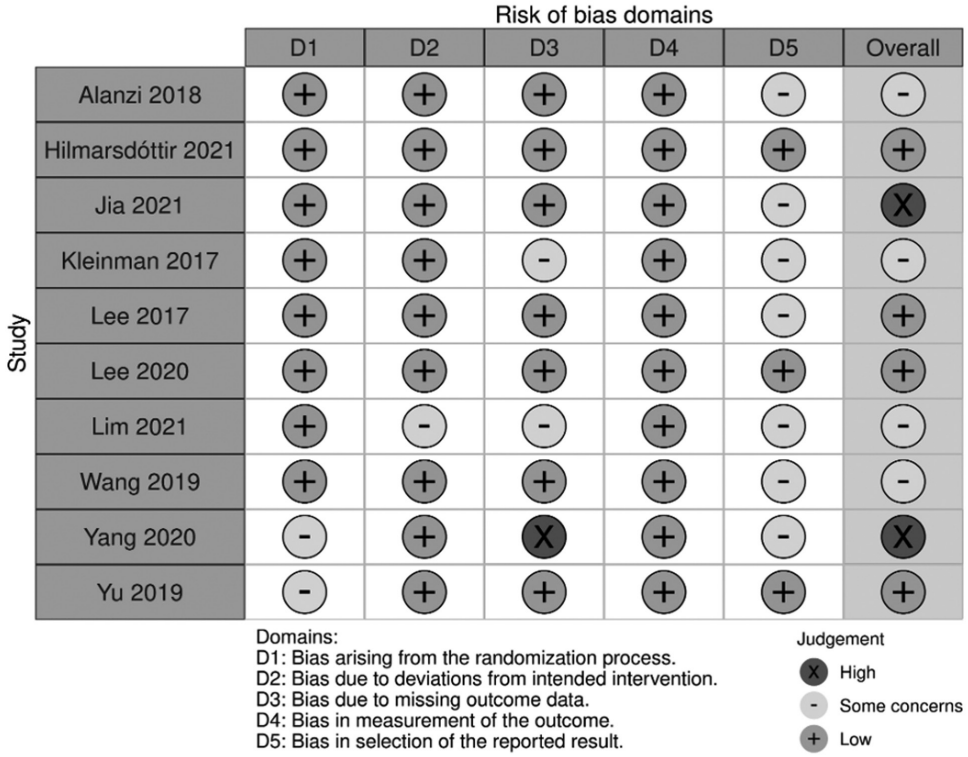

Figure 5. Risk of bias assessment detailing individual study contributions in mobile health application versus standard care analysis.

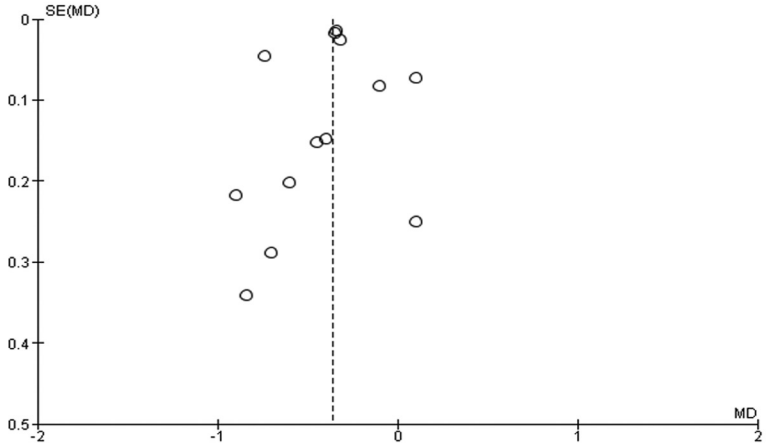

Figure 6. Funnel plot depicting comparison of mobile application usage versus standard care in glycemic management.

Discussion

The results show a pivotal interpretation of the effectiveness of mHealth applications as adjuncts in managing T2DM. By analyzing data from ten studies with 20,984 participants, there was a significant pooled mean reduction of 0.36% in HbA1c levels in patients using mHealth applications as adjuncts compared to those receiving standard care alone. The younger and older age groups, shorter and longer T2DM duration, and lower and higher HbA1c baseline benefited from its use. In the context of other evidence, the narrative analysis suggests that using mHealth applications as an adjunct to routine care is superior to routine care alone for these specific outcomes. The observed improvements in medication adherence and the ability of these applications to facilitate comprehensive diabetes self-management – encompassing dietary monitoring, physical activity, and vital statistics tracking – highlight their transformative potential. This synthesis positions the use of mHealth applications as adjuncts as a more effective intervention for reducing HbA1c levels and improving medication adherence in T2DM patients.

The research underscores the potential role of mHealth applications as adjuncts in diabetes management, offering substantial benefits across various healthcare sectors. These findings support the integration of mHealth applications as adjuncts into family medicine practices, providing a modern, evidence-based approach to diabetes management that is tailored to individual patient needs. For patients, using mHealth applications as adjuncts facilitates a more involved and tailored healthcare experience, allowing real-time monitoring and individualized guidance, thus improving health outcomes. For family and community practice, mHealth application use serves as a practical, community-level tool, enhancing the efficiency of routine family medicine. Healthcare providers can leverage these applications to improve patient engagement and medication adherence. For policymakers and health systems, the evidence of the effectiveness of mHealth application use in diabetes management points to the need for policy reinforcement and investment in digital health, potentially improving care quality and reducing healthcare expenses. This research suggests a direction for future collaborations with local software developers to create educational materials specifically for Filipino diabetic patients and to automate glucose monitoring and dietary intake. Such initiatives can potentially advance patient-centered care strategies and public health policies in the Philippines. This paper highlights the transformative potential of mHealth application use in diabetes care, impacting all stakeholders within the healthcare ecosystem.

This meta-analysis aligns with the findings of Bagala et al. (2019) and Yu Heng Kwan et al. (2023), which highlighted the effectiveness of mHealth applications as adjuncts in enhancing glycemic control and medication adherence in diabetes management, likely due to the emphasis on patient engagement and personalized care. This alignment is further supported by a study involving 233 patients, demonstrating a strong inclination towards notifications from mHealth applications and indicating patients' acceptance of digital health tools.[20,29] A large retrospective propensity score-matched cohort study in an Asian population involving 37,913 T2DM patients showed consistent improvements in glycemic control over two years, displaying the same substantial HbA1c reductions as similarly observed in this study.[30] However, an Indonesian systematic review found five studies where changes in HbA1c were not statistically significant. This may be due to the smaller population size included in their studies.[31]

Nevertheless, the robustness of the conclusions is bound by the inherent limitations of the included studies. The high heterogeneity observed among the younger age group and those with higher HbA1c baseline suggests a variance in methodology, demographics, and duration of interventions, potentially impacting the extrapolation of these results to broader populations. The exclusion of non-English language studies may have omitted relevant global data. At the same time, the funnel plot analysis raises the concern of publication bias, possibly leading to an overstatement of the effectiveness of mHealth application use. Additionally, the reliance on self-reported data could introduce reporting bias, and focusing on short-term studies limits insight into the long-term sustainability of benefits. These factors necessitate a prudent analysis interpretation and highlight the imperative for future, more inclusive research.

Conclusion

This meta-analysis showed the effectiveness of mobile health (mHealth) applications in enhancing glycemic control among individuals with type 2 diabetes mellitus, with significant reductions in Hemoglobin A1c levels. Since most of the studies were from Asian countries, these findings highlight the potential of mHealth applications as an adjunct in diabetes management in the Philippines. Future collaboration with local software developers in improving medication adherence through features like reminders, personalized feedback, and educational content tailor-made for Filipino families and communities. Future research should prioritize longitudinal studies, delving into the linguistic and cultural nuances of the Filipino population and employing objective measures for medication adherence and health outcomes to fully realize the potential of mHealth applications in the family medicine context of type 2 diabetes care.

Acknowledgement

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