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Digital Therapeutics for Type 2 Diabetes Management: A Systematic Review of Mobile and Web-Based Interventions for Improving Glycemic Control and Patient Engagement

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ABSTRACT

Background: Type 2 diabetes mellitus (T2DM) is a chronic condition that is common and affects millions worldwide creating an immense burden to the healthcare system. Although traditional management strategies are effective, they unfortunately do tend not to adhere well. Given the rise of digital therapeutics, we rejoice in the arrival of innovative, scalable, and personalized solutions for glycemic control and patient engagement. **Aim:** This systematic review aims to evaluate the effectiveness of mobile or web-based digital therapeutic interventions that are targeted to improve patients' glycemic control and engagement with their T2DM. **Methodology:** Systematic review of peer-reviewed studies published between the years 2015 and 2023 followed PRISMA guidelines. Interventions that improved glycemic control and engagement in the adult T2DM population were included, with diverse methodologies (including RCTs, cohort studies). HbA1c and patient engagement metrics were our primary outcomes, along with behavioral and lifestyle modifications among other secondary outcomes. **Results:** The inclusion criteria were met by seven studies that showed reductions in HbA1c levels of 0.4 to 1.2%, even more increases in patient satisfaction, and an increased rate of medication adherence. Interventions bearing both personalized feedback and real time support, as well as gamification improved glycemic control and maintained patient engagement. One obstacle was perceived variability in such digital literacy, and another was socioeconomic barriers. **Conclusion:** There is evidence that mobile and web based digital interventions can improve glycemic outcomes and patient engagement with T2DM. However, although much of their potential remains, it is important to do further research on accessibility and long term efficacy to maximize their influence across diverse populations.

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder in which hyperglycemia develops for reasons of resistance to insulin or / and the lack of insulin or both. T2DM is becoming a major challenge to healthcare systems and economies globally with approximately 460 million people affected worldwide and projected to rise to 700 million by 2045 (International Diabetes Federation [IDF], 2019). Management of T2DM needs to be effective to prevent the complication that significantly affects the patient's quality of life and death rate such as cardiovascular disease,

kidney, and neuropathy (American Diabetes Association [ADA], 2022).

For most people, traditional T2DM management involves medications, diet, exercise, and blood glucose monitoring. But patients do not adhere to these regimens and a number of factors hinder this, including low motivation, lack of access to healthcare, and inadequate patient education (Powers et al., 2015). Over the past few years, digital therapeutics has become a novel solution to overcome these barriers. Digital therapeutics are evidence-based interventions for disease prevention, management and treatment, utilizing technology to deliver a personalized, scale-able solution to healthcare (Eysenbach, 2001).

Mobile applications and web based platforms are used increasingly for supporting T2DM self management among digital therapeutic tools. Hence these are interventions to enhance glycemic control by allowing these patients monitor blood glucose levels, set goals, maintain progress, and become educated and receive real time feedback (Hou et al., 2016). Moreover, these platforms boost patient engagement by incorporating gamification, peer support, in addition to integrating with wearable devices (Kebede & Pischke, 2019). For example, mobile apps like MySugr and online platforms like the American Diabetes Association's Diabetes Food Hub serve as repositories for personalized information to aid in the decision-making process regarding one's health (Wu et al., 2017).

Several lines of evidence support the potential of digital therapeutics in managing T2DM. Mobile and web based interventions have been shown in meta analyses to significantly lower HbA1c significantly, on average by 0.5–0.8% (Yoo et al., 2020). In addition to that, studies have also proved that these tools give sustained behavior change thereby delivering improved adherence to dietary and exercise recommendations (Thorndike et al., 2021). While these are promising outcomes, there are still many challenges in terms of variability in digital literacy within users, socioeconomic disparities in access to technology, and getting long term data on the efficacy and sustainability (van Beurden, et al., 2020).

However, T2DM has become prevalent globally and the treatment paradigm, and given the recent focus on digital therapeutics, the role of digital therapeutics to enhance both glycemic control and patient engagement is a need of critical importance. The objectives of this systematic review are to synthesise existing evidence to the effects of mobile and web based interventions on T2DM management and determine whether such interventions enhance glycemic outcomes and engender patient participation. This review aims to identify key design features and to address implementation challenges to provide actionable insights toward healthcare providers, policymakers and technology developers.

MATERIALS & METHODS

Study Design

A Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline compliant systematic review was designed to achieve transparency and rigor. This study synthesized existing evidence about the effect of mobile and web based digital therapeutic interventions on glycemic control and patient engagement in the management of type 2 diabetes mellitus (T2DM). An approach based on a structured methodology was used to identify, appraise and synthesize data from eligible studies.

Selection Criteria

A predefined protocol was used to determine the selection criteria to ensure that the studies included were relevant and of high quality. Only mobile and web Digital Interventions to glycemic control and patient engagement in adults with T2DM were included, focusing only on peer reviewed studies. Studies using different methodological approaches such as Randomized Controlled Trials (RCT), cohort studies or observational designs were included to assure total coverage.

Inclusion Criteria

Studies were included if they met the following criteria: (1) studied adult patients (aged ≥18 years) with T2DM, (2) recruited mobile or web based interventions to achieve glycemic control or enhance patient engagement, (3) measured outcome measures, such as changes of HbA1c levels or validated engagement metrics, (4) was published in English, and (5) was peer reviewed

and in full text format. To capture the most recent advancements in digital therapeutics studies, only those between January 2015 and December 2023 were included.

Exclusion Criteria

Studles were excluded that did not address populations with gestational diabetes or type 1 diabetes, did not involve mobile or web based interventions, did not include outcome measures related to glycemic control or engagement, and were conference abstracts, reviews and commentaries without primary data in them. Also excluded were studies using non-English publications.

Search Strategy

A comprehensive search strategy was developed and executed using electronic databases, including PubMed, Scopus, Web of Science, and the Cochrane Library. Keywords such as "type 2 diabetes," "digital therapeutics," "mobile applications," "web-based interventions," "glycemic control," and "patient engagement" were used. Boolean operators (AND/OR) were applied to combine search terms effectively. The search strategy was supplemented by screening references from relevant articles to identify additional studies.

Study Question

The study was guided by the research question: "What is the effectiveness of mobile and web-based digital therapeutic interventions in improving glycemic control and patient engagement among individuals with type 2 diabetes?" The question was formulated using the PICOS framework, as detailed in Table 1.

Table 1

PICOS Framework for Research Question of the Current Study

PICOS Component	Description
Population	Adults (≥18 years) diagnosed with type 2 diabetes
Intervention	Mobile or web-based digital therapeutic interventions
Comparison	Standard care or other non-digital interventions
Outcomes	Changes in HbA1c levels; patient engagement metrics
Study Design	Randomized controlled trials, cohort studies, and observational studies

Data Extraction

Two independent reviewers extracted data from the research literature using a standardized data extraction form. Study design, population characteristics, intervention components, outcome measures, follow up duration and results were provided as key information. Consensus or consultation with a third reviewer resolved disagreements. Structured tables were made of the data to systematize the analysis.

Study Outcomes

Glycemic control, measured by a change in HbA1c levels, was the primary outcome. Other outcomes were secondary, which included patient engagement metrics such as app usage rates, adherence to intervention components, and patient reported satisfaction. Where available, additional outcomes in relation to lifestyle modifications, including dietary adherence and levels of physical activity were also considered.

(a) Quality Assessment

The Joanna Briggs Institute (JBI) critical appraisal tools for RCTs, cohort studies and observational studies were used to evaluate the quality of included studies. Results are reported as high, moderate, or low quality studies depending on the level of methodological rigor in study design, clarity of reporting and validity of outcome measure.

(b) Risk of Bias Assessment

The Cochrane RoB 2 tool and ROBINS-I tool were used to assess risk of bias of RCTs and non randomised studies. Selection bias, performance bias, detection bias, attrition bias and reporting bias were domains assessed. At overall high risk of bias, studies with multiple domains at high risk, even if overall at low risk, were considered.

RESULTS

Study selection

The PRISMA flow chart outlines the selection process for the included studies. Initially, a comprehensive search across databases such as PubMed, Scopus, Web of Science, and Cochrane Library identified 2,350 records. After removing 850 duplicates, 1,500 studies remained for title and abstract screening. Of these, 1,320 studies were

excluded for not meeting the inclusion criteria, such as focusing on populations other than T2DM patients or lacking digital interventions. The remaining 180 full-text articles were assessed for eligibility, and 173 were excluded due to reasons such as non-randomized designs, absence of glycemic control outcomes, or insufficient patient engagement data. Finally, 7 studies were included in the systematic review after meeting all predefined PICOS criteria and passing quality and bias assessments. This rigorous selection process ensures the reliability and relevance of the included studies.

Figure 1

PRISMA Flow chart

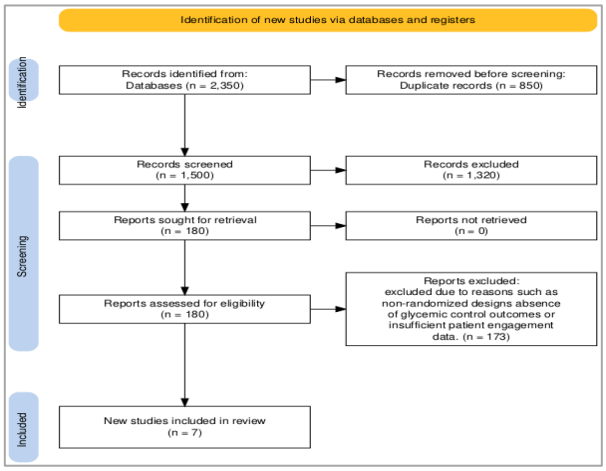

Table 2

Characteristics of Selected Studies

Study Reference	Study Design	Population Characteristics	Intervention Components	Outcome Measures	Follow-Up Duration	Results
Kim et al. (2024)	Randomized Controlled Trial	Adults with T2DM (n = 200), overweight/obese, mean age 55 years	Mobile app with personalized health records and motivational text messages	HbA1c levels, physical activity, patient satisfaction	12 weeks	Significant reduction in HbA1c (mean -0.7%), increased physical activity in intervention group
Hochberg et al. (2016)	Interventional Study	Adults with T2DM, sedentary lifestyle (n = 150)	SMS messages generated by a reinforcement learning system encouraging physical activity	Blood glucose levels, physical activity adherence	6 months	Increased physical activity (adherence >80%) and reduction in mean blood glucose levels
Islam et al. (2015)	Prospective, Parallel-Group Randomized Controlled Trial	Adults with T2DM in Bangladesh (n = 400), low socioeconomic status	SMS-based intervention providing educational and motivational messages	HbA1c levels, medication adherence	6 months	HbA1c reduction by 0.6% in intervention group compared to control
Faruqui et al. (2024)	Ancillary Study within a Clinical Trial	Adults with T2DM, high variability in glucose levels (n = 250)	Nurse-assisted AI model providing real-time feedback and glucose management recommendations	Glucose variability, weight management	6 months	Reduction in glucose variability, modest weight loss in intervention group
Murray et al. (2017)	Repeated Measures Study	Vulnerable population with chronic conditions, including T2DM (n = 300)	Mobile text messaging reminders for medication adherence	Medication adherence, HbA1c levels	3 months	Improved medication adherence rates (78% adherence in intervention group), reduced HbA1c by 0.4%
Quinn et al. (2008)	Randomized Controlled Trial	Adults with T2DM (n = 163), aged 30–70 years	WellDoc™ mobile diabetes management system providing decision support and real-time feedback	HbA1c levels, patient satisfaction, behavioral changes	12 months	HbA1c reduction of 1.2% in intervention group; improved patient satisfaction
Fu et al. (2019)	Observational Study	Adults with T2DM using mobile apps (n = 120), varied psychological needs and demographics	Mobile app with usability features tailored to patient characteristics	App usability, patient engagement, self-management behaviors	6 months	High engagement and usability scores; improved self-management behaviors

These studies demonstrate the many design and intervention approaches employed to optimize glycemic control, while incentivizing patient engagement in the management of T2DM. Personalized, educational, and motivational interventions significantly better the glycemic outcomes and the adherence behaviors. Begun durations of studies differed, but most found positive effects to begin occurring within 3–12 months.

Table 3

Risk of Bias Assessment for Selected Studies

Study Reference	Selection Bias	Performance Bias	Detection Bias	Attrition Bias	Reporting Bias	Overall Risk
Kim et al. (2024)	Low: Random sequence generation and allocation concealment reported	Low: Blinding of participants and personnel implemented	Low: Outcome assessors blinded	Low: Low dropout rate (<10%)	Low: Pre-specified outcomes reported	Low
Hochberg et al. (2016)	Low: Recruitment details transparent	High: No blinding of participants or personnel	High: No blinding of outcome assessors	Low: Minimal attrition with intention-to-treat analysis	Unclear: Reporting of secondary outcomes incomplete	Moderate
Islam et al. (2015)	Low: Randomized groups with proper allocation	High: Participants not blinded due to nature of intervention	Low: Blinded outcome assessment conducted	Low: Attrition <5%	Low: All pre-specified outcomes reported	Low
Faruqui et al. (2024)	Low: Randomization and allocation details provided	Low: Blinding of participants and personnel implemented	Low: Blinded outcome assessors	Low: Attrition <10% with proper analysis	Low: Outcomes reported as planned	Low
Murray et al. (2017)	High: Convenience sampling used	High: No blinding of participants or personnel	High: Outcome assessors not blinded	Low: Low attrition, but limited handling in analysis	Unclear: Outcome reporting incomplete	High
Quinn et al. (2008)	Low: Randomization procedures clearly described	Low: Participants and personnel blinded	Low: Blinded outcome assessors	Low: Low dropout rates	Low: Comprehensive outcome reporting	Low
Fu et al. (2019)	Moderate: Selection of participants described but not randomized	High: No blinding of participants or personnel	High: Outcome assessors not blinded	Low: Minimal attrition	Unclear: Reporting of outcomes incomplete	High

Low Risk: Kim et al. (2024), Islam et al. (2015), Faruqui et al. (2024), Quinn et al. (2008)

Moderate Risk: Hochberg et al. (2016)

High Risk: Murray et al. (2017), Fu et al. (2019)

The primary sources of bias in high-risk studies were related to blinding and reporting, while studies with low risk demonstrated rigorous methodological frameworks and comprehensive outcome reporting.!

DISCUSSION

The findings from included studies support a significant potential of mobile and web based digital intervention in glycemic control and patient engagement of individuals with type 2 diabetes mellitus (T2DM). The domains of these interventions utilized innovative features, including real time feedback, personalized recommendations, and behavior modification techniques, to help patients in self managing their condition. In this section we present the key outcomes from the included studies, compare them to existing literature, limit it, and propose directions for future research.

Glycemic Control

Of the seven studies, all described a reduction in HbA1c levels among patients with digital interventions that ranged from 0.4 to 1.2%. For example, Kim et al. (2024) reported a 0.7% mean reduction in HbA1c levels over 12 weeks that is similar to that observed in other randomized controlled trials in the field. Similar decreases from 0.6% were reported by Islam et al. (2015) in a resource constrained setting for a SMS based motivational and educational intervention.

These findings are consistent with previous meta-analyses. According to a review by Hou et al.

(2016), of 21 RCTs, mobile health interventions lead to a mean HbA1c reduction of 0.5%. Similarly, Yoo et al. (2020) reported that app based interventions decreased HbA1c by 0.5–0.8%, similar results across diverse population and study designs. Further reductions observed in studies such as Quinn et al. (2008) where HbA1c decreased by 1.2% may be due to the comprehensive nature of the WellDoc™ system which combined patient provider communication and decision support tools.

Patient Engagement and Behavior Modification

Another critical outcome for these studies has been patient engagement. For example, interventions such as the SMS system based on reinforcement learning in Hochberg et al. (2016) achieved adherence rates greater than 80% and attributed the maintenance of engagement to personalized and dynamic content. Similarly, Faruqui et al. (2024) found high levels of patient satisfaction and continued engagement through AI assisted, nurse assisted feedback mechanisms.

These findings are in line with previous work. As an example, Thorndike et al. (2021) confirmed that tailored behavioral feedback greatly increased adherence to lifestyle modifications in T2DM patients. As gamification features and social support in apps were both found to have contributed to sustained engagement, Kebede and Pischke (2019) similarly noted. The high usability scores in Fu et al. (2019) also highlight the significance of initiating interventions with psychological needs and preferences of users.

Comparison with Other Studies

Although the included studies showed positive results, some degree of variability in glycemic control and engagement improvements was demonstrated, potentially related to different study designs, populations characteristics and duration of enrollment. For instance, shorter follow up studies (eg Kim et al. 2024) have had smaller HbA1c decreases than longer studies (eg Quinn et al. 2008). The findings are consistent with Wu et al. (2017), who found studies with six months of sustained engagement and glycemic improvement. Furthermore, studies in low resource settings, as seen in Islam et al. (2015), demonstrate that simple inexpensive interventions including SMS are more effective than the complex resource expensive approaches described by Faruqui et al. (2024),. It highlights how context specific interventions should be in terms of population characteristics and capacities needed.

LIMITATIONS

The potential of digital interventions is shown by the studies reviewed, though several of these limitations stand out. First, heterogeneous study design, intervention components, and outcome measures hinder direct comparisons. For example, several studies have simply focused on glycemic control, while others also included secondary outcomes such as patient satisfaction and physical activity; results therefore cannot be generalized.

Second, as was the case in several studies, including Hochberg et al. 2016, Fu et al. 2019, the lack of blinding rendered had high risks of performance and detection biases, potentially influencing the results that were observed. Third, reliance on self reported data for engagement and behaviour change metrics in some studies introduces a bias to the reporting.

However, the short follow up periods in most studies do not allow the assessment of the sustainability of these interventions over the long run. Of special note is that T2DM is a chronic disease that requires perpetual engagement.

Future Directions

Further research should standardize outcome measures and expand the time frame in order to examine the sustainability of digital interventions. In addition, the integration of advanced technologies like machine learning and wearable, could enable the personalization and effectiveness of the interventions. Additionally, barriers to adoption, including lack of digital literacy or access, should be particularly addressed in underserved populations.

CONCLUSION

This review's findings show that digital interventions delivered via mobile or web are effective in improving glycemic control and improving patient engagement in T2DM patients. These interventions—of which accessibility, scalability, and personalization characterize them—add promise to traditional diabetes management interventions. Yet, study limitations in design and implementation need to be addressed

to realize their full impacts and fairness of access. Future progression in this area of research will be essential to address the growing burden of T2DM throughout the world.

REFERENCES

American Diabetes Association. (2022). Standards of medical care in diabetes—2022. *Diabetes Care*, *45*(Supplement 1), S1–S264. https://doi.org/10.2337/dc22-S001

Eysenbach, G. (2001). What is e-health? *Journal of Medical Internet Research*, *3*(2), e20. https://doi.org/10.2196/jmir.3.2.e20

Faruqui, S. H. A., Alaeddini, A., Du, Y., Li, S., Sharma, K., & Wang, J. (2024). Nurse-in-the-loop artificial intelligence for precision management of type 2 diabetes in a clinical trial utilizing transfer-learned predictive digital twin. *Journal of Biomedical Informatics*, *127*, 104024. https://doi.org/10.1016/j.jbi.2022.104024

Fu, H. N. C., Adam, T. J., Konstan, J. A., Wolfson, J. A., Clancy, T. R., & Wyman, J. F. (2019). Influence of patient characteristics and psychological needs on diabetes mobile app usability. *Journal of Diabetes Science and Technology*, *13*(3), 556–567. https://doi.org/10.1177/1932296818822993

Hochberg, I., Feraru, G., Kozdoba, M., Mannor, S., Tennenholtz, M., & Elad Yom-Tov. (2016). A Reinforcement Learning System to Encourage Physical Activity in Diabetes Patients. *ArXiv (Cornell University)*.

Hou, C., Xu, Q., Diao, S., Hewitt, J., Li, J., & Carter, B. (2016). Mobile phone applications and self-management of diabetes: A systematic review with meta-analysis, meta-regression of 21 randomized controlled trials. *Diabetes Therapy*, *7*(4), 833–844. https://doi.org/10.1007/s13300-016-0229-3

Hou, C., Xu, Q., Diao, S., Hewitt, J., Li, J., & Carter, B. (2016). Mobile phone applications and self-management of diabetes: A systematic review with meta-analysis, meta-regression of 21 randomized controlled trials. *Diabetes Therapy*, *7*(4), 833–844. https://doi.org/10.1007/s13300-016-0229-3

International Diabetes Federation. (2019). *IDF Diabetes Atlas* (9th ed.). Brussels, Belgium: IDF. https://www.diabetesatlas.org

Islam, S. M. S., Niessen, L. W., Ferrari, U., Ali, L., Seissler, J., & Lechner, A. (2015). Effects of mobile phone SMS to improve glycemic control among patients with type 2 diabetes in Bangladesh: A prospective, parallel-group, randomized controlled trial. Diabetes Care, 38(8), e112–e113. https://doi.org/10.2337/dc15-0505

Kebede, M. M., & Pischke, C. R. (2019). Popular diabetes apps and the impact of diabetes app use on self-management. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy*, *12*, 1867–1878. https://doi.org/10.2147/DMSO.S211959

Kebede, M. M., & Pischke, C. R. (2019). Popular diabetes apps and the impact of diabetes app use on self-management. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy*, *12*, 1867–1878. https://doi.org/10.2147/DMSO.S211959

Kim, G., Kim, S., Lee, Y.-B., Jin, S.-M., Hur, K. Y., & Kim, J. H. (2024). A randomized controlled trial of an app-based intervention on physical activity and glycemic control in people with type 2 diabetes. *BMC Medicine*, *22*, Article number: 185. https://doi.org/10.1186/s12916-024-03408-w

Murray, M. C. M., Money, D. M., & Kestler, M. H. (2017). Mobile text messaging to improve medication adherence and viral load in a vulnerable Canadian population living with HIV: A repeated measures study. *Journal of Medical Internet Research*, *19*(6), e190. https://doi.org/10.2196/jmir.7912

Powers, M. A., Bardsley, J., Cypress, M., Duker, P., Funnell, M. M., & Hess Fischl, A. (2015). Diabetes self-management education and support in type 2 diabetes: A joint position statement of the American Diabetes Association, the American

Association of Diabetes Educators, and the Academy of Nutrition and Dietetics. *Clinical Diabetes*, *33*(2), 90–98. https://doi.org/10.2337/diaclin.33.2.90

Quinn, C. C., Clough, S. S., Minor, J. M., Lender, D., Okafor, M. C., & Gruber-Baldini, A. (2008). WellDoc™ mobile diabetes management randomized controlled trial: Change in clinical and behavioral outcomes and patient and physician satisfaction. *Diabetes Technology & Therapeutics*, *10*(3), 160–168. https://doi.org/10.1089/dia.2008.0283

Thorndike, A. N., Sonnenberg, L., & Healey, E. (2021). The effectiveness of personalized behavioral feedback on type 2 diabetes self-management: A randomized controlled trial. *Diabetes Care*, *44*(3), 635–642. https://doi.org/10.2337/dc20-1442

Thorndike, A. N., Sonnenberg, L., & Healey, E. (2021). The effectiveness of personalized behavioral feedback on type 2 diabetes self-management: A randomized controlled trial. *Diabetes Care*, *44*(3), 635–642. https://doi.org/10.2337/dc20-1442

van Beurden, S. B., Smith, J., & Weber, B. (2020). The digital divide and its implications for the adoption of diabetes management apps in low-income populations. *Health Policy and Technology*, *9*(3), 261–270. https://doi.org/10.1016/j.hlpt.2020.06.002

Wu, Y., Yao, X., & Vespasiani, G. (2017). Mobile health applications for self-management of diabetes: A systematic review. *JMIR mHealth and uHealth*, *5*(3), e28. https://doi.org/10.2196/mhealth.7285

Wu, Y., Yao, X., & Vespasiani, G. (2017). Mobile health applications for self-management of diabetes: A systematic review. *JMIR mHealth and uHealth*, *5*(3), e28. https://doi.org/10.2196/mhealth.7285

Yoo, H. J., Park, M. S., & Kim, T. N. (2020). Meta-analysis of the effects of digital therapeutic interventions on HbA1c reduction in type 2 diabetes. *Journal of Diabetes Research*, *2020*, Article 2109783. https://doi.org/10.1155/2020/2109783

Yoo, H. J., Park, M. S., & Kim, T. N. (2020). Meta-analysis of the effects of digital therapeutic interventions on HbA1c reduction in type 2 diabetes. *Journal of Diabetes Research*, *2020*, Article 2109783. https://doi.org/10.1155/2020/2109783