Systematic Review

The Clinical Effects of Type 2 Diabetes Patient Management Using Digital Healthcare Technology: A Systematic Review and Meta-Analysis

Ji-eun Kim, Tae-shin Park and Kwang Joon Kim *

College of Pharmacy, Mokpo National University, Youngsan-ro 1666, Cheonggye-myeon, Mokpo 58554, Korea; kimjiji427@naver.com (J.-e.K.); ptsxotls@naver.com (T.-s.P.)
* Correspondence: kjkim0901@mnu.ac.kr; Tel.: +82-61-450-2334

Abstract: The disease control rate is very low (at less than 30%) for diabetes. The use of digital healthcare technology is increasing recently for continuous management in daily life. In this study, a meta-analysis was conducted to evaluate the clinical effects of digital healthcare technology for patients with type 2 diabetes management. For a review of the literature, databases such as PubMed, Embase, and Cochrane Library were searched using Medical Subject Heading (MeSH) terms published up to 9 August 2021. As a result, 2354 articles were identified, and 12 randomized controlled trial articles were finally included. Digital healthcare technology combined management for type 2 diabetes significantly decreased HbA1c ($p < 0.00001$, standardized mean difference (SMD) = −0.49) and marginally decreased triglyceride, compared with usual care ($p = 0.06$, SMD = −0.18). However, it did not significantly affect BMI ($p = 0.20$, SMD = −0.47), total cholesterol ($p = 0.13$, SMD = −0.19), HLD-C ($p = 0.89$, SMD = −0.01), LDL-C ($p = 0.95$, SMD = −0.01), systolic BP ($p = 0.83$, SMD = 0.03), or diastolic BP ($p = 0.23$, SMD = 0.65), compared with usual care. These results indicate that digital healthcare technology can improve HbA1c and triglyceride levels of type 2 diabetes patients. Further well-designed randomized controlled clinical trials are needed to confirm the clinical effect of digital healthcare technology.

Keywords: digital healthcare technology; type 2 diabetes; HbA1c

1. Introduction

Diabetes is among the top 10 global causes of mortality in adults, with four million deaths estimated globally in 2017 [1]. The global prevalence of diabetes was estimated at 9.3% in 2019 and was predicted to rise to 10.2% by 2030 [2]. According to “Diabetes Fact Sheet in Korea 2020” of the Korean Diabetes Association, the prevalence of diabetes mellitus in Korea was high in 2018 (13.8% in those over 30 years old and 27.6% in those over 65 years old) [3]. Recently, new medicines such as dipeptidyl peptidase-4 (DPP4) inhibitor, sodium-glucose co-transporter-2 (SGLT-2) inhibitor, and glucagon-like peptide-1 (GLP-1) agonist for type 2 diabetes mellitus (T2DM) are being introduced to the clinical field in addition to traditional medicines such as metformin, sulfonylurea, thiazolidinedione, and insulin. Among diabetic patients, 60.1% of those over 30 years old and 72.9% of those over 65 years old received pharmacotherapy in Korea [3]. However, the disease control rate for diabetic patients was very low, at less than 30% [3]. Specifically, less than 30% of adult diabetic patients had glycated hemoglobin (HbA1c) levels under 6.5%. Particularly, those with HbA1c levels over 6.5% but under 7% had continuously increased in 2016, 2018, and 2020 reports [3]. These data show that using pharmacotherapy alone is difficult to achieve sufficient effects in diabetes care. Thus, clinical practice guidelines of the American Diabetes Association and Korean Diabetes Association recommend starting lifestyle modification and monitoring pharmacotherapy response when patients are diagnosed with T2DM [4,5]. In other words, after patients are diagnosed with T2DM, proper modification of lifestyle...
including diet and physical activity is regarded as one of the most crucial factors along with
the use of medicines. However, a recent Korean survey found that only 35.7% of diabetic
patients regularly walked above 30 min per day [3]. This figure showed consistent decreases
in 2016, 2018, and 2020 reports [3]. The ratio of obese patients (BMI $\geq 25$ kg/m$^2$) among
diabetic patients had consistently increased, reaching up to 53.2% in 2020 [3]. Regarding
diet associated with excess energy intake, it was found that protein and fat intake rates
of diabetic patients were lower, but carbohydrate intake rate was higher than those of
nondiabetic patients [3]. This indicates that continuous management of diet is necessary for
diabetic patients. Based on these data of diabetic patients in Korea, inappropriate lifestyle
habits can be one of the major reasons for the significantly lower disease control rates than
treatment rates.

Although T2DM is a chronic disease that requires not just pharmacotherapy but also
continuous lifestyle management, current diabetes management services mostly use labora-

tory test results and counseling data, which can be obtained restrictively at face-to-face
meetings with medical specialists. However, such counseling data have limitations in accu-
rately monitoring and providing intervention to modify lifestyles of patients who are not
sincere in recording a diabetic diary. In fact, Kim et al. [6] have provided diabetes manage-
ment service through regular face-to-face and telephone counseling to T2DM patients. They
found that such a service had limitations in improving patients’ lifestyles. Along with the
recent increase in smartphone owners, the development of 5G communication technology,
and the development of Internet of Things (IoT) technology, digital healthcare technology
using wearable and mobile devices is continuously developing, and continuous attempts
are made to use such technology as a tool for caring patients with chronic diseases [7].

The objective of this systematic review and meta-analysis was to evaluate clinical
effects of counseling and intervention service for diabetes management by healthcare
providers (medical doctors, pharmacists, nurses, nutritionists, exercise therapists, etc.)
using daily life data of T2DM patients collected through digital healthcare technology such
as internet web, mobile phone apps, and connected devices. Based on the results of this
study, we intend to find a more advanced management plan for type 2 diabetic patients.

2. Materials and Methods

This study was performed according to the Preferred Reporting Items for Systematic
Reviews and Meta-Analyses (PRISMA) statement. Each process of this study was
performed independently by two authors.

2.1. Search Method

PubMed, Embase, and Cochrane Library were selected as literature search databases
to conduct a systematic literature review. The literature search was conducted for papers
published until 9 August 2021. We used the PICO method to elaborate a specific key ques-
tion suitable for the purpose of this study. Patient population (P): type 2 diabetes patients;
Intervention (I): digital healthcare technology by healthcare providers; Comparison (C):
usual patient care; Outcomes (O): HbA1c, BMI, LDL-C, HDL-C, blood pressure; Study
design (SD): randomized controlled trials (RCTs).

We searched databases using Medical Subject Headings (MeSHs) and free-text terms
combined with Boolean operators “AND” and “OR”, etc. (Supplementary Table S1).

2.2. Study Selection and Quality Assessment

Among studies searched from each database, only full-text articles designed as “Rand-
omized clinical trial” and written in English were included. We screened and included
studies to evaluate how healthcare providers applied to improve clinical outcomes for Type
2 diabetes patients. Duplicated studies between databases were excluded using EndNote
20 program. Studies unrelated to the purpose of this study were also excluded by screening
titles and abstracts. Studies without HbA1c data, the primary outcome to be analyzed in
this study, were also excluded by a full-text review. Two authors independently performed
study selection and data extraction. A third author resolved any conflicts occurring through mutual consultation between authors and made final decisions. Two authors assessed the quality of each study and ultimately selected studies using the Cochrane’s risk of bias (RoB) tool [8]. RoB has seven domains: two selection bias, performance bias, detection bias, attrition bias, reporting bias, and other bias. Each domain was scored as “high risk”, “low risk”, or “unclear risk” according to the degree of the risk of bias. If it was difficult to identify the risk of bias, the study was assessed as having an “unclear risk of bias”. Publication bias of selected studies was assessed using a funnel plot.

2.3. Data Extraction

From each study, data of HBA1c as the primary outcome and body mass index (BMI), total cholesterol, triglyceride, low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), systolic blood pressure, and diastolic blood pressure as secondary outcomes were extracted.

2.4. Data Synthesis and Statistical Analysis

Review manager 5.4 and R studio Version 1.4.1717 were utilized for data analysis. Since the extracted data in this study were continuous variables, standardized mean difference (SMD) was weighted by the number of study subjects of the intervention group and the control group in each study. Mean and standard deviations were calculated with 95% confidence intervals (CIs). Results are presented as a forest plot using the random effect model. Heterogeneity of results was assessed using Higgin’s $I^2$: 0% ≤ $I^2$ ≤ 40%, “may not be important”; 30% ≤ $I^2$ ≤ 60%, “may represent moderate heterogeneity”; 50% ≤ $I^2$ ≤ 90%, “may represent substantial heterogeneity”; 75% ≤ $I^2$ ≤ 100%, “considerable heterogeneity” [9].

3. Results

3.1. Search Results

A total of 2354 studies were retrieved from PubMed, Embase, Cochrane Library in August 2021. After excluding non-RCT, non-trial, and duplicate studies, 323 studies remained. After secondarily excluding 99 studies not eligible for full-text criteria, the remaining 224 studies were screened for titles and abstracts. Finally, 12 studies were found to be eligible for analysis in this study (Figure 1) (Table 1).

3.2. Study Characteristics and Quality Assessment

The country, study design, study length, intervention patients, comparison patients, types of tools for intervention, contents of intervention, and clinical outcome measurements of the finally selected studies are summarized in Table 1. The meta-analysis was performed on a total of 1362 patients (digital healthcare: 686 patients, usual care: 676 patients) in the 12 studies. As a result of the quality assessment of the 12 studies, studies using a random number generated by a computer were assessed as having a “low risk” of selection bias. They were assessed as “unclear risk” if it was difficult to identify the appropriateness of a randomized method, or if the method was not described. All studies were assessed as “unclear risk” of performance bias because there was not enough evidence to evaluate the effect of a blind test. In cases in which there was no dropout during the intervention period, or it was determined that the missing value would not significantly affect the effect size, studies were assessed as having a “low risk” of attrition bias. If outcomes presented in study protocols were excluded from study results, such studies were assessed as having a “high risk” of reporting bias (Figure 2). A funnel plot was expressed for the publication bias of selected studies (Figure 3).
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A funnel plot was expressed for the publication bias of selected studies (Figure 3).

3.3. Primary Outcome Analysis

As a result of a meta-analysis of the 12 studies to determine the reduction in HbA1c in the intervention group using digital healthcare technology, the intervention group showed a statistically significant reduction in HbA1c, compared with the comparison group (SMD: −0.49 [95% CI: −0.64, −0.33], I² = 48%, p < 0.00001) (Figure 4).
| Author | Location and Duration | Intervention; Digital Healthcare (n, Mean Age) | Comparison; Usual Care (n, Mean Age) | Healthcare Providers for Intervention | Type of Tools for Intervention | Contents of Intervention | Clinical Outcome Measurements |
|--------|-----------------------|---------------------------------------------|--------------------------------------|-------------------------------------|--------------------------------|--------------------------|-------------------------------|
| Anzaldo-Campos, M.C. et al. 2016 [10] | Mexico, Hospital based, 10 months | n = 102, 51.5 | n = 100, 52.5 | (1) Physician (2) Nurse | Glucose meter with USB connection | (1) Tracking glucose level (2) Interactive surveys and text messages through the app (3) Educational brochures and videos through the app | HbA1C (%), total cholesterol, LDL-C, triglycerides, blood pressure (systolic, diastolic), BMI |
| Hilmarsson E. et al. 2020 [11] | Iceland, Hospital-based endocrine clinic, 6 months | n = 15, 50.9 | n = 15, 51.5 | Doctor | Smartphone application | (1) Guidance for a healthy lifestyle through the app (2) Individualized encouragement through the app | HbA1c (%), total cholesterol, triglycerides, HDL-C, LDL-C, weight, BMI, waist circumference, blood pressure (systolic, diastolic) |
| Hu, Y. et al. 2021 [12] | China, Hospital-based endocrine clinic, 6 months | n = 72, 50.04 | n = 70, 52.21 | (1) Endocrinologist (2) Nurse | Blood-glucose management platform | (1) Providing diabetes education (self-monitoring of blood glucose levels, dietary habits, medication timing, and physical activity) (2) Contacting patients through telephone or other online connections, if necessary | HbA1c (%), hypoglycemic events, UACR, carotid plaque |
| Kim, H.S. et al. 2016 [13] | Korea, Hospital based, 6 months | n = 92, 52.5 | n = 90, 55.6 | (1) Doctor (2) Nurse | Blood sugar monitoring through the Internet | (1) Tracking blood glucose levels and health conditions regularly (2) Recommendations on blood glucose control | HbA1C (%), FBG, FBG, BMI, LDL-C, HDL-C, total cholesterol, triglycerides, weight, blood pressure (systolic, diastolic) |
| Kleinman, N.J. et al. 2016 [14] | India, Hospital-based, 6 months | n = 44, 48.8 | n = 46, 48.0 | (1) Doctor (2) Health coach | Smartphone application, (m-Health diabetes management platform) | (1) Reminding participants to complete missions every day (2) Automated follow-up to abnormal blood glucose tests (3) Regular responding to patient questions and system-generated alerts | HbA1C (%), FBG, BMI |
| Lee, D.Y. et al. 2018 [15] | Korea, Hospital-based, 6 months | n = 74, 51.4 | n = 74, 52.6 | (1) Endocrinologist (2) Nurse (3) Dietitian | Mobile application | (1) Tailored mobile coaching (2) Regular mobile messages (3) Communication through the app | HbA1c (%), BMI, blood pressure (systolic, diastolic), total cholesterol, triglycerides, HDL-C, LDL-C |
Table 1. Cont.

| Author                      | Location and Duration | Intervention; Digital Healthcare (n, Mean Age) | Comparison; Usual Care (n, Mean Age) | Healthcare Providers for Intervention | Type of Tools for Intervention | Contents of Intervention                                                                                      | Clinical Outcome Measurements |
|-----------------------------|-----------------------|-----------------------------------------------|-------------------------------------|--------------------------------------|---------------------------------|----------------------------------------------------------------------------------------------------------------|------------------------------|
| Quinn, C.C. et al. 2011 [16]| USA, University Hospital-based, 12 months | $n = 62$, 52                                  | $n = 56$, 53.2                      | Doctor                               | Mobile diabetes management software application and a web portal | (1) Receiving automated and real-time messages specific to the entered data (educational, behavioral, and motivational message) (2) Analyzing patient data based on standards of care | HbA1C (%), blood pressure (Systolic, Diastolic), LDL-C, HDL-C, triglycerides, total cholesterol |
| Quinn, C.C. et al. 2016 [17]| USA, University Hospital-based, 12 months | $n = 25$, 59.0                                | $n = 27$, 59.5                      | Physician                            | Mobile diabetes management software application                  | (1) Receiving automated and real-time messages specific to the entered data (educational, behavioral, and motivational message) (2) Intermittently reviewed by virtual case managers | HbA1C (%)                        |
| Sun, C. et al. 2019 [18]   | China, University Hospital-based, 6 months | $n = 44$, 67.9                                | $n = 47$, 68.04                     | (1) Medical team (2) Dietitian       | mHealth management system based on mobile phone                | (1) Sending medical advice and reminders to patients (2) Guidance for blood glucose monitoring and dietary advice based on the individual blood glucose levels (3) Guidance related to aerobic and resistance-based exercise | HbA1c (%), FBG, total cholesterol, triglycerides, HDL-C, LDL-C, BMI, blood pressure (systolic, diastolic) |
| Wayne, N. et al. 2015 [19] | Canada, Primary care Health-center-based, 6 months | $n = 48$, 53.1                                | $n = 49$, 53.3                      | Health coach (behavior-change counseling specialist with expertise in chronic disease management) | Smartphone application                        | (1) Tracking key metrics (blood glucose levels, exercise frequency, exercise duration, exercise intensity, food intake, and mood) (2) Communicating with a health coach at any time (3) Communicating with a health coach at scheduled phone contact and during in-person meetings | HbA1C (%), weight, BMI, waist circumference |
Table 1. Cont.

| Author | Location and Duration | Intervention; Digital Healthcare (n, Mean Age) | Comparison; Usual Care (n, Mean Age) | Healthcare Providers for Intervention | Type of Tools for Intervention | Contents of Intervention | Clinical Outcome Measurements |
|--------|-----------------------|---------------------------------------------|-------------------------------------|--------------------------------------|--------------------------------|--------------------------|-------------------------------|
| Yu, Y et al. 2019 [20] | China, University Hospital-based endocrine clinic, 6 months | n = 45, 50.3 | n = 45, 51.4 | Physician | Smartphone application | (1) Virtual education through the app (diet library, video and picture demonstration for exercise, information about blood glucose monitoring, and latest guidelines) (2) Automatically generated message to the patient and notification to clinicians if the blood glucose value was found abnormal value (3) Answering patient’s questions and offering recommendations based on individual data through the app | HbA1c (%) | FBG, 1,5-anhydroglucitol, proportions of patients achieving HbA1c < 7.0% |
| Zhai, Y et al. 2020 [21] | China, Hospital-based, 6 months | n = 60, 54.12 | n = 60, 55.64 | (1) Physician (2) Nurses | Smartphone application | (1) Providing support for diabetes self-management (diet advice, emotional management, and medication guidance) (2) Reviewing blood glucose data (3) Providing online instruction (diet, exercise, blood glucose monitoring, insulin injection) and answering patient’s questions (4) Analyzing the causative factors of abnormal blood glucose and giving advice on how to avoid them | HbA1c (%) |

1 Low-density lipoprotein, 2 high-density lipoprotein, 3 body mass index, 4 UACR, urine albumin-to-creatinine ratio, 5 mobile health, fasting blood glucose.
Figure 3. Check for funnel plot.

3.3. Primary Outcome Analysis

As a result of a meta-analysis of the 12 studies to determine the reduction in HbA1c in the intervention group using digital healthcare technology, the intervention group showed a statistically significant reduction in HbA1c, compared with the comparison group (SMD: $-0.49$ [95% CI: $-0.64$, $-0.33$], $I^2 = 48\%$, $p < 0.00001$) (Figure 4).

Figure 4. Forest plot for meta-analysis results of HbA1c [10–21].

3.4. Secondary Outcome Analysis

As a result of a meta-analysis of five studies presenting BMI levels to determine the effects of interventions on BMI, the intervention group did not show a statistically significant difference in BMI, compared with the comparison group (SMD: $-0.47$ [95% CI: $-1.20$, $0.25$], $I^2 = 95\%$, $p = 0.20$) (Figure 5). Results of a meta-analysis of three studies presenting total cholesterol levels showed that total cholesterol levels in the intervention group were not significantly different from those in the comparison group (SMD: $0.03$ [95% CI: $0.26$, $0.32$], $I^2 = 69\%$, $p = 0.06$) (Figure 6). Results of a meta-analysis of three studies presenting triglyceride levels showed a marginally significant reduction in the intervention group, compared with the comparison group (SMD: $-0.19$ [95% CI: $-0.43$, $0.05$], $I^2 = 41\%$, $p = 0.13$) (Figure 6). Results of a meta-analysis of three studies presenting LDL-C levels showed that LDL-C levels in the intervention group were not significantly different from those in the comparison group (SMD: $-0.01$ [95% CI: $-0.30$, $0.29$], $I^2 = 52\%$, $p = 0.95$) (Figure 8). Results of a meta-analysis of three studies presenting HDL-C levels showed no statistically significant difference between the intervention group and the comparison group (SMD: $0.01$ [95% CI: $-0.21$, $0.19$], $I^2 = 0\%$, $p = 0.89$) (Figure 9). Results
of a meta-analysis of five studies presenting systolic blood pressure levels showed no significant difference between the intervention group and the comparison group (SMD: 0.03 [95% CI: −0.26, 0.32], I² = 69%, p = 0.83) (Figure 10). Results of a meta-analysis of five studies presenting diastolic blood pressure levels showed an increase in the intervention group, compared with the comparison group, although such increase was not statistically significant (SMD: 0.65 [95% CI: −0.41, 1.71], I² = 97%, p = 0.23) (Figure 11).

![Figure 5. Forest plot for meta-analysis results on BMI [10,11,13–15].](image)

![Figure 6. Forest plot for meta-analysis results on total cholesterol [10,15,16].](image)

![Figure 7. Forest plot for meta-analysis results on triglyceride [10,15,16].](image)

![Figure 8. Forest plot for meta-analysis results on LDL-C [10,15,16].](image)

![Figure 9. Forest plot for meta-analysis results on HDL-C [10,15,16].](image)

![Figure 10. Forest plot for meta-analysis results on systolic blood pressure [10,11,13,15,16].](image)
We found that digital healthcare technology for type 2 diabetes patient management did not significantly decrease HbA1c, the primary outcome, compared with usual care ($p < 0.00001$, SMD = −0.49). The control group also showed a decrease in HbA1c. However, the decrease in the study group was larger than that in the control group. This finding indicates that digital healthcare technology is effective in improving clinical outcomes of T2DM patients. Similarly, Park et al. [24] systemically reviewed digital health interventions using telephones, web tools, and mobile apps by clinical pharmacists. Their recent study results found that mobile-based and web-based interventions improved clinical effects on lab outcomes. For behavioral parameters, some studies evaluated self-efficacy, anxiety and depression, quality of life (QOL), diabetes knowledge, etc. [10,11,15,16,18–20]. QOL and self-efficacy scores were generally increased, although such increases in some of these results were not statistically significant. For example, one research in India with a low penetration rate (20%) of smartphones showed that the effectiveness of digital healthcare technology was insufﬁcient due to the relatively low ability to use smartphones [14]. The use of mobile- and web-based devices can be considered a barrier for elderly patients or low-educated participants [25]. Therefore, education on the use of basic equipment such as smartphones and connected devices will be required continuously for digital healthcare technology to achieve more than a certain level of effect.

The results from this systematic review and meta-analysis of the clinical impact of digital healthcare technology intervention by healthcare providers demonstrated that closer and continuous monitoring by healthcare providers using digital healthcare technology, i.e., mobile-app-based and web-based interventions, may potentially help solve type 2 diabetes management challenges. Nevertheless, there are several limitations to this study. First, there may be selection bias because non-English publications were excluded. Second, there is a limitation in the generalization of the meta-analysis results of secondary outcomes because target patients were recruited based on HbA1c levels with deviations for other secondary outcomes. Third, recent study results published after the literature search were not reflected.
Fourth, each study had different types of tools and contents for intervention, and individual ability in adopting this digital technology was not reflected. Fifth, this study did not assess the cost-effectiveness of digital healthcare technology intervention by healthcare providers. Therefore, the cost-effectiveness of digital healthcare technology intervention needs to be evaluated in future studies. Additionally, since more advanced devices such as wearable devices capable of continuous blood glucose measurement (CBGM) are being developed recently, it seems necessary to evaluate the study results using these new devices in the future.

5. Conclusions
Management for type 2 diabetes patients using digital healthcare technology significantly decreased HbA1c levels, compared with usual care \( (p < 0.00001, \text{SMD} = -0.49) \). It also marginally decreased triglyceride levels, compared with usual care \( (p = 0.06, \text{SMD} = -0.18) \). However, it did not significantly affect BMI, total cholesterol, HDL-C, LDL-C, systolic BP, or diastolic BP, compared with usual care. These results show that digital healthcare technology can decrease HbA1c and triglyceride levels of type 2 diabetes patients with improved clinical effects. However, further well-designed randomized controlled clinical trials are needed to prove and confirm the clinical effects of digital healthcare technology on T2DM patient management.

Supplementary Materials: The following supporting information can be downloaded at https://www.mdpi.com/article/10.3390/healthcare10030522/s1. Table S1: Search Strategy in PubMed.

Author Contributions: Study conception and methodology, K.J.K.; data collection, J.-e.K. and T.-s.P.; data analysis and writing—original draft preparation, K.J.K.; writing—review and editing, J.-e.K., T.-s.P. and K.J.K. All authors have read and agreed to the published version of the manuscript.

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References
1. International Diabetes Federation. *IDF Diabetes Atlas*, 8th ed.; International Diabetes Federation: Brussels, Belgium, 2017.
2. Saeedi, P.; Petersohn, I.; Salpea, P.; Malanda, B.; Karuranga, S.; Unwin, N.; Colagiuri, S.; Guariguata, L.; Motala, A.A.; Ogurtsova, K.; et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas. *Diabetes Res. Clin. Pract.* 2019, 157, 107843. [CrossRef] [PubMed]
3. Diabetes Factsheet in Korea; Korean Diabetes Association: Seoul, Korea, 2020.
4. Standards of Medical Care in Diabetes; American Diabetes Association: Arlington, TX, USA, 2021.
5. Clinical Practice Guidelines for Diabetes; Korean Diabetes Association: Seoul, Korea, 2021.
6. Kim, K.J.; Choi, C.O.; Kim, D.G.; Song, M.S.; Kim, M.H.; Jung, H.C.; Lee, G.H. Short-term clinical outcomes and assessment of diabetes self-care activities of the community pharmacy diabetes care service in South Korea: A pilot study. *Korean J. Community Pharm.* 2019, 5, 1–7.
7. Choi, Y.S. How digital technology will contribute to future innovation in healthcare. *J. Korean Diabetes* 2015, 16, 231–235. [CrossRef]
8. Higgins, J.P.; Altman, D.G. Assessing risk of bias in included studies. In *Cochrane Handbook for Systematic Reviews of Interventions: Cochrane Book Series*; Higgins, J.P., Green, S., Eds.; John Wiley & Sons, Ltd.: Chichester, UK, 2008.
9. Kim, S.Y.; Park, J.E.; Seo, H.J.; Lee, Y.J.; Jang, B.H.; Son, H.J.; Suh, H.S.; Shin, C.M. NECA’s Guidance for Undertaking Systematic Reviews and Meta-Analyses for Intervention; National Evidence-Based Healthcare Collaborating Agency: Seoul, Korea, 2011.
10. Anzaldo-Campos, M.C.; Contreras, S.; Vargas-Ojeda, A.; Menchaca-Diaz, R.; Fortmann, A.; Philis-Tsimikas, A. Dulce wireless Tijuana: A randomized control trial evaluating the impact of Project Dulce and short-term mobile technology on glycemic control in a family medicine clinic in northern Mexico. *Diabetes Technol. Ther.* 2016, 18, 240–251. [CrossRef] [PubMed]
11. Hilmarsson, E.; Sigurardottir, A.K.; Arnardottir, R.H. A Digital Lifestyle Program in Outpatient Treatment of Type 2 Diabetes: A Randomized Controlled Study. *J. Diabetes Sci. Technol.* 2021, 15, 1134–1141. [CrossRef] [PubMed]
12. Hu, Y.; Wen, X.; Ni, L.; Wang, F.; Hu, S.; Fang, F. Effects of telemedicine intervention on the management of diabetic complications in type 2 diabetes. *Int. J. Diabetes Dev. Ctries.* 2021, 41, 322–328. [CrossRef]

13. Kim, H.S.; Sun, C.; Yang, S.J.; Sun, L.; Li, F.; Choi, I.Y.; Cho, J.H.; Wang, G.; Yoon, K.H. Randomized, open-label, parallel group study to evaluate the effect of internet-based glucose management system on subjects with diabetes in China. *Telmed. e-Health* 2016, 22, 666–674. [CrossRef] [PubMed]

14. Kleinman, N.J.; Shah, A.; Shah, S.; Phatak, S.; Viswanathan, V. Improved medication adherence and 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 diabetes in India. *Telmed. e-Health* 2017, 23, 733–740. [CrossRef] [PubMed]

15. Lee, D.Y.; Park, J.; Choi, D.; Ahn, H.; Park, S.; Park, C. The effectiveness, reproducibility, and durability of tailored mobile coaching on diabetes management in policyholders: A randomized, controlled, open-label study. *Sci. Rep.* 2018, 8, 3642. [CrossRef] [PubMed]

16. Quinn, C.C.; Shardell, M.D.; Terrin, M.L.; Barr, E.A.; Ballew, S.H.; Gruber-Baldini, A.L. Cluster-randomized trial of a mobile phone personalized behavioral intervention for blood glucose control. *Diabetes Care* 2011, 34, 1934–1942. [CrossRef]

17. Quinn, C.C.; Shardell, M.D.; Terrin, M.L.; Barr, E.A.; Park, D.; Shaikh, F.; Gruber-Baldini, A.L. Mobile diabetes intervention for glycemic control in 45- to 64-year-old persons with type 2 diabetes. *J. Appl. Gerontol.* 2016, 35, 227–243. [CrossRef] [PubMed]

18. Sun, C.; Sun, L.; Xi, S.; Zhang, H.; Wang, H.; Feng, Y.; Wang, G. Mobile phone–based telemedicine practice in older chinese patients with type 2 diabetes mellitus: Randomized controlled trial. *JMIR Mhealth Uhealth* 2019, 7, e10664. [CrossRef] [PubMed]

19. Wayne, N.; Perez, D.F.; Kaplan, D.M.; Ritvo, P. Health coaching reduces HbA1c in type 2 diabetic patients from a lower-socioeconomic status community: A randomized controlled trial. *J. Med. Internet Res.* 2015, 17, e224. [CrossRef] [PubMed]

20. Yu, Y.; Yan, Q.; Li, H.; Li, H.; Wang, L.; Wang, H.; Feng, B. 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. *J. Diabetes Investig.* 2019, 10, 1365–1371. [CrossRef] [PubMed]

21. Zhai, Y.; Yu, W. A Mobile App for Diabetes Management: Impact on Self-Efficacy Among Patients with Type 2 Diabetes at a Community Hospital. *Med. Sci. Monit. Int. Med. J. Exp. Clin. Res.* 2020, 26, e926719-1. [CrossRef] [PubMed]

22. Noble, K.; Brown, K.; Medina, M.; Alvarez, F.; Young, J.; Leadley, S.; Kim, Y.; DiCarlo, L. Medication adherence and activity patterns underlying uncontrolled hypertension: Assessment and recommendations by practicing pharmacists using digital health care. *J. Am. Pharm. Assoc.* 2016, 56, 310–315. [CrossRef] [PubMed]

23. Bonn, S.E.; Alexandrou, C.; Steiner, K.H.; Wiklander, K.; Östenson, C.G.; Löf, M.; Lagerros, Y.T. App-technology to increase physical activity among patients with diabetes type 2-the DiaCert-study, a randomized controlled trial. *BMC Public Health* 2018, 18, 1–7. [CrossRef] [PubMed]

24. Park, T.; Muzumdar, J.; Kim, H.M. Digital Health Interventions by Clinical Pharmacists: A Systematic Review. *Int. J. Environ. Res. Public Health* 2022, 19, 532. [CrossRef] [PubMed]

25. Bonoto, B.C.; Araujo, V.E.; Godói, I.P.; Lemos, L.L.P.; Godman, B.; Diniz, L.M.; Guerra Junior, A.A. Efficacy of mobile apps to support the care of patients with diabetes mellitus: A systematic review and meta-analysis of randomized controlled trials. *JMIR Mhealth Uhealth* 2017, 5, e6309. [CrossRef] [PubMed]