Systematic Review

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The effectiveness of telemedicine in the management of type 2 diabetes: A systematic review

Truong Van Dat[1,2], Van Binh[3], Thai Minh Hoang[3], Vo Linh Tu[3], Pham Dinh Luyen[3] and Le Thi Kim Anh[1]

Abstract

Background: Type 2 diabetes, a lifestyle-related disease demanding daily self-management, is a significant health concern. In this context, the use of telemedicine as a management tool is a relatively new and promising approach. This study aims to contribute to the growing body of knowledge by identifying the effectiveness of telemedicine in managing type 2 diabetes through a systematic review approach.

Methods: Four databases were searched including PubMed, Virtual Health Library, Global Health Library, and Google Scholar on 27 July 2022. Additionally, a manual search was performed to identify any relevant articles that may have been missed. The quality of the included articles was rigorously assessed using the Study Quality Assessment Tools of the National Institute of Health.

Results: We analyzed data from 134 articles. All 134 studies were published between 2002 and 2022, including 103 controlled intervention trials, 13 cohort studies, 7 before–after (pre–post) studies with no control group, 1 initial trial, 1 case study, 1 pilot study, and 8 two-arm studies that did not report the study design. Accordingly, most studies show positive changes in glycemic index in every group using telemedicine. Overall, although the BMI and weight indices in the studies improved at the end of the course, the improvement values were considered insignificant.

Conclusion: Telemedicine may be a valuable solution for blood sugar management in patients with type 2 diabetes. However, the effectiveness of telemedicine in improving BMI and quality of life is unclear.

Keywords

Telemedicine, systematic review, type 2 diabetes, effectiveness, management

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Introduction

The world is witnessing an increasing number of people having diabetes, in which type 2 diabetes is the predominant case. It is estimated that approximately 1.31 billion people will have diabetes by 2050, with patient groups mainly from North Africa, Middle East, Latin America and Caribbean.[1] WHO defines diabetes as a chronic metabolic disease characterized by elevated levels of blood glucose (or blood sugar), which leads over time to severe damage to the heart, blood vessels, eyes, kidneys, and nerves.[2] Challenges in preventing and controlling type 2 diabetes are still affecting all income levels. The government in the United States spent roughly 237 billion dollars in direct health care costs, and this spending amount of money will become a burden for society.[3]

A new technology called Telemedicine—a delivery of health-related services and information via telecommunications technologies—could be a method to address these challenges. This allows clinical services to leverage information technologies, video imaging, and telecommunication linkages

[1]Hanoi University of Public Health, Vietnam
[2]Ministry of Health, Hanoi, Vietnam
[3]University of Medicine and Pharmacy at Ho Chi Minh City, Vietnam

Corresponding authors:
Truong Van Dat, Hanoi University of Public Health, 1A Duc Thang, Bac Tu Liem, Hanoi 100000,Vietnam.
Email: dattv@ump.edu.vn

Le Thi Kim Anh, Hanoi University of Public Health, 1A Duc Thang, Bac Tu Liem, Hanoi 100000, Vietnam.
Email: ltka@huph.edu.vn

to enable doctors to provide healthcare services at a distance by using two-way video, smartphones, wireless tools, and other telecommunications technology.[4] Throughout the decade, telemedicine has been applied in many countries with different approaches. One such approach was installing an integrated app "Mobile Health" on patients' electronic devices.[5] With this installed application, healthcare professionals or providers can collect data, monitor lifestyle, and evaluate the effectiveness of treatment outcomes. Moreover, patients can immediately contact emergency physicians or nurses or request a health status update.

However, there exist various reported regarding the effectiveness of telemedicine. With the American Diabetes Association (ADA)'s emphasis on person-centered team care combined with a long-term treatment approach for diabetes, applying digital interventions (also known as technology applications in treatment) is generally considered to be fully adaptable to different functions for patient care, especially for type 2 diabetes patients.[3] To be more specific, the ADA guidelines in 2023 recommend that telehealth should be used as a complementary method to optimize glycemic management in people with uncontrolled diabetes. Evidence suggests that various telehealth approaches may improve HbA1c in type 2 diabetes compared with usual care.[3] However, irregular data and applications to different populations suggest a potential gap in outcomes for telehealth intervention.[3] This systematic review aims to evaluate telemedicine's effectiveness in managing type 2 diabetes comprehensively.

Methods

Protocol and registration

This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) Checklist[6] (Supplemental Table S1). Our protocol was registered at PROSPERO with ID number CRD42022351941.

Eligibility criteria

We selected original studies published in English that reported the effectiveness of telemedicine in the management of type 2 diabetes. No restrictions were made for publication year or the type of publication. We excluded materials that are not original articles such as thesis, book chapters, editorials, author responses, posters, letters, conference papers, reviews, and patents; abstracts only or studies with limited access; studies unrelated to telemedicine care; studies unrelated to illness such as the introduction of telemedicine techniques; studies that did not report of any glycemic index (HbA1c, FBG, . . .); studies with populations other than patients with type 2 diabetes.

Information sources and search strategies

Four databases, including PubMed, Virtual Health Library (VHL), Global Health Library (GHL), and Google Scholar, were searched on 27 July 2022. The search was completed in 1 day. A manual search was applied to find more relevant articles. Study Quality Assessment Tools (SQAT) of the National Institute of Health assessed the quality of included articles. The research uses a research object filter and a language filter to select research articles with the subject *human*, and written in *English*. A manual search using the references of included studies was performed to find more relevant studies. The search terms are provided in Supplemental Table S2.

Study selection

Search results were imported into Endnote X8.1 (Thomson Reuters, CA, USA) to delete duplicates automatically. We selected articles in two phases: 1. title and abstract screening of all searched articles; 2. full-text screening and selecting articles. Two independent reviewers completed these two stages of selection according to our inclusion and exclusion criteria. Any disagreement was discussed among two reviewers to reach a final decision.

Data collection process and data items

We created an extract form in the spreadsheet editor to extract all included articles. The extracted data included basic information (such as author, publication year, country, study design, and follow-up period), population baseline characteristics, descriptions of interventions, and outcomes. For baseline population characteristics, the extracted information should include population description, number of patients, age, sex, HbA1c, BMI, and diabetes duration. We describe telemedicine models based on information such as intervention setting (community-based, primary care-based, or hospital setting-based), medium of communication used (short message service, telephone, web-based, mobile phone app, or video conferencing system), telemedicine strategies (teleconsultation, tele-education, tele-case management, telemonitoring, or telementoring) were collected from the intervention section in the methods section of each article. For example, one article could report patterns in different intervention sites and use multiple telemedicine strategies and communication methods. Our primary outcome is the effectiveness of the patient's blood sugar control expressed by a glycemic index such as (HbA1c, FBG, . . .). Weight control and patients' quality of life are also included in the results.

Risk of bias in individual studies

The quality of the selected studies was assessed for risk of bias by two independent reviewers using the Study Quality Assessment Tools (SQAT)[7] of the National Institute of Health. Each item was rated NO for potential flaws or YES for good practice. Additionally, we followed SQAT's instructions to categorize "NA" (not applicable), "NR" (not reported), or "CD" (cannot be determined). These notations were used for ambiguous fields when our investigators were unsure how scores should be allotted, suggesting caution to others when adopting data from those studies. Each item would receive equal points in the final percentage calculation. The scoring cut-off at 75% or above of the total points places the article as having "good" quality, anything between 75% and 43% is "fair" and articles that are 43% or below are considered "poor" quality.

Results

Systematic search, study selection, and study characteristics

As a result, 1221 articles were identified from 4 databases. After excluding all duplicates by Endnote X8.1, 792 articles had potentially relevant articles. The selection of titles and abstracts resulted in 177 articles, subsequently analyzed as full texts by the reviewers. After excluding studies that did not meet the inclusion criteria and adding 47 articles from the manual search, 134 articles were eligible for systematic review Figure 1. All 134 studies were published between 2002 and 2022, including 103 controlled intervention trials, 13 cohort studies, 7 before–after (pre–post) studies with no control group, 1 initial trial, 1 case study, 1 pilot study, and 8 two-arm studies that did not report the study design.

Among the 134 eligible studies, 49 were from the United States, 26 from Korea, 8 from China, 7 from Australia, 6 from United Kingdom, 3 from Canada, 3 from India, 3 from Italy, 3 from Iran, 3 from Malaysia, 2 from Denmark, 2 from Germany, 2 from Ireland, 2 from Poland, 2 from Taiwan, 2 from Spain, 1 from Belgium, 1 from Brazil, 1 from Finland, 1 from France, 1 from Indonesia, 1 from Iraq, 1 from Japan, 1 from Norway, 1 from Singapore, 1 from Slovenia, and 1 from Turkey. All 134 studies were published between 2002 and 2022, with intervention settings including community-based (50 studies), primary care (38 studies), hospital (30 studies), community-based and primary care (7 studies), community-based and hospital (2 studies), primary care and hospital (5 studies), and all three intervention settings (2 studies). A summary of the characteristics of the studies included is depicted in Table 1. Risk of bias and methodological quality of included studies.

The studies were evaluated using the Study Quality Assessment Tools (SQAT)[7] of the National Institute of Health. A total of 49 studies out of 103 controlled intervention trials received a good rating, while 54 received a fair rating (Supplemental Table S3). Among 13 cohort studies, 2 had a good rating, and 11 had a fair rating (Supplemental Table S4). All seven before–after (pre–post) studies with no control group had a fair rating (Supplemental Table S5). One initial trial, one case study, one pilot study, and eight two-arm studies that did not report the study design were evaluated using Quality Assessment of Controlled Intervention Studies, 2 studies received a fair rating, and 9 received a poor rating (Supplemental Table S3).

Description of telemedicine intervention

The application of telemedicine in type 2 diabetes management has adopted various communication procedures to communicate and perform interventions, including short message service (57/134 studies), telephone (77/134 studies), web-based (59/134 studies), mobile phone app (30/134 studies), and video conferencing system (15/134 studies) (Figure 2).

Telemedicine strategies used in the studies included teleconsultation (59/134 studies), tele-education (90/134 studies), tele-case management (67/134 studies), tele-monitoring (100/134 studies) studies, and tele-mentoring (57/134 studies) (Figure 3).

The effectiveness of telemedicine in improved glycemic control

The change in glycemic index assessed the effectiveness of telemedicine in glycemic control before and after innovation. In 11 noncontrolled cohort studies and 7 pretest and posttest studies, 2 studies showed no impact of telemedicine use on glycemic control in patients,[121,130] 3 studies showed telemedicine application helps improve blood sugar index but not statistically significant,[116,126,127] 13 studies showed that telemedicine significantly improved clinical outcomes in patients.[111–115,117,118,120,122,124,125,128,129] There were significant differences in HbA1c at baseline and HbA1c at the end of the follow-up period (Table 2).[111–115,117,118,120,122,124,125,128,129] Telemedicine has proved effective in providing glycemic control results that are comparable to therapies that are widely recognized.[113] Better glycemic control results were linked to higher patient activation and engagement levels with telemedicine technology.[114,117] Telemedicine solutions might help improve illness management.[120]

The blood sugar control effectiveness of telemedicine was also evaluated carefully through studies with control groups of patients receiving usual care, with no telemedicine intervention. Two controlled cohort studies showed an improvement affecting the clinical outcomes in the telemedicine group compared to the usual care control group.[119,123] Cheng and Kao,[119] showed that managing type 2 diabetes patients with telemedicine for 1 month resulted in a statistically significant difference ($p < 0.001$) in glucose variability value and 2-h PPG value.[119] Meanwhile, Shane–McWhorter and McAdam–Marx,[123] showed that telemedicine administration for 9 months resulted in a difference in the average change in HbA1c compared to baseline and compared to the control group ($p < 0.001$).[123] In controlled clinical trials, these results also show that managing type 2 diabetes by using telemedicine can be as effective as or better than conventional care management. Out of a total of 98 clinical trials with usual care control groups, 38 studies showed

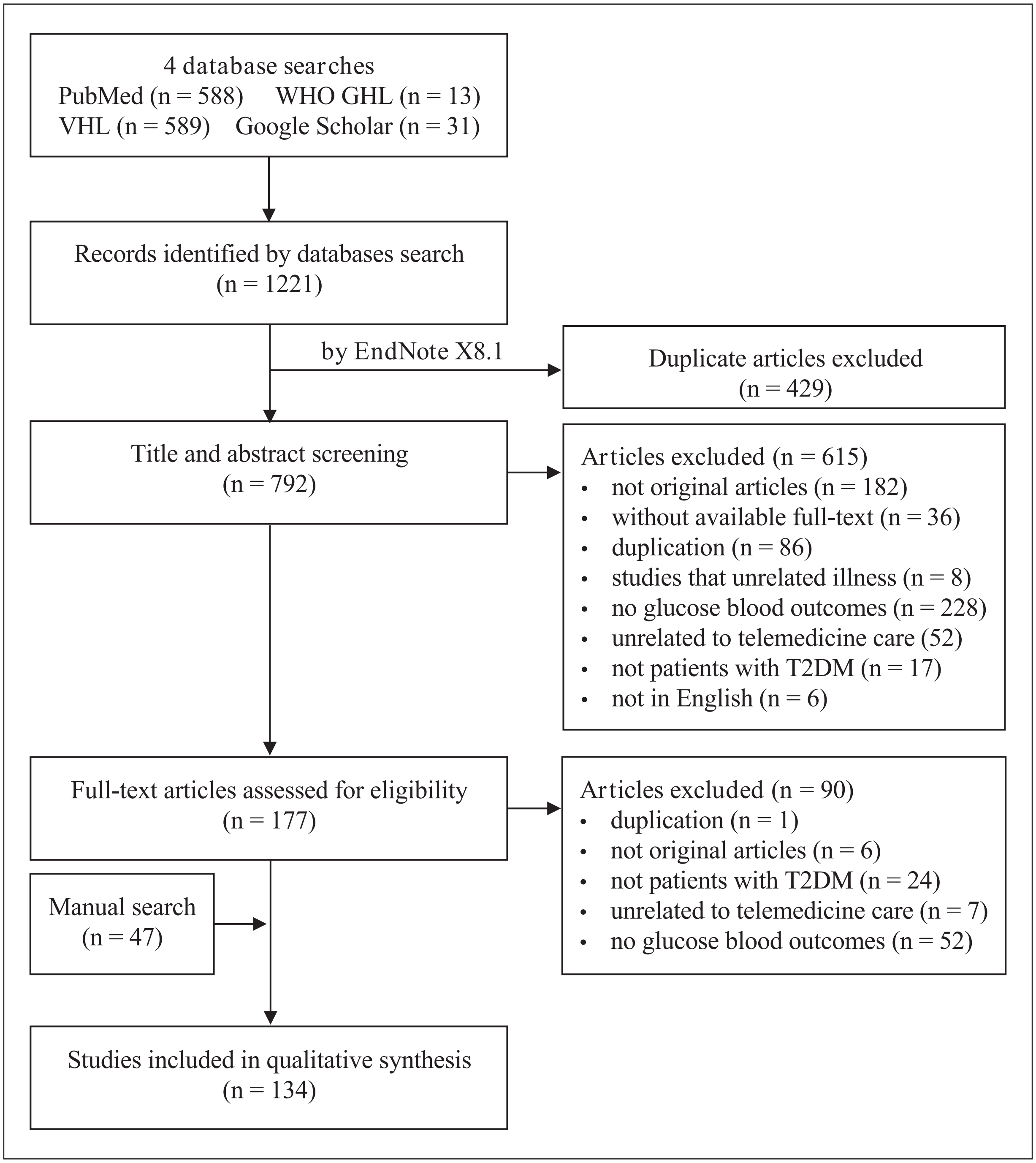

Figure 1. PRISMA flow diagram of study selection.

that telemedicine intervention helped patients improve blood glucose levels with a significant difference compared to others in the control group.[8,11–13,17–19,21,22,27–29,37,41,42,46,48,53,55,57,64,69,70,71,79,80,81,82,84,85–88,95,100,101,108,110] The participants in the intervention group had lower HbA1c than the control group.[8,11–13,16–18,21,22,27–29,37,42,46,48,55,57,69,70,71,80,82,84,85,86,88,101,108,110] The largest reduction in HbA1c index was 3.2 ± 1.5% after 6 months, compared to the control group received standard care at the clinic ($p < 0.05$).[69] Additionally,[100] Lee et al. showed that frequent user participation (at least twice daily) in self-monitoring may result in meaningful improvements in glycemic control compared with infrequent user participation.[100] In some studies, patient management by telemedicine has also been shown to be effective in improving FBG, postprandial blood glucose and 2HPMG level,[16,64,84,85,95] A total of 19 studies showed that only the group of patients receiving telemedicine care had a significant change in blood glucose index compared to baseline while the change was not significant in the control group.[9,23,26,30,35,43,56,59,66,67,68,72,75,77,98,99,102,104,109] Some studies show that telemedicine administration can lead to a significant improvement in

Table 1. Characteristics of study participants in included studies.

Author, year, country	Study design	Follow-up period	Population description	Intervention			Conjtrol	Baseline characteristics of patients (mean ± SD)						Outcome included in review
				Intervention setting (Community-based = 1, Primary care based = 2, Hospital setting based = 3)	Medium of communication used (Short message service = 1, Telephone = 2, Web-based = 3, Mobile phone app = 4, Video conferencing system = 5)	Telemedicine strategies (Teleconsultation = 1, Tele-education = 2, Telecase-management = 3, Telemonitoring = 4, Telementoring = 5)		*N* patients	Age (years)	Male sex (*n* or %)	BMI (kg/m^2)	HbA1c	Diabetes duration	
Hansel et al., 2017, France[8]	Randomized trial	4 months	Patients with abdominal obesity and T2DM, HbA1c >5.6% and <8.5%	3	3	125	Usual care	60^c, 60^i	57 ± 9	40 (33.3%)	33 ± 4	7.2 ± 1.1	no data	HbA1c, body weight
Kim and Jeong, 2007, South Korea[9]	A control group pretest–posttest design	6 months	Patients with T2DM	3	13	234	Usual care	26^c, 25^i	47.5 ± 9.1^c, 46.8 ± 8.8^i	11^c, 11^i	23.4 ± 2.5^c, 24.5 ± 2.9^i	7.59 ± 1.09^c, 8.09 ± 1.72^i	8.0 ± 4.9^c, 5.2 ± 5.9^i	HbA1c, FBG, 2HPMG
Basudev et al., 2016, United Kingdom[10]	Prospective randomized controlled study	12 months	Patients with T2DM of >1 year duration and HbA1c > 69 mmol/mol (>8.5%)	1	5	134	Usual care	115^c, 93^i	59.3 ± 12.0^c, 60.5 ± 12.3^i	68 (59.6%)^c, 51 (54.8%)^i	31.4 ± 7.1^c, 30.8 ± 6.7^i	10.4 ± 1.4^c, 10.2 ± 1.7^i	9.4 ± 5.2^c, 10.7 ± 6.8^i	HbA1c, BMI
Nicolucci et al., 2015, Italy[11]	A randomized, parallel group (1:1), open-label, multicenter study	12 months	Patients with T2DM HbA1c between 7.5% and 10%	1	12	24	Usual care	149^c, 153^i	57.8 ± 8.9^c, 59.1 ± 10.3^i	61.7^c, 61.4^i	29.0 ± 5.0^c, 28.7 ± 4.6^i	8.0 ± 0.8^c, 7.9 ± 0.7^i	8.7 ± 6.2^c, .3 ± 6.2^i	HbA1c, weight
Oh et al., 2003, South Korea[12]	A randomized comparison experimental design	3 months	Patients with T2DM, HbA1c ⩾ 7%	3	2	124	Usual care	25^c, 25^i	62.0 ± 5.7^c, 59.2 ± 7.2^i	36.0%^{c}, 36.0%^{i}	24.4 ± 2.6^c, 24.6 ± 2.6^i	8.3 ± 0.9^c, 8.8 ± 1.1^i	162.4 ± 8.35^c, 158.1 ± 99.3^i (months)	HbA1c, FBG, 2HPMG, BMI
Stone et al., 2010, USA[13]	Randomized controlled trial	6 months	Patients with T2DM, HbA1c ⩾ 7.5%	12	123	124	Usual care	77^c, 73^i	One-third of the participants in both groups were aged 65 years	The vast majority were male	No data	9.4 ± 1.4^c, 9.6 ± 1.6^i	No data	HbA1c, Weight
Kim and Oh, 2003, Korea[14]	Randomized controlled trial	12 weeks	Patients with T2DM, HbA1c ⩾ 7%	3	2	245	Usual care	16^c, 20^i	60.9 ± 5.8^c, 59.7 ± 7.3^i	25%^{c}, 35%^{i}	24.6 ± 2.8^c, 24.6 ± 2.8^i	8.2 ± 0.8^c 8.8 ± 1.2^i	13.4 ± 7.7^c, 14.0 ± 8.9^i	HbA1c
Khanna et al., 2014, Spanish[15]	Prospective, randomized, open-label trial with blinded endpoint assessment	12 weeks	Patients with T2DM, HbA1c >8.5% (not being on insulin) and >8% (being on insulin)	1	2	124	Usual care	37^c, 38^i	53 ± 12^c, 51 ± 12^i	68%^{c}, 50%^{i}	33 ± 7^c, 35 ± 10^i	8.9 ± 1.3^c, 9.2 ± 1.9^i	No data	HbA1c, BMI
Cho et al., 2017, Korea[16]	A randomized, prospective open trial	6 months	Patients with T2DM, HbA1c between 7% and 10%	3	3	1234	Usual care	240^c, 244^i	53.4 ± 8.7^c, 52.9 ± 9.2^i	63.3%^{c}, 63.5%^{i}	25.5 ± 3.2^c, 25.6 ± 3.4^i	7.81 ± 0.66^c, 7.86 ± 0.69^i	No data	HbA1c, FBG, Postprandial glucose, BMI
Welch et al., 2011, USA[17]	Randomized controlled trial	12 months	Patients with T2DM, HbA1c >7.5% within the past 3 months but not >14%	12	3	2345	Usual care	21^c, 25^i	57.5 ± 9.5^c, 54.4 ± 10.4^i	38.1%^{c}, 32%^{i}	35.8 ± 14.0^c, 33.8 ± 7.8^i	8.5 ± 1.0^c, 9.0 ± 1.2^i	13.8 ± 7.7^c, 10.3 ± 8.0^i	HbA1c, BMI
Fortmann et al., 2017, USA[18]	A randomized, nonblinded, parallel groups clinical trial	6 months	Patients with T2DM, HbA1c ⩾ 7.5%	2	1235	245	Usual care	63^c, 63^i	49.1 ± 10.6^c, 47.8 ± 9.0^i	15 (24%)^c, 17 (27%)^i	32.2 ± 6.6^c, 31.5 ± 6.0^i	9.6 ± 1.4^c, 9.5 ± 1.2^i	No data	HbA1c, FBS, BMI

(Continued)

Table 1. (Continued)

Author, year, country	Study design	Follow-up period	Population description	Intervention			Conjtrol	Baseline characteristics of patients (mean ± SD)						Outcome included in review
				Intervention setting (Community-based = 1, Primary care based = 2, Hospital setting based = 3)	Medium of communication used (Short message service = 1, Telephone = 2, Web-based = 3, Mobile phone app = 4, Video conferencing system = 5)	Telemedicine strategies (Teleconsultation = 1, Tele-education = 2, Telecase-management = 3, Telemonitoring = 4, Telementoring = 5)		*N* patients	Age (years)	Male sex (*n* or %)	BMI (kg/m²)	HbA1c	Diabetes duration	
Yang et al., 2020, Korea[19]	Randomized controlled trial	3 months	Patients with T2DM, HbA1c between 7% and 10%	2	1234	145	Usual care	97[c], 150[i]	60.6 ± 10.2[c], 54.1 ± 10.1[i]	45 (46%)[c], 80 (53.3%)[i]	25.7 ± 3.9[c], 26.3 ± 3.7[i]	7.9 ± 0.8[c], 8 ± 0.8[i]	No data	HbA1C, BMI
Wakefield et al., 2014, Missouri[20]	A single-center randomized controlled clinical trial	3 months	Patients with T2DM, HbA1c ⩾8%	2	3	45	Usual care	55[c], 53[i]	62.5 ± 10.9[c], 57.7 ± 10.8[i]	41%[c], 7%[i]	No data	7.4 ± 0.18 (*n* = 53)[c], 7.2 ± 0.21 (*n* = 41)[i]	No data	HbA1c
Egede et al., 2018, USA[21]	A randomized controlled trial	12 months	Patients with T2DM	1	25	124	Usual care	47[c], 43[i]	62.7 ± 3.4[c], 63.5 ± 4.9[i]	97.9%[c], 97.7%[i]	No data	7.3 ± 2.0[c], 6.9 ± 1.1[i]	No data	HbA1c
Steventon et al., 2014, United Kingdom[22]	A large cluster randomized trial	12 months	Patients with T2DM	1	3	245	Usual care	213[c], 300[i]	66.2 ± 11.9[c], 63.9 ± 13.0[i]	64.3%[c], 3.3%[i]	30.3 ± 5.9 (*n* = 189)[c], 31.8 ± 6.6 (*n* = 245)[i]	8.3 ± 1.7[c], 8.5 ± 1.8[i]	No data	HbA1c
Duruturk and Özköslü, 2019, Turkey[23]	A double-blind randomized controlled trial	6 weeks	Patients with T2DM at least 6 months	3	5	15	Usual care	21[c], 23[i]	53.04 ± 10.45[c], 52.82 ± 11.86[i]	14[c], 12[i]	29.90 ± 4.63[c], 32.07 ± 6.51[i]	7.57 ± 0.99[c], 7.14 ± 0.91[i]	5.23 ± 3.36[c], 4.89 ± 3.86[i]	HbA1c
Cho et al., 2011, Korea[24]	A randomized controlled trial	24 weeks	Patients with T2DM, HbA1c between 6% and 10%	3	13	4	Usual care	41[c], 38[i]	51 ± 11[c], 48 ± 13[i]	68%[c], 63%[i]	24.2 ± 2.1[c], 22.8 ± 2.8[i]	6.7 ± 0.8[c], 6.9 ± 0.9[i]	3.3 ± 0.8[c], 3.7 ± 1.0[i]	HbA1c
Wakefield et al., 2011, USA[25]	Randomized controlled trial	12 months	Patients with T2DM	2	123	2345	Usual care	107[c], 93[i] (High-intensity group) 102[i] (Low-intensity group)	67.9 ± 9.9[c], 67.8 ± 10[i] (High-intensity group) 68.4 ± 9.5[i] (Low-intensity group)	96[c], 99[i] (High-intensity group) 99[i] (Low-intensity group)	33.8 ± 6.9[c], 33.1 ± 6.6[i] (High-intensity group), 33.1 ± 7.3[i] (Low-intensity group)	7.2[c], 7.1[i] (High-intensity group) 7.2[i] (Low-intensity group)	No data	HbA1c
Kim et al., 2008, South Korea[26]	Quasi-experimental design	12 months	Patients with T2DM and obese	3	123	2345	Usual care	16[c], 18[i]	48.5 ± 8.0[c], 45.5 ± 9.1[i]	7 (43.8%)[c], 9 (50.0%)[i]	25.0 ± 1.7[c], 25.6 ± 2.4[i]	7.6 ± 0.7[c], 8.1 ± 1.9[i]	7.8 ± 5.0[c], 4.6[i] ± 6.3[i]	HbA1c, FBG, 2HPMG
Katula et al., 2022, USA[27]	Single-blind RCT	12 months	Patients with BMI ⩾ 25 kg/m² (⩾22 kg/m2 if participant self-identified as Asian), and had baseline HbA1c in the prediabetic range (5.7%–6.4% (39–46 mmol/mol))	12	3	2345	Usual care	300[c], 299[i]	55.6 ± 12.6[c], 55.3 ± 12.9[i]	116 (38.7%)[c], 115 (38.5%)[i]	36.1 ± 6.6[c], 35.8 ± 6.1[i]	5.8 ± 0.2[c], 5.8 ± 0.3[i]	No data	BMI, HbA1c
Hu et al., 2021, China[28]	A randomized controlled trial	6 months	Patients with T2DM more than 3 months	3	4	14	Usual care	70[c], 72[i]	52.21 ± 8.38[c], 50.04 ± 5.76[i]	43[c], 51[i]	24.05 ± 3.98[c], 24.69 ± 3.39[i]	8.63 ± 1.62[c], 8.96 ± 1.78[i]	6.09 ± 1.66[c], 6.24 ± 1.95[i]	HbA1c
Warren et al., 2018, Australia[29]	A prospective randomized controlled trial	6 months	Patients with T2DM, HbA1c level measured at ⩾58 mmol/mol (7.5%) at least once in the previous 12 months	1	35	134	Usual care	63[c], 63[i]	61.3 ± 11.4[c], 61.3 ± 10.8[i]	48%[c], 60%[i]	34.1 (30.3–40.6)[c], 34.2 (29.6–39.8)[i]	8.1 (7.1–8.9)[c], 8.4 (7.8–9.0)[i]	No data	HbA1c, BMI
Cho et al., 2011, Korea[30]	A randomized controlled design	3 months	Patients with T2DM, HbA1c 7.0%–11.0%	2	3	124	Usual care	35[c], 36[i]	63.1 ± 10.3[c], 5.3 ± 9.3[i]	34%[c], 44%[i]	24.7 ± 3.1[c], 25.2 ± 3.4[i]	8.0 ± 1.0[c], 8.0 ± 0.8[i]	9.9 ± 9.6[c], 7.9 ± 6.8[i]	HbA1c

(Continued)

Table 1. (Continued)

Author, year, country	Study design	Follow-up period	Population description	Intervention			Conjtrol	Baseline characteristics of patients (mean ± SD)						Outcome included in review
				Intervention setting (Community-based = 1, Primary care based = 2, Hospital setting based = 3)	Medium of communication used (Short message service = 1, Telephone = 2, Web-based = 3, Mobile phone app = 4, Video conferencing system = 5)	Telemedicine strategies (Teleconsultation = 1, Tele-education = 2, Telecase-management = 3, Telemonitoring = 4, Telementoring = 5)		*N* patients	Age (years)	Male sex (*n* or %)	BMI (kg/m^2)	HbA1c	Diabetes duration	
Jia et al., 2021, China[31]	A cluster randomized trial	12 months	Patients with T2DM	123	34	145	Usual care	6509[c], 13037[i]	60.8 ± 8.4[c], 60.4 ± 8.4[i]	2613 (40.1%)[c], 5447 (41.8%)[i]	25.6 ± 3.6[c], 25.7 ± 3.5[i]	7.83 ± 1.91[c], 7.89 ± 1.93[i]	6 (3, 11)[c] median (Q1, Q3), 6 (3, 10)[i] median (Q1, Q3)	HbA1c < 7.0%, BMI
Trief et al., 2016, USA[32]	Randomized clinical trial	12 months	Patients with T2DM, HbA1c ⩾ 7.5%	1	2	2	—	Diabetes education: 78 individual calls: 93 couples calls: 97	Diabetes education: 56.9 ± 10.4, individual calls: 55.6 ± 11.4, couples calls: 57.8 ± 10.8	Diabetes education: 59.0%, individual calls: 62.4%, couples calls: 62.9%	Diabetes education: 36 ± 8.1, individual calls: 36 ± 8.2, couples calls: 35.7 ± 6.3	Diabetes education: 9.1 ± 1.6, individual calls: 9.3 ± 1.7, couples calls: 8.9 ± 1.3	Diabetes education: 12.6 ± 8.3, individual calls: 11.9 ± 6.9, couples calls: 12.8 ± 8.5	HbA1c, BMI
Wayne et al., 2015, Canada[33]	Pragmatic randomized controlled trial	6 months	Patients with T2DM, HbA1c ⩾ 7.3%	1	124	345	Usual care	49[c], 48[i]	53.3 ± 11.9[c], 53.1 ± 10.9[i]	10 (20%)[c], 17 (35%)[i]	37.00 ± 7.92[c], 33.74 ± 6.70[i]	8.89 ± 1.30[c], 8.69 ± 1.32[i]	No data	HbA1c, BMI
Benson et al., 2019, USA[34]	Randomized controlled trial	12 months	Patients with T2DM	23	12	125	Usual care	58[c], 60[i]	60.0 ± 8.66[c], 59.8 ± 10.20[i]	56.9%[c], 53.3%[i]	36.2 ± 6.21[c], 37.8 ± 9.80[i]	8.3 ± 1.66[c], 8.1 ± 1.55[i]	<1 (10.3%), 1–3 (19.0%), 3–5 (15.5%), 5–10 (29.3%), >10 (25.9%)[c], <1 (8.3%), 1–3 (13.3%), 3–5 (10.0%), 5–10 (25.0%), >10 (40.0%)[i]	HbA1c, BMI
Hee-Sung, 2007, Korea[35]	A control group pretest–posttest design	12 weeks	Patients with T2DM	3	123	2345	Usual care	HbA1c <7.0%, 11[c], 13[i], HbA1c ⩾ 7.0%, 15[c], 12[i]	49.2 ± 9.2[c], 50.0 ± 8.6[i], 46.2 ± 9.1[c], 43.4 ± 7.9[i]	5[c], 5[i], 6[c], 6[i]	23.1 ± 2.9[c], 24.6 ± 2.2[i], 23.6 ± 2.3[c], 24.5 ± 3.6[i]	6.71 ± 0.39[c], 6.92 ± 0.35[i], 8.24 ± 0.98[c], 9.35 ± 1.72[i]	7.8 ± 5.2[c], 5.5 ± 4.8[i], 8.1 ± 4.7[c], 4.8 ± 7.0[i]	HbA1c
Xu et al., 2020, Missouri[36]	A randomized controlled trial	6 months	Patients with T2DM, HbA1c > 7%	2	12	34	Usual care	32[c], 33[i]	55.34 ± 1.94[c], 54.6 ± 1.82[i]	25%[c], 37.5%[i]	No data	9.23 ± 0.32[c], 9.8 ± 0.45[i]	No data	HbA1c, FBG
Lu et al., 2021, China[37]	A randomized controlled trial	6 months	Patients with T2DM, HbA1c 7%–10%	3	3	34	Usual care	59[c], 60[i]	53.17 ± 11.44[c], 56.75 ± 12.05[i]	55.93%[c], 53.33%[i]	No data	9.20 ± 1.92[c], 9.27 ± 2.26[i]	No data	HbA1c, FBG
Anderson et al., 2010, USA[38]	A randomized controlled trial	12 months	Patients with T2DM	1	2	134	Usual care	149[c], 146[i]	No data	64 (43.0%)[c], 60 (41.1%)[i]	33.7 ± 6.64[c], 35.4 ± 8.63[i]	8.4 ± 2.33[c], 7.6 ± 1.75[i]	No data	HbA1c, BMI
Agarwal et al., 2019, Canada[39]	Multicenter pragmatic randomized controlled trial	6 months	Patients with T2DM, HbA1c > 8.0%	23	14	234	Usual care	113[c], 110[i]	52.1 ± 10.7[c], 51.5 ± 10.6[i]	55 (49.0%)[c], 61 (55.0%)[i]	no data	9.03 ± 1.53[c], 8.89 ± 1.82[i]	No data	HbA1c
Cho et al., 2009, Korea[40]	Randomized controlled trial	3 months	Patients with T2DM	1	123	12345	—	Internet group: 34, Phone group: 35	Internet group: 45.2 ± 11.3, Phone group: 51.1 ± 13.2	Internet group: 26 (76%), Phone group: 28 (80%)	Internet group: 23.6 ± 3.0, Phone group: 25.3 ± 4.7	Internet group: 7.6 ± 1.9, Phone group: 8.3 ± 2.3	Internet group: 5.3 ± 4.8, Phone group: 8.2 ± 7.8	HbA1c, FBG, 2HPMG

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Table 1. (Continued)

Author, year, country	Study design	Follow-up period	Population description	Intervention			Conjtrol	Baseline characteristics of patients (mean ± SD)						Outcome included in review
				Intervention setting (Community-based = 1, Primary care based = 2, Hospital setting based = 3)	Medium of communication used (Short message service = 1, Telephone = 2, Web-based = 3, Mobile phone app = 4, Video conferencing system = 5)	Telemedicine strategies (Teleconsultation = 1, Tele-education = 2, Telecase-management = 3, Telemonitoring = 4, Telementoring = 5)		*N* patients	Age (years)	Male sex (*n* or %)	BMI (kg/m²)	HbA1c	Diabetes duration	
Quinn et al., 2016, USA[41]	Randomized controlled trial	12 months	Patients with T2DM at least 6 months, HbA1c level ⩾7.5% within the past 3 months	1	1234	234	Usual care	Age < 55 years, 29[c], 37[i], age > 55 years, 27[c], 25[i]	47.4 ± 7.5[c], 47.4 ± 6.8[i], 59.5 ± 2.8[c], 59.0 ± 2.9[i]	62.1%[c],37.8%[i], 37%[c], 68%[i]	33.9 ± 5.4[c], 36.5 ± 8.3[i], 34.7 ± 7.2[c], 34.8 ± 4.8[i]	9.9 ± 1.8[c], 9.9 ± 2.0[i], 8.4 ± 1.2[c], 9.8 ± 2.3[i]	8.9 ± 7.5[c], 6.8 ± 4.5[i], 9.2 ± 6[c], 10.3 ± 5.8[i]	HbA1c
Sun et al., 2019, China[42]	Randomized controlled trial	6 months	Patients with T2DM, HbA1c 7.0%–10.0%	3	14	2345	Usual care	47[c], 44[i]	68.04[c], 67.9[i]	18 (38%)[c], 19 (43%)[i]	23.30[c], 23.60[i]	7.88 ± 0.64[c], .84 ± 0.73[i]	11.52 ± 7.73[c], 11.19 ± 6.39[i]	HbA1c, BMI
Lim et al., 2016, Korea[43]	Randomized, controlled clinical trial	6 months	Patients with T2DM, HbA1c 7.0%–10.5%	3	13	2345	Usual care	50[c], 50[i]	65.8 ± 4.7[c], 64.3 ± 5.2[i]	35[c], 40[i]	25.4 ± 3.3[c], 25.9 ± 3.6[i]	7.9 ± 0.8[c], 8.1 ± 0.9[i]	14.6 ± 8.4[c], 14.4 ± 9.5[i]	HbA1C, BMI
Tang et al., 2013, USA[44]	Randomized clinical trial	12 months	Patients with T2DM ⩾18 y.o, HbA1c ⩾ 7.5% more than 1 year resulted within 30 days	123	1245	345	Usual care	213[c], 202[i]	53.5 ± 10.2, 54.0 ± 10.7	61%, 58.9%	No data	9.28, 9.24	No data	HbA1c
Greenwood et al., 2015, USA[45]	Randomized clinical trial	6 months	Patients with T2DM	1	3	1234	Usual care	45[c], 45[i]	57.5 ± 10.6[c], 53.9 ± 10.4[i]	79%[c], 75%[i]	34.1 ± 6.6[c], 34.1 ± 6.8[i]	8.2 ± 1.1[c], 8.5 ± 1.1[i]	8.1 ± 5.3[c], 8.3 ± 5.5[i]	HbA1c
Williams et al., 2012, Australia[46]	Randomized controlled trial	6 months	Adults with type 2 diagnosis of ⩾3 months and HbA1c ⩾ 7.5%,	1	2	1234	Usual care	60[c], 60[i]	56.4 ± 8.3[c], 58.4 ± 8.2[i]	63.3%[c], 61.7%[i]	No data	8.9[c], 8.7[i]	No data	HbA1c, HRQL
Ramadas et al., 2018, Malaysia[47]	Randomized clinical trial	12 months	Patients with T2DM, HbA1c ⩾ 7%	23	13	235	Usual care	62[c], 66[i]	51.5 ± 10.3, 49.6 ± 10.7	75.8%, 62.1%	no data	8.9 ± 1.9, 9.1 ± 2.0	6.8, 9.3	HbA1c
Egede et al., 2017, United States[48]	Randomized clinical trial	6 months	Patients with T2DM aged ⩾ 18 years from the southeastern United States, HbA1c ⩾ 8%	1	23	234	Usual care	59[c], 54[i]	53.4 ± 10.5, 55.1 ± 11.4	18.6%, 18.5%	36.9 ± 9.4, 34.2 ± 7.8	10.1 ± 2.1, 10.1 ± 1.8	11.5 ± 7.2, 13.0 ± 8.1	HbA1c
Kim et al., 2016, China[49]	Randomized open-label, parallel group design	6 months	T2DM Chinese patients were diagnosed ⩾ 1 year, HbA1c level of 7.0%–10.0%	3	123	1234	Usual care	90[c], 92[i]	55.6 ± 10.0[c], 52.5 ± 9.1[i]	43.3%[c], 53.3%[i]	25.2 ± 3.5[c], 25.8 ± 2.7[i]	8.0 ± 0.8[c], 7.9 ± 0.7[i]	No data	HbA1c
Goode et al., 2015, Australia[50]	A randomized trial	18 months	Patients with T2DM	1	2	14	Usual care	151[c], 151[i]	Usual group: no data. Intervention group: Low: 57.1 ± 7.3, Medium: 59.4 ± 7.4, High: 56.8 ± 9.3	Usual group: no data. Intervention group: - Low: 29 (58.0%), Medium: 23 (50.0%), High: 32 (58.2%)	Usual group: no data. Intervention group: Low: 32.4 ± 6.3, Medium: 33.7 ± 7.1, High: 33.2 ± 5.5	Usual group: no data. Intervention group: Low: 6.9 ± 7.93. Medium: 7.3 ± 8.33, High: 7.1 ± 7.9	Usual group: no data. Intervention group: Low: 4 ± 6.3, Medium: 4.5 ± 2, 7.3. High: 4 ± 10	HbA1c
Jeong et al., 2018, Korea[51]	Randomized clinical trial	24 weeks	Patients with T2DM, HbA1c from 7% to 11%	3	1235	12345	Usual care	113[c], 113[i], 112[i]	53.16 ± 9.06, 53.65 ± 9.10, 52.46 ± 8.48	67.26%, 66.37%, 68.75%	25.39 ± 3.07, 25.22 ± 3.64, 25.21 ± 3.27	8.39 ± 1.10, 8.21 ± 0.93, 8.39 ± 1.10	No data	HbA1c

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Table 1. (Continued)

Author, year, country	Study design	Follow-up period	Population description	Intervention			Conjtrol	Baseline characteristics of patients (mean ± SD)						Outcome included in review
				Intervention setting (Community-based = 1, Primary care based = 2, Hospital setting based = 3)	Medium of communication used (Short message service = 1, Telephone = 2, Web-based = 3, Mobile phone app = 4, Video conferencing system = 5)	Telemedicine strategies (Teleconsultation = 1, Tele-education = 2, Telecase-management = 3, Telemonitoring = 4, Telementoring = 5)		N patients	Age (years)	Male sex (n or %)	BMI (kg/m^2)	HbA1c	Diabetes duration	
Nagrebetsky et al., 2013, United Kingdom[52]	Feasibility trial	12 months	Patients with T2DM, HbA1c 8%–11%	2	123	45	Usual care	9^{c}, 8^{i}	60 ± 13, 56 ± 8	71%, 71%	32.4 ± 6.2, 33.4 ± 7.1	66 ± 13 mmol/mol, 64 ± 11 mmol/mol	2.3, 3.0	HbA1c
Wild et al., 2016, United Kingdom[53]	Randomized clinical trial	9 months	Patients with T2DM aged > 17 years, HbA1c > 58 mmol/mol.	2	23	134	Usual care	161^{c}, 160^{i}	61.4 ± 9.8, 60.5 ± 9.8	66.2%, 67.1%	31.9 ± 6.3, 33.8 ± 7.0	8.8 ± 1.1, 8.9 ± 1.3	7.4 ± 5.8, 7.4 ± 5.7	HbA1c
de Vasconcelos et al., 2018, Brazil[54]	Randomized clinical trial	24 weeks	Patients with T2DM for at least 1 year	2	2	1235	Usual care	15^{c}, 16^{i}	59.6, 60.9	5, 2	29.87 ± 5.25, 29.99 ± 5.82	6.9 ± 1.31, 8.0 ± 2.14	8.67 ± 6.39, 10 ± 8.48	HbA1c, BMI
Rasmussen et al., 2016, Denmark[55]	Randomized controlled trial	6 months	Patients with T2DM	3	5	1	Usual care	22^{c}, 18^{i}	64.6^{c}, 60.7^{i}	14 (63.6%)^{c}, 13 (72.2%)^{i}	30.4^{c}, 32.6^{i}	8.1^{c}, 9.0^{i}	8.4^{c}, 10.7^{i}	HbA1c, Blood glucose level, Weight
Rodríguez-Idígoras et al., 2009, Spain[56]	Randomized controlled parallel-group trial	1 year	Patients with T2DM	2	234	234	Usual care	167^{c}, 161^{i}	64.52, 63.32	49.10%, 54.04%	No data	7.41, 7.62	10.18, 11.32	HbA1c
von Storch et al., 2019, Germany[57]	Prospective study	3 months	Patients with T2DM	2	2	1345	Usual care	55^{c}, 60^{i}	58.4 ± 7.3, ,59.4 ± 6.3	85% 78%	29.3 ± 4.43, 31.9 ± 7.06	6.89 ± 1.01, 7 ± 0.96	7± 4.1, 7± 4	HbA1c, BMI
Lee et al., 2020, Malaysia[58]	Cluster-randomized controlled trial	52 weeks	Patients with T2DM	2	2	234	Usual care	120^{c}, 120^{i}	56.3 ± 8.6, 56.1 ± 9.2	45.8%, 44.2%	No data	9.00, 9.00	6.6 ± 7.0, 6.7 ± 5.3	HbA1c
Lee et al., 2017, Malaysia[59]	Cluster-randomized controlled trial	12 weeks	Patients with T2DM, HbA1c between 7.5% and 11.0%	12	134	234	Usual care	40^{c}, 45^{i}	53.77 ± 8.03^{c}, 53.24 ± 7.29^{i}	16 (40.00%)^{c}, 24 (60.00%)^{i}	30.28 ± 5.05^{c}, 29.20 ± 5.98^{i}	8.79 ± 1.15^{c}, 8.69 ± 1.12^{i}	10.04 ± 7.64^{c}, 7.91 ± 4.81^{i}	HbA1c, BMI
Dario et al., 2017, Italy[60]	Randomized controlled trial	12 months	Patients with T2DM, HbA1c > 7.0%	1	4	4	Usual care	91^{c}, 208^{i}	73.04 ± 5.28^{c}, 73.05 ± 5.79^{i}	49 (53%)^{c}, 119 (57%)^{i}	No data	7.93 ± 1.10^{c}, 7.94 ± 0.98^{i}	16.01 ± 9.84, 15.01 ± 10.24	HbA1c
Egede et al., 2017, USA[61]	Randomized controlled trial	4 years	Patients with T2DM, HbA1c ⩾ 9%	23	2	12345	Usual care	64^{c}, 63^{i} (knowledge), 65^{i} (skills) 63^{i} (combination)	56.1 ± 10.3^{c}, 56.5 ± 11.5^{i}, 58.3 ± 9.5^{i}, 58.2 ± 10.0^{i}	51.6%^{c}, 55.6%^{i}, 61.5%^{i}, 52.4%^{i}	No data	9.5 ± 2.5^{c}, 9.3 ± 1.8^{i}, 9.2 ± 2.1^{i}, 9.2 ± 1.9^{i}	13.5 ± 9.3^{c}, 12.5 ± 8.3^{i}, 13.5 ± 8.8^{i}, 13.7 ± 9.7^{i}	HbA1c
Bujnowska-Fedak et al., 2011, Poland[62]	Randomized clinical trial	6 months	Patients with T2DM	2	124	4	Usual care	48^{c}, 47^{i}	57.5 ± 27.4, 53.1 ± 25.2	25, 26	26.2 ± 6.6, 25.4 ± 7.2	7.61 ± 1.65, 7.63 ± 1.53	7.7 ± 6.8, 8.1 ± 7.6	HbA1c
Arora et al., 2014, United States[63]	Randomized controlled trial	6 months	Patients with T2DM, HbA1c ⩾ 8%	3	1	23	Usual care	64^{c}, 64^{i}	51.0 ± 10.2, 50.5 ± 10.3	20, 26	No data	10.0 ± 1.7, ,10.2 ± 1.7	10.1 ± 6.5 10.9 ± 10.4	HbA1c
Kardas et al., 2016, Poland[64]	A feasibility prospective parallelarm randomized controlled trial	6 weeks	Patients with T2DM	2	45	34	Usual care	30^{c}, 30^{i}	59.0 ± 8.09^{c}, 59.9 ± 5.31^{i}	19 (63.3%)^{c}, 17 (56.7%)^{i}	30.3 ± 3.35^{c}, 31.6 ± 5.27^{i}	6.84 ± 0.98^{c}, 6.78 ± 1.10^{i}	No data	FBG, HbA1c
McFarland et al., 2012, USA[65]	Nonrandomized, parallel, control group study	6 months	Patients with T2DM, HbA1c ⩾ 7%	12	12	34	Usual care	67^{i}, 36^{c}	63 ± 10^{c}, 66 ± 9^{i}	64 (96%)^{c}, 36 (100%)^{i}	No data	9.1 ± 1.6^{c}, 9 ± 1.5^{i}	No data	HbA1c

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Table 1. (Continued)

Author, year, country	Study design	Follow-up period	Population description	Intervention: Intervention setting (Community-based = 1, Primary care based = 2, Hospital setting based = 3)	Medium of communication used (Short message service = 1, Telephone = 2, Web-based = 3, Mobile phone app = 4, Video conferencing system = 5)	Telemedicine strategies (Teleconsultation = 1, Tele-education = 2, Telecase-management = 3, Telemonitoring = 4, Telementoring = 5)	Conjtrol	Baseline characteristics of patients (mean ± SD): *N* patients	Age (years)	Male sex (*n* or %)	BMI (kg/m^2)	HbA1c	Diabetes duration	Outcome included in review
Hansen et al., 2017, Denmark[66]	Cross-sectional randomized controlled trial	8 months	Patients with T2DM, HbA1c > 7.5%	13	5	134	Usual care	82^{c}, 83^{i}	58.3 ± 9.3^{c}, 57.8 ± 9.4^{i}	53 (65%)^{c}, 53 (64%)^{i}	33.6 ± 5.6^{c}, 33.9 ± 6.2^{i}	9.36 ± 1.3^{c}, 9.25 ± 1.2^{i}	12.5 ± 7.3^{c}, 12.1 ± 6.6^{i}	HbA1c
Zhou et al., 2014, China[67]	Prospective randomized study	3 months	Patients with T2DM	3	123	234	Usual care	55^{c}, 53^{i}	No data	No data	23.64 ± 3.01, 24.72 ± 3.38	8.22 ± 1.58, 8.44 ± 1.58	No data	FBG, HbA1c
Luley et al., 2011, Germany[68]	Randomized clinical trial	6 months	Patients with T2DM with BMI > 25 kg/m^2	1	2	45	Usual care	35^{c}, 35^{i}	58 ± 7, 57 ± 9	54%, 43%	34.8 ± 5.9, 35.3 ± 5.7	7.6 ± 1.1, 7.5 ± 1.1	No data	HbA1c, BMI
Hsu et al., 2016, USA[69]	A randomized controlled study	12 ± 2 weeks	Patients with T2DM, HbA1c levels of 9%–14%	1	3	234	Usual care	20^{c}, 20^{i}	53.8^{c}, 53.3^{i}	No data	31.7^{c}, 30.8^{i}	10.9^{c}, 10.8^{i}	9^{c}, 9.6^{i}	HbA1c
Kleinman et al., 2017, India[70]	A randomized clinical trial	6 months	Patients with T2DM, HbA1c levels between 7.5% and 12.5%	3	34	4	Usual care	46^{c}, 44^{i}	48.0 ± 9.5^{c}, 48.8 ± 9.0^{i}	58.7%^{c}, 81.8%^{i}	28.0 ± 4.2^{c}, 29.7 ± 6.0^{i}	9.1 ± 1.1^{c}, 9.4 ± 1.2^{i}	8.5^{c}, 10.0^{i}	HbA1c, FBG, BMI
Orsama et al., 2013, Finland[71]	A randomized controlled trial	10 months	Patients with T2DM, HbA1c levels 6.5% and 11%	1	124	234	Usual care	24^{c}, 24^{i}	61.5 ± 9.1^{c}, 62.3 ± 6.5^{i}	54%^{c}, 54%^{i}	33.5 ± 8.0^{c}, 30.7 ± 4.5^{i}	7.09 ± 1.51^{c}, 6.86 ± 1.56^{i}	No data	HbA1c, weight
Kim et al., 2007, Korea[72]	A randomized controlled trial	12 weeks	Patients with T2DM	3	123	123	Usual care	26^{c}, 25^{i}	47.5 ± 9.1^{c}, 46.8 ± 8.8^{i}	11^{c}, 11^{i}	23.4 ± 2.5^{c}, 24.5 ± 2.9^{i}	7.59 ± 1.09^{c}, 8.09 ± 1.72^{i}	8.0 ± 4.9^{c}, 5.2 ± 5.9^{i}	HbA1c, 2HPMG
Bender et al., 2017, USA[73]	A randomized controlled trial	6 months	Patients with T2DM and BMI > 23 kg/m^2	1	34	245	Usual care	23^{c}, 22^{i}	57.7 ± 10.0^{c}, 57.4 ± 0.8^{i}	40%^{c}, 37%^{i}	31.5 ± 5.1^{c}, 28.6 ± 3.6^{i}	7.44 ± 0.93^{c}, 7.39 ± 0.82^{i}	No data	HbA1c, Fasting glucose, BMI, weight
Blackberry et al., 2013, Australia[74]	Prospective, cluster randomized controlled trial	18 months	Patients with T2DM, HbA1c > 7.5% in the past 12 months	1	2	25	Usual care	237^{c}, 236^{i}	61.9 ± 10.5^{c}, 63.6 ± 10.4^{i}	142 (60%)^{c}, 127 (54%)^{i}	No data	8.13 ± 1.34^{c}, 7.98 ± 1.22^{i}	9^{c},10^{i}	HbA1c, weight
Borhani et al., 2013, Kerman[75]	A quasi-experimental study	3 months	Patients with T2DM, HbA1c > 7%	1	2	35	Usual care	25^{c}, 25^{i}	No data	No data	30.69 ± 6.67^{c}, 27.93 ± 4.84^{i}	9.38 ± 1.53^{c}, 9.98 ± 1.34^{i}	No data	HbA1c, FBS, postprandial glucose, BMI
Faridi et al., 2008, USA[76]	A pilot controlled trial	3 months	Patients with T2DM, BMI > 25, HbA1c < 8%	2	1	35	Usual care	15^{c}, 15^{i}	56.7 ± 10.6^{c}, 55.3 ± 8.7^{i}	33.3%^{c}, 40%^{i}	36.9 ± 12.5^{c}, 34.3 ± 7.4^{i}	6.5 ± 0.7^{c}, 6.4 ± 0.6^{i}	No data	HbA1c, BMI, weight
Hallberg et al., 2018, USA[77]	An open-label, nonrandomized, controlled, before-and-after 1-year study	1 year	Patients with T2DM	1	34	235	Usual care	87^{c}, 262^{i}	52.33 ± 9.52^{c}, 53.75 ± 8.35^{i}	No data	36.72 ± 7.26^{c}, 40.43 ± 8.81^{i}	7.64 ± 1.76^{c}, 7.60 ± 1.50^{i}	7.85 ± 7.32^{c}, 8.44 ± 7.22^{i}	HbA1c, weight
Holmen et al., 2014, Norway[78]	A 3-arm prospective randomized controlled trial	12 months	Patients with T2DM, HbA1c level ⩾ 7.1%	1	124	345	Usual care	50^{c}, few touch application: 51^{i} FTA-health counseling: 50^{i}	55.9 ± 12.2^{c}, 58.6 ± 11.8^{i}, 57.4 ± 12.1^{i}	60%^{c}, 50%^{i}, 67%^{i}	32.0 ± 6.0^{c}, 32.4 ± 6.5^{i}, 30.7 ± 5.6^{i}	8.3 ± 1.2^{c}, 8.1 ± 1.1^{i}, 8.2 ± 1.1^{i}	9.4 ± 5.5^{c}, 11.2 ± 7.3^{i}, 9.6 ± 8.4^{i}	HbA1c, weight

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Table 1. (Continued)

Author, year, country	Study design	Follow-up period	Population description	Intervention: Intervention setting (Community-based = 1, Primary care based = 2, Hospital setting based = 3)	Medium of communication used (Short message service = 1, Telephone = 2, Web-based = 3, Mobile phone app = 4, Video conferencing system = 5)	Telemedicine strategies (Teleconsultation = 1, Tele-education = 2, Telecase-management = 3, Telemonitoring = 4, Telementoring = 5)	Conjtrol	Baseline characteristics of patients (mean ± SD): N patients	Age (years)	Male sex (n or %)	BMI (kg/m^2)	HbA1c	Diabetes duration	Outcome included in review
Lim et al., 2011, Korea[79]	A randomized controlled trial	6 months	Patients with T2DM, A1C level was 6.5%–10.5%	2	123	12345	Usual care	52[c], clinical decision support system (CDSS)-based ubiquitous healthcare: 51[i] self-monitored blood glucose: 51[i]	68.1 ± 5.5[c], 67.2 ± 4.1[i], 67.2 ± 4.4[i]	19[c], 23[i], 22[i]	25.4 ± 3.3[c], 24.7 ± 2.3[i], 24.9 ± 3.0[i]	7.9 ± 0.8[c], 7.8 ± 1.0[i], 7.9 ± 0.9[i]	15.8 ± 10.7[c], 14.1 ± 10.1[i], 15.4 ± 8.3[i]	HbA1c
Odnoletkova et al., 2016, Belgium[80]	A parallel-group, randomized controlled trial	18 months	Patients with T2DM	1	2	12345	Usual care	287[c], 287[i]	62.4 ± 8.9[c], 63.8 ± 8.7[i]	63%[c], 60%[i]	30.6 ± 5.2[c], 30.2 ± 4.9[i]	7.0 ± 1.0[c], 7.0 ± 1.1[i]	No data	HbA1c, BMI
Quinn et al., 2011, USA[81]	A cluster-randomized clinical trial	12 months	Patients with T2DM, HbA1c level ⩾ 7.5% (within 3 months)	2	3	45	Usual care	56[c], coach-only: 23[i] coach PCP portal: 22[i] coach PCP portal with decision support: 62[i]	53.2 ± 8.4, 52.8 ± 8.0[i], 53.7 ± 8.2[i], 52 ± 8.0[i]	50%[c], 52.2%[i], 45.5%[i], 50%[i]	34.3 ± 6.3[c], 36.9 ± 7.5[i], 35.5 ± 10.3[i], 35.8 ± 7.1[i]	9.2 ± 1.7[c], 9.3 ± 1.8[i], 9.0 ± 1.8[i], 9.9 ± 2.1[i]	9.0 ± 7.0[c], 7.7 ± 5.6[i], 6.8 ± 4.9[i], 8.2 ± 5.3[i]	HbA1c
Rothman et al., 2005, USA[82]	A randomized controlled trial	12 months	Patients with T2DM, HbA1c level ⩾ 8.0%	2	2	245	Usual care	105[c], 112[i]	57 ± 11[c], 54 ± 13[i]	44%[c], 44%[i]	34 ± 8[c], 35 ± 9[i]	11 ± 3[c], 11 ± 2[i]	9 ± 9[c], 8 ± 9[i]	HbA1c
Varney et al., 2014, Australia[83]	A random controlled trial	12 months	Patient with T2DM and HbA1c level >7%	2	2	245	Usual care	47[c], 47[i]	64[c], 59[i]	64%[c], 72%[i]	30.9[c], 32.1[i]	8.5[c], 8.2[i]	13.1[c], 12.6[i]	HbA1c, BMI
Waki et al., 2014, Japan[84]	A nonblinded randomized controlled study	3 months	Patient with T2DM	1	13	4	Usual care	27[c], 27[i]	57.4 ± 9.4[c], 57.1 ± 10.2[i]	21[c], 20[i]	27.1 ± 7.6[c], 26.2 ± 6.1[i]	7.0 ± 0.9[c], 7.1 ± 1.0[i]	No data	HbA1c, FBS, BMI
Wang et al., 2019, China[85]	A random controlled trial	6 months	Patient with T2DM and HbA1c level >7%	3	4	1234	Usual care	60[c], 60[i]	45.8 ± 8.38[c], 45.13 ± 7.83[i]	31[c], 33[i]	No data	8.68 ± 2.26[c], 8.62 ± 2.33[i]	No data	HbA1c, FBG, 2HPMG
Kusnanto et al., 2019, Indonesia[86]	A randomized experimental study	3 months	Patient with T2DM and HbA1c level >7%	1	4	45	Usual care	15[c], 15[i]	No data	40%[c], 46.7%[i]	No data	8.18 ± 1.02[c], 8.74 ± 1.34[i]	No data	HbA1c
Yoo et al., 2009, Korea[87]	A randomized, controlled clinical trial	3 months	Patient with T2DM, HbA1c 6.5%–10.0% and BMI ⩾ 23.0 kg/m^2	13	13	4	Usual care	54[c], 57[i]	59.4 ± 8.4[c], 57.0 ± 9.1[i]	64.8[c], 52.6[i]	25.5 ± 3.3[c], 25.6 ± 3.5[i]	7.4 ± 0.9[c], 7.6 ± 0.9[i]	7.2 ± 6.0[c], 6.0 ± 5.4[i]	HbA1c
Meigs et al., 2003, USA[88]	A group randomized controlled trial	12 months	Patient with T2DM	3	3	23	Usual care	291[c], 307[i]	67 ± 12[c], 68 ± 12[i]	50.5%[c], 44.9%[i]	No data	No data	9.7 ± 5.6[c], 9.9 ± 5.5[i]	HbA1c
Tutino et al., 2017, China[89]	A multicenter randomized nonblinded study	12 months	Patient with T2DM	3	3	23	—	DIAMOND: 1728[i], JADE: 1858[i]	56.8 ± 11.7[i], 56.1 ± 11.6[i]	54.5%[i], 54.4[i]%	25.32 ± 3.62[i], 25.18 ± 3.58[i]	7.91 ± 2.08[i], 7.78 ± 1.95[i]	5[i], 5[i]	HbA1c
Graziano et al., 2009, USA[90]	A randomized controlled trial	3 months	Patient with T2DM and HbA1c level ⩾ 7%	2	12	24	Usual care	58[c], 61[i]	63.0 ± 9.3[c], 60.1 ± 7.4[i]	33[c], 33[i]	no data	8.59 ± 1.96[c], 8.71 ± 1.74[i]	12.2 ± 8.2[c], 13.5 ± 8.4[i]	HbA1c
Middleton et al., 2021, Australisa[91]	A randomized controlled trial	12 months	Patient with T2DM	3	1	123	Usual care	19[c], 21[i]	32.4 ± 4.4[c], 33.0 ± 5.8[i]	53%[c], 48%[i]	31.6 ± 5.1[c], 31.8 ± 8.6[i]	7.3 ± 2.1[c], 7.2 ± 1.6[i]	5.0 ± 5.9[c], 7.6 ± 6.2[i]	HbA1c, BMI

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Table 1. (Continued)

Author, year, country	Study design	Follow-up period	Population description	Intervention			Conjtrol	Baseline characteristics of patients (mean ± SD)						Outcome included in review
				Intervention setting (Community-based = 1, Primary care based = 2, Hospital setting based = 3)	Medium of communication used (Short message service = 1, Telephone = 2, Web-based = 3, Mobile phone app = 4, Video conferencing system = 5)	Telemedicine strategies (Teleconsultation = 1, Tele-education = 2, Telecase-management = 3, Telemonitoring = 4, Telementoring = 5)		*N* patients	Age (years)	Male sex (*n* or %)	BMI (kg/m^2)	HbA1c	Diabetes duration	
Smith et al., 2008, USA[92]	A randomized controlled trial	12 months	Patient with T2DM	2	12	12	Usual care	227^{c}, 358^{i}	60^{c}, 62^{i}	50%^{c}, 45%^{i}	34^{c}, 33^{i}	7.3^{c}, 7.3^{i}	4^{c}, 4^{i}	HbA1c
Farmer et al., 2021, UK[93]	Two parallel-arm, individually randomized controlled trial	12 months	Patient with T2DM	12	1	2	Usual care	561^{c}, 558^{i}	no average	30.1%^{c}, 30.1%^{i}	30.8 ± 7.4^{c}, 30.6 ± 6.5^{i}	10.2 ± 3.6^{c}, 10.1 ± 3.4^{i}	5.2^{c}, 5.0^{i}	HbA1c
Vinitha et al., 2019, India[94]	A multicentric, randomized controlled trial	24 months	Patient with T2DM	1	1	25	Usual care	122^{c}, 126^{i}	44.1 ± 8.9^{c}, 42.4 ± 8.5^{i}	82^{c}, 86^{i}	27.3 ± 4.7^{c}, 27.2 ± 4.5^{i}	9.5 ± 1.9^{c}, 9.5 ± 2.1^{i}	no data	HbA1c, FBG
Peimani et al., 2016, Iran[95]	A three-arm randomized controlled trial	3 months	Patient with T2DM	2	1	25	Usual care	50^{c}, Tailored-SMS group: 50^{i}, Non-tailored-SMS group: 50^{i}	54.56 ± 9.88^{c}, 49.78 ± 9.76^{i}, 53.26 ± 10.49^{i}	26^{c}, 27^{i}, 28^{i}	27.92 ± 4.97^{c}, 27.71 ± 5.29^{i}, 27.40 ± 4.73^{i}	7.52 ± 1.49^{c}, 7.29 ± 1.33^{i}, 7.53 ± 1.47^{i}	9.98 ± 7.51^{c}, 8.09 ± 6.95^{i}, 8.9 ± 6.63	HbA1c, FBS, BMI
Schillinger et al., 2009, USA[96]	A three-arm practical clinical trial	12 months	Patient with T2DM and HbA1C ⩾ 8.0%	12	12	2	Usual care	114^{c}, ATSM: 112^{i}, GMV: 113^{i}	55.8 ± 11.8^{c}, 55.9 ± 12.7^{i}, 56.5 ± 11.4^{i}	44.7%^{c}, 42%^{i}, 36.3%^{i}	32.3 ± 13.5^{c}, 30.3 ± 6.7^{i}, 31.9 ± 8.2^{i}	9.8 ± 2.0^{c}, 9.3 ± 1.8^{i}, 9.4 ± 2.0^{i}	10.4 ± 8.1^{c}, 9.1 ± 7.3^{i}, 9.2 ± 6.8^{i}	HbA1c
Kim et al., 2014, Korea[97]	Clinical trial	3 months	Patient with T2DM and HbA1C was 7.0%–10.0%	3	4	13	Usual care	35^{c}, 35^{i}	53.8 ± 9.0^{c}, 51.8 ± 10.3^{i}	20^{c}, 20^{i}	24.9 ± 3.4^{c}, 25.0 ± 3.3^{i}	7.7 ± 0.5^{c}, 7.7 ± 0.7^{i}	, 11.8 ± 7.3^{i}	HbA1c, BMI
Iljaž et al., 2017, Slovenia[98]	A randomized controlled trial	6 months	Patient with T2DM	2	4	124	Usual care	62^{c}, 58^{i}	54.7^{c}, 56.3^{i}	36^{c}, 37^{i}	no data	6.8 ± 1.2^{c}, 7.1 ± 1.5^{i}	5.7 ± 4.8^{c}, 5.1 ± 5.7^{i}	HbA1c
Kwon et al., 2004, Korea[99]	A randomized controlled trial	3 months	Patient with T2DM	2	13	1234	Usual care	55^{c}, 55^{i}	54.7 ± 9.4^{c}, 53.5 ± 8.8^{i}	32^{c}, 35^{i}	23.9 ± 3.1^{c}, 24.4 ± 3.4^{i}	7.19 ± 1.17^{c}, 7.59 ± 1.43^{i}	6.6 ± 5.7^{c}, 7.0 ± 6.3^{i}	HbA1c
Lee et al., 2017, Korea[100]	A subanalysis of clinical trial	6 months	Patient with T2DM and HbA1c ⩾7.5%	1	2	14	Usual care	91^{c}, infrequent users: 54^{i}, frequent users: 53^{i}	56.4 ± 8.7^{c}, 53.5 ± 9.6^{i}, 55.8 ± 9.^{i}9	55^{c}, 32^{i}, 35^{i}	35.5 ± 6^{c}, 35.5 ± 6.5^{i}, 34.1 ± 6.4^{i}	9.2 ± 1.5^{c}, 9.4 ± 1.4^{i}, 9.2 ± 1.4^{i}	No data	HbA1c, BMI
Kim et al., 2010, Korea[101]	Clinical trial	12 weeks	Patient with T2DM and HbA1c was >7.0% and <12.0%, body mass index values <35 kg/m^2	1	13	2	Usual care	45^{c}, 47^{i}	49.0 ± 10.7^{c}, 47.8 ± 9.6^{i}	22^{c}, 24^{i}	24.4 ± 3.5^{c}, 23.6 ± 2.5^{i}	9.8 ± 1.2^{c}, 9.8 ± 1.3^{i}	8.4 ± 6.2^{c}, 8.5 ± 6.4^{i}	HbA1c
Song et al., 2009, Korea[102]	A randomized two-group pretest/posttest experimental study	12 weeks	Patient with T2DM	1	2	124	Usual care	25^{c}, 24^{i}	49.5 ± 10.6^{c}, 51.0 ± 11.3^{i}	50%^{c}, 36%^{i}	25.5 ± 3.7^{c}, 24.2 ± 3.9^{i}	9.0 ± 1.2^{c}, 9.4 ± 1.8^{i}	5.0 ± 5.7^{c}, 4.9 ± 5.3^{i}	HbA1c

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Table 1. (Continued)

Author, year, country	Study design	Follow-up period	Population description	Intervention			Conjtrol	Baseline characteristics of patients (mean ± SD)						Outcome included in review
				Intervention setting (Community-based = 1, Primary care based = 2, Hospital setting based = 3)	Medium of communication used (Short message service = 1, Telephone = 2, Web-based = 3, Mobile phone app = 4, Video conferencing system = 5)	Telemedicine strategies (Teleconsultation = 1, Tele-education = 2, Telecase-management = 3, Telemonitoring = 4, Telementoring = 5)		*N* patients	Age (years)	Male sex (*n* or %)	BMI (kg/m^2)	HbA1c	Diabetes duration	
McKay et al., 2002, USA[103]	A randomized design study	3 months	Patient with T2DM	2	23	125	Usual care	Information-only condition: 40[c], peer support condition: 40[i], personal self-management coach condition: 40[i], combined condition: 40[i]	60.8 ± 9.1[c], 57.6 ± 9.2[i], 57.6 ± 9.0[i], 62.1 ± 9.5[i]	47.5%[c], 52.5%[i], 42.5%[i], 45.0%[i]	No data	7.2 ± 1.36[c], 7.64 ± 1.71[i], 7.75 ± 1.33[i], 7.46 ± 1.35[i]	11.85 ± 6.8[c], 11.72 ± 8.71[i], 10.00 ± 6.39[i], 11.60 ± 9.23[i]	HbA1c
Cho et al., 2006, Korea[104]	A randomized controlled trial	30 months	Patient with T2DM	2	3	24	Usual care	40[c], 40[i]	54.6 ± 8.6[c], 51.3 ± 9.1[i]	57.5%[c], 65%[i]	23.8 ± 2.8[c], 22.8 ± 2.6[i]	7.5 ± 1.3[c], 7.7 ± 1.5[i]	6.9 ± 5.7[c], 6.7 ± 5.3[i]	HbA1c
Eakin et al., 2013, Australia[105]	A two-arm randomized controlled trial	6 months	Patient with T2DM and BMI ⩾ 25.0 kg/m2	1	2	14	Usual care	151[c], 151[i]	58.3 ± 9.0[c], 57.7 ± 8.1[i]	57%[c], 55.6%[i]	33.2 ± 6.0[c], 33.1 ± 6.3[i]	7.5 ± 1.7[c], 7.4 ± 1.5[i]	5[c], 4[i]	HbA1c, weight
Agboola et al., 2016, USA[106]	A randomized controlled trial	6 months	Patient with T2DM and HbA1c > 7%	1	12	245	Usual care	62[c], 64[i]	52.6 ± 12.6[c], 50.3 ± 10.5[c]	40%[c], 56%[i]	No data	8.38 ± 1.37[c], 9.02 ± 1.63[i]	No data	HbA1c
Glasgow et al., 2012, USA[107]	A patient-randomized practical effectiveness trial	12 months	Patient with T2DM and BMI ⩾ 25.0 kg/m^2	2	23	12	Usual care	EUC: 132[c], CASM: 169[i], CASM+: 162[i]	58.7 ± 9.1[c], 58.7 ± 9.3[i], 57.8 ± 9.3[i]	48.5%[c], 55.4%[i], 46.3%[i]	34.8 ± 0.6[c], 34.9 ± 0.4[i], 34.9 ± 0.4[i]	8.16 ± 0.16[c], 8.14 ± 0.10[i], 8.14 ± 0.10[i]	No data	HbA1c, BMI
Ralston et al., 2009, USA[108]	A pilot randomized trial	12 months	Patient with T2DM and HbA1c ⩾ 7%	2	3	35	Usual care	41[c], 42[i]	57.6[c], 57.0[i]	48.8%[c], 52.4%[i]	No data	7.9[c], 8.2[i]	No data	HbA1c
Noh et al., 2010, Korea[109]	A randomized controlled trial	6 months	Patient with T2DM and HbA1c was ⩾7.0% and ⩽10.0%	3	3	234	Usual care	20[c], 20[i]	42.3 ± 7.6[c], 42.5 ± 10.6[i]	75%[c], 80%[i]	24.7 ± 2.8[c], 25.7 ± 3.1[i]	8.6 ± 1.2[c], 9.0 ± 2.3[i]	8.4 ± 5.9[c], 4.6 ± 6.9[i]	HbA1c
Murray et al., 2017, England[110]	A multicenter, two-arm individually randomized controlled trial	12 months	Patient with T2DM	1	123	1245	Usual care	189[c], 185[i]	64.7 ± 9.1[c], 64.7 ± 9.1[i]	69%[c], 69%[i]	29.6 ± 5.2[c], 30.1 ± 5.3[i]	7.35 ± 1.37[c], 7.26 ± 1.25[i]	No average	HbA1c
Bingham et al., 2021, USA[111]	A retrospective study	3 months	Patients with T2DM	1	2	234	No control	444	70 [40-75]	180 (40%)	No data	7.4 [4.5-13.9]	No data	HbA1c
Michaud et al., 2020, Nebraska[112]	Retrospective observational study	3 months	Patients with T2DM	3	2	234	No control	1103	60.5 ± 11.4	0.45	No data	7.6 ± 1.9	No data	HbA1c
Kesavadev et al., 2012, India[113]	A retrospective cohort study	6 months	Patients with T2DM, HbA1c ⩾ 6.5%	1	23	134	No control	1000	53.2 ± 9.8	0.64	25.4 ± 3.8	8.5 ± 1.4	10.9 ± 7.1	HbA1c, FBS, BMI
Su et al., 2019, USA[114]	Cohort study	3 months	Patients with T2DM	3	2	14	No control	1354	59.6 ± 11.8	45.1%	BMI[i] ⩾ 30 kg/m2: 74.2%	7.7 ± 2.0	No data	HbA1c
Musacchio et al., 2011, Italy[115]	Cohort study	12 months	Patients with T2DM	2	13	234	No control	1004	66.6 ± 9.5	54.1%	29.5 ± 4.8	6.9 ± 0.9	10.8 ± 7.7	HbA1c
Turner et al., 2009, USA[116]	Exploratory study	3 months	HbA1c >7.5% commencing treatment with a basal insulin regimen during the past 12 months	2	124	35	No control	23	57.6 ± 12.0	18 (78%)	33.2 ± 6.3	9.5 ± 2.2	6.4 ± 4.5	HbA1c

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Table 1. (Continued)

Author, year, country	Study design	Follow-up period	Population description	Intervention: Intervention setting (Community-based = 1, Primary care based = 2, Hospital setting based = 3)	Intervention: Medium of communication used (Short message service = 1, Telephone = 2, Web-based = 3, Mobile phone app = 4, Video conferencing system = 5)	Intervention: Telemedicine strategies (Teleconsultation = 1, Tele-education = 2, Telecase-management = 3, Telemonitoring = 4, Telementoring = 5)	Conjtrol	Baseline characteristics of patients (mean ± SD): *N* patients	Age (years)	Male sex (*n* or %)	BMI (kg/m^2)	HbA1c	Diabetes duration	Outcome included in review
Bergenstal et al., 2021, USA[117]	Cohort study	17 months	Patients with T2DM	1	45	1245	No control	594	53.0 ± 8.4	224	35.4 ± 7.7 (*n* = 550)	7.7 ± 1.6 (*n* = 563)	No data	HbA1c
Michaud et al., 2018, USA[118]	Retrospective, observational study	3 months	Patients with type 2 diabetes	1	2	2345	No control	955	No data	432 (45%)	35.59 ± 7.79	7.91 ± 2.07	No data	HbA1c, BMI
Cheng et al., 2021[119]	Cross-sectional study	1-month	Patients with T2DM	1	12	1234	Usual care	207^{c}, 168^{i}	64.9 ± 13.1^{c}, 66.9 ± 12.0^{i}	99 (47.8%)^{c}, 76 (45.2%)^{i}	25.8 ± 4.8^{c}, 25.9 ± 4.2^{i}	9.3 ± 2.3^{c}, 9.1 ± 2.2^{i}	No data	FBS, 2HPMG, Glucose variability
Shane-McWhorter et al., 2014, USA[120]	A nonrandomized prospective observational preintervention–postintervention study	6 months	Patients with T2DM, HbA1c level >7%	2	12	245	No control	95	No data	40	No data	9.73	No data	HbA1c
Yu et al., 2014, Canada[121]	A single-arm pre–post cohort study	9 months	Patients with T2DM, HbA1c > 7.0%	2	123	25	—	Observational cohort: 81. Qualitative study: 21	No average	Observational cohort: 54%, Qualitative study: 43%	No data	Observational cohort: 7.64 ± 1.29, Qualitative study: 7.17 ± 0.98	No average	HbA1c
Berman et al., 2018, USA[122]	Cohort study	12 weeks	Patients with T2DM, HbA1c > 6.5%	1	24	125	No control	118	50.7 ± 9.4	18.6%	38.1 ± 8.8	8.1 ± 1.6	1.4 ± 0.9	HbA1c
Shane-McWhorter et al., 2015, USA[123]	Cohort study	6 months	Patients with T2DM	1	123	1245	Usual care	75^{c}, 75^{i}	50.57 ± 11.01^{c}, 48.28 ± 10.62^{i}	33.3%^{c}, 34.7%^{i}	33.29 ± 6.95^{c}, 33.13 ± 6.79^{i}	9.44 ± 1.72^{c}, 9.87 ± 2.06^{i}	No data	HbA1c
Dixon et al., 2020, United States[124]	Technology report	6 months	Patients with T2DM	1	1245	12345	No control	740	53.8 ± 8.8	0.37	35.6 ± 8.5	7.7 ± 1.7	No data	HbA1c
Majithia et al., 2020, USA[125]	Prospective single-arm study	4 months	Patients with T2DM, HbA1c from 8% to 12%	1	4	12345	No control	55	57.3 ± 11.6	33 (60%)	33.7 ± 7.2	8.9 ± 1.0	No data	HbA1c
Kim et al., 2006, Korea[126]	Pre–posttest	12 weeks	Patients with T2DM	3	13	234	No control	33	43.5 ± 12.6	42.4%	24.3 ± 3.7	8.1 ± 2.1	5.6 ± 5.7	HbA1c
Mayes et al., 2010, USA[127]	Pre–posttest	3.5 years	T2DM Hispanic patients	2	245	123	No control	16	51 ± 2.5	0.19	no data	9.6 ± 0.6	No data	HbA1c
McGloin et al., 2020, Ireland[128]	An observational, pre–post, multimethod, and triangulation design	12 weeks	Patients with T2DM and commencing with insulin therapy	1	2	4	No control	39	62.4	0.59	30.16 ± 7.32	9.62	No data	HbA1c, BMI
Bollyky et al., 2018, USA[129]	Pre–post test	12 months	T2DM, HbA1c > 7.5%, BMI ⩾ 25	1	12	125	No control	330	50.3 ± 9.6	146 (44.2%)	No data	7.5 ± 1.9 %	No data	HbA1c

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Table 1. (Continued)

Author, year, country	Study design	Follow-up period	Population description	Intervention			Conjtrol	Baseline characteristics of patients (mean ± SD)						Outcome included in review
				Intervention setting (Community-based = 1, Primary care based = 2, Hospital setting based = 3)	Medium of communication used (Short message service = 1, Telephone = 2, Web-based = 3, Mobile phone app = 4, Video conferencing system = 5)	Telemedicine strategies (Teleconsultation = 1, Tele-education = 2, Telecase-management = 3, Telemonitoring = 4, Telementoring = 5)		*N* patients	Age (years)	Male sex (*n* or %)	BMI (kg/m^2)	HbA1c	Diabetes duration	
McGloin et al., 2015, Ireland[130]	A longitudinal mixed-method case study	12 months	Patient with T2DM	1	2	5	No control	10	54.5 ± 6.9	0.5	34.5 ± 6.9	7.85 ± 1..98	6.5 ± 6.3	HbA1c
Carter et al., 2011, USA[131]	Not reported	9 months	Patients with T2DM	2	35	24	Usual care	21[c], 26[i]	49[c], 52[i]	9[c], 8[i]	36.1[c], 35.4[i]	8.8[c], 9.0[i]	No data	HbA1c, BMI, weight
King et al., 2009, USA[132]	Initial pilot program	12 months	Patients with T2DM	2	2	124	Usual care	101[c], 34[i]	61.0 ± 13.7[c], 62.8 ± 14.0[i]	46.5%[c], 48.5%[i]	No data	7.8 ± 1.9[c], 7.0 ± 1.1[i]	No data	HbA1c
Carallo et al., 2015, Singapore[133]	Not reported	1 year	Patients with T2DM	3	2	1	Usual care	208[c], 104[i]	61.4 ± 11.2[c], 63.9 ± 9.3[i]	62[c], 63[i]	30.6 ± 5.8[c], 31.0 ± 4.8[i]	61 ± 7 mmol/mol[c], 58 ± 6 mmol/mol[i]	No data	HbA1c
Chen et al., 2011, Taiwan[134]	Not reported	1 year	Patients with T2DM, HbA1c >7% more than 1 year	23	124	2345	Usual care	32[c], 32[i]	55.8 ± 17.5, 51.8 ± 15.8	43.8%, 46.9%	No data	9.6 ± 1.5, 9.5 ± 1.8	15.1 ± 9.5, 12.3 ± 7.2	HbA1c
Myers et al., 2021, USA[135]	Pilot study	3 months	Patients with T2DM, HbA1c ⩾ 9%	1	125	124	—	Telephone: 13, Telehealth: 9	Telephone: 58.69 ± 11.80, Telehealth: 56.56 ± 7.97	Telephone: 5, Telehealth: 5	No data	Telephone: 11.1, Telehealth: 10.3	No data	HbA1c
Istepanian et al., 2014, Iraq[136]	Case study	6 months	Patients with T2DM first year	2	24	4	Usual care	6[c], 6[i]	55.2 ± 10.1, 54.8 ± 12.7	No data	26.0 ± 3.5, 26.8 ± 3.1	8.95 ± 2.17, 8.95 ± 0.73	9.7 ± 9.4, 10.7 ± 11.3	HbA1c
Lim et al., 2009, Korea[137]	Not reported	3 months	Patients with T2DM	1	2	124	Usual care	34[c], 67[i]	58.0 ± 1.0[c], 59.0 ± 1.3[i]	49.3%[c], 44.1%[i]	24.8 ± 0.6[c], 24.4 ± 0.4[i]	8.5 ± 0.3[c], 8.0 ± 0.2[i]	8.6 ± 1.4[c], 7.1 ± 0.7[i]	HbA1c, BMI, FBS
Yoon et al., 2008, Korea[138]	Not reported	12 months	Patients with T2DM	2	13	24	Usual care	26[c], 25[i]	47.5 ± 9.1[c], 46.8 ± 8.8[i]	42.3%[c], 0.44%[i]	23.4 ± 2.5[c], 24.5 ± 2.9[i]	7.59 ± 1.09[c], 8.09 ± 1.72[i]	8.0 ± 4.9[c], 5.2 ± 5.9[i]	HbA1c
Nesari et al., 2010, Iran[139]	Not reported	3 months	Patients with T2DM, HbA1c >7%	1	2	123	Usual care	30[c], 30[i]	51 ± 8.2[c], 51.9 ± 7.6[i]	20%[c], 36.7%[i]	28.21 ± 4.70[c], 28.23 ± 4.01[i]	9.60 ± 1.56[c], 8.90 ± 1.44[i]	No average	HbA1c
McIlhenny et al., 2011, USA[140]	Not reported	6 months	Patients with T2DM	1	3	124	Usual care	50[c], 48[i]	61.8 ± 10.88[c], 65.8 ± 14.04[i]	48%[c], 54%[i]	No data	7.44 ± 1.65[c], 7.12 ± 1.61[i]	No data	HbA1c, weight
Kim et al., 2006, Korea[141]	Not reported	12 weeks	Patients with T2DM, HbA1c was < 10%, FBS <240 mg/dL	2	3	145	Usual care	23[c], Web-based: 28[i], Printed-material: 22[i]	No data	No data	No data	7.87 ± 1.52[c], Web-based: 7.99 ± 1.22[i], Pr'nted-mater'a: 7.51 ± 1.40[i]	No data	HbA1c, FBS

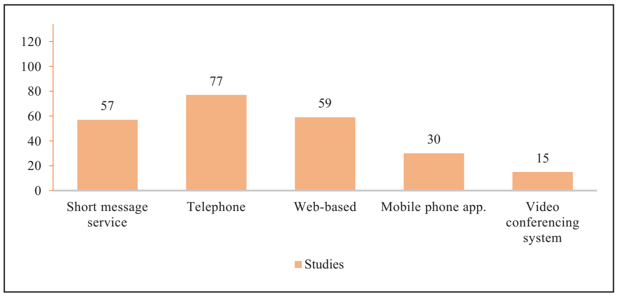

Figure 2. The medium of communication used.

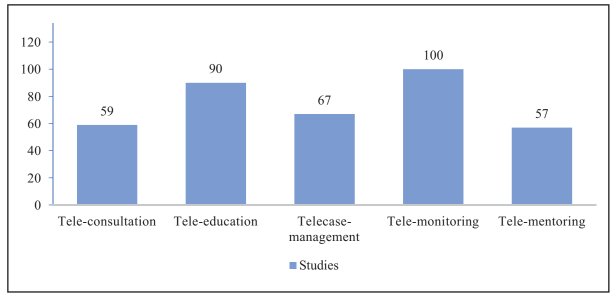

Figure 3. Telemedicine strategies.

HbA1c index ($p < 0.05$ vs baseline). Hee-Sung et al.,[35] showed a significant percentage change in baseline-glycosylated hemoglobin ⩾7.0% for the intervention group. However, there was still no change in the intervention group with baseline HbA1C < 7.0% and the control group. A total of 28 studies showed that managing patients with diabetes via telemedicine improved blood glucose levels comparable to usual care.[10,14,24,25,31,34,36,44,45,47,49,51,52,54,60,62,73,74,76,78,83,90,91,94,97,96,106,107] Telemedicine is believed to be a viable method for implementing chronic disease management. Only 14 studies showed that the addition of telemedicine had limited clinical benefit in improving glycemic control.[15,20,33,39,38,50,58,61,63,65,92,93,103,105] Pilot studies also show that telemedicine provides equivalent or better diabetes management effectiveness than the control group.[126,131–140]

The effectiveness of telemedicine in improved obesity control and quality of life

In addition to the effects of telemedicine on glycemic control, the systematic review analyzed other outcomes of telemedicine related to obesity management and quality of patient's life. The obesity status of patients was studied based on two leading indices: weight and body mass index (BMI). Regarding the effectiveness of improving the quality of life for patients, there are few research articles in this field, and they are only based on the Health-related Quality of Life (HRQoL) rating scale.

There were a total of five studies with a noncontrolled design model that were interested in indicators related to the obesity control status of patients. All the studies found above were of the preinterventional comparative study type. There were no comparative trials between intervention groups (no control groups) and only based on BMI to assess status. Five studies showed telemedicine results that had an improved impact on BMI,[113,118,125,131,133] and two studies did not find a difference in BMI before and after the intervention or that difference has no statistical significance.[128,130] A total of 54 controlled design articles evaluated BMI or weight values or assessed both as a consequence of the study. Forty-three trials indicated little or no statistically significant improvement[10,11–13,15–19,29,33,34,38,42,49,54,57,62,70,73–76,78,79,67,80,83,84,87,91,94,97,98,100,105,107,109,101,110,123,140]; five trials showed significant improved outcomes when compared baseline and postintervention, which were observed only in the intervention group; four trials showed that clinical outcomes improved significantly in the intervention compared with control group.[8,27,55,71]

In addition, seven trials with a model design of a control group and an intervention group assessed the quality of life through the main scale, health-related quality of life (HRQoL), with only three trials performed. Assessing quality of life is the second output next to the glycemic index. In which, three trials showed no improvement in quality of life in groups or statistically significant differences,[59,61,62] and four trials showed that telemedicine intervention has positive effects on patients' lives and activities.[11,16,46]

Discussion

Type 2 diabetes is a chronic condition characterized by high blood sugar levels resulting from the body's insufficient response to insulin, a hormone responsible for regulating blood sugar.[141] It is a global health burden that affects millions of people worldwide.[142] Through all studies, we see the benefits of telemedicine when supporting patients with type 2 diabetes. Accordingly, most studies show positive changes in glycemic index in every group using telemedicine. Moreover, when compared with traditional healthcare, these findings suggest that telemedicine can be as effective as, or even superior to, traditional care management.[8,11–13,16–19,21,22,27–29,37,41,42,46,48,53,55,57,64,69,70,71,79,80,81,82,84,85–,95,100,101,108,110] Above all, the role of telemedicine is also confirmed to be extremely important in some special cases such as the patient's residence distance to the center, where there is a hospital with adequate equipment, or the ability for patients to be admitted directly to medical facilities for examination with exception to emergency or urgent cases.

Overall, although the BMI and weight indices in the studies improved at the end of the course, the improvement values were considered insignificant. There were a few cases where the treatment effect changed significantly after the first 3 months of the trial but showed no overall improvement at the end. Quality of life and understanding of diabetes, as well as the level of satisfaction with the treatment course after the study, all tend to increase with statistical significance. Managing type 2 diabetes requires significant

Table 2. The effectiveness of telemedicine in improved glycemic control, obesity control, and quality of life.

Author, Year, Country	Study design	Follow-up period and *n* patients last visit	Primary Outcome		Secondary Outcome		Conclusion
			Control	Telemedicine	Control	Telemedicine	
Hansel et al., 2017, France[8]	Randomized trial	4 months, control group ($n=55$), telemedicine group ($n=49$)	Average change in HbA1c value was 0.23% (95% CI: 0.73)	Average change in HbA1c value was −0.37% (95% CI: 1.04) ($p<0.001$ vs. control) ($n=48$)	Average change in body weight was 0.2 (kg) (95% CI: 2.6)	Average change in body weight was −2.9 (kg) (95% CI: 3.1) ($p<0.001$ vs. control) ($n=47$)	Body weight and HbA1c changes improved significantly in the intervention
Kim and Jeong, 2007, South Korea[9]	A control group pretest–posttest design	6 months, control group ($n=26$), telemedicine group ($n=25$)	HbA1c value was 7.70 ± 0.90%, FBG was 149.5 ± 39.3 mg/dl, 2 h post−meal glucose was 218.0 ± 82.0 mg/dl	HbA1c value was 7.04 ± 1.39% ($p<0.05$ vs. baseline) FBG was 145.7 ± 39.7 mg/dl, 2 h post−meal glucose was 192.6 ± 55.2 mg/dl ($p<0.05$ vs. baseline)	No data	No data	Web-based intervention using SMS of cellular phone improved HbA1c and 2HPMG for 6 months in type-2 diabetic patients
Basudev et al., 2016, United Kingdom[10]	Prospective randomized controlled study	12 months, control group ($n=88$), telemedicine group ($n=79$)	HbA1c value was 9.4 ± 1.7%, change in HbA1c value was −0.8 ± 1.9	HbA1c value was 9.6 ± 1.7%, change in HbA1c value was −0.6 ± 1.7 ($p=0.4$ vs. control)	Change in body weight was 0.2 ± 5.4 (kg). Change in BMI was 0.20 ± 1.9 kg/m^2	Change in body value was 0.2 ± 5.4 (kg) ($p=0.99$ vs. control), Change in BMI was 0.13 ± 2.0 kg/m^2 ($p=0.84$ vs. control)	The virtual clinic model showed improvement in metabolic control, HbA1c within 12 months, however it was not significantly superior to the control group
Nicolucci et al., 2015, Italy[11]	A randomized, parallel-group (1:1), open-label, multicenter study	12 months, control group ($n=135$), telemedicine group ($n=114$)	HbA1c value was 7.78 ± 1.1%	HbA1c value was 7.44 ± 1.0% ($p=0.001$ vs. control)	Body weight was 81.3 ± 14.3 kg	Body weight was 82.2 ± 15.4 kg ($p=0.66$ vs. control), All SF−36 QoL scores improved in the telemedicine group but not in the control group	Use of the HT system was associated with better metabolic control and quality of life
Oh et al., 2003, South Korea[12]	A randomized comparison experimental design	3 months, control group ($n=18$), telemedicine group ($n=20$)	Average change in HbA1c value was 0.6 ± 0.9% ($p=0.005$ vs. baseline). . BG decreased of 6.9 ± 68.5 mg/dl ($p=0.675$ vs. baseline). Two hours post−meal glucose was increased of 19.6 ± 75.3 mg/dl ($p=0.315$ vs. baseline)	Average change in HbA1c value was −1.2 ± 1.5% ($p=0.002$ vs. baseline, $p=0.000$ vs. control). FBG decreased of 15.7 ± 52.0 mg/dl ($p=0.193$ vs. baseline, $p=0.245$ vs. control). Two hours postmeal glucose was decreased of 42.6 ± 114.8 mg/dl ($p=0.114$ vs. baseline, $p=0.071$ vs. control)	BMI increased of 0.2 ± 0.6 kg/m^2 ($p=0.278$ vs. baseline)	BMI increased of 0.3 ± 0.6 kg/m^2 ($p=0.068$ vs. baseline, $p=0.607$ vs. control)	A near-normal glycemic control delivered by telephone would imrprove HbA1c, but would not significantly affect BMI
Stone et al., 2010, USA[13]	Randomized controlled trial	6 months, home telemonitoring ($n=64$), monthly care coordination telephone call ($n=73$)	HbA1c value was 8.6 ± 1.3%	HbA1c value was 7.9 ± 1.2%, HbA1c was 0.7% lower than monthly care coordination telephone call ($p<0.001$)	Body weight was 223.9 ± 48.6 (lb)	Body weight was 229.5 ± 47.6 (lb) ($p=0.49$ vs. monthly care coordination telephone call)	Compared with the monthly care coordination telephone call group, the home telemonitoring group demonstrated significantly greater reductions in HbA1c
Kim and Oh, 2003, Korea[14]	Randomized controlled trial	12 weeks, control group ($n=16$), telemedicine group ($n=20$)	HbA1c value was 8.8 ± 0.9% ($p<0.05$ vs. baseline)	HbA1c value was 7.6 ± 1.0% ($p<0.05$ vs. baseline)	No data	No data	The nurse telephone intervention can improve HbA1c
Khanna et al., 2014, Spanish[15]	Prospective, randomized, open-label trial with blinded endpoint assessment	12 weeks, control group ($n=26$), telemedicine group ($n=23$)	Average change in HbA1c value was −0.3%	Average change in HbA1c value was −0.1% ($p=0.41$ vs. control)	Average change in BMI value was −0.1 kg/m^2	Average change in BMI value was 0.4 kg/m2 ($p=0.21$ vs. control)	There were no statistically or clinically significant differences between these 2 groups in changes in HbA1c
Cho et al., 2017, Korea[16]	A randomized, prospective open trial	6 months, control group ($n=240$), telemedicine group ($n=244$)	Average change in HbA1c value was −0.11 ± 0.76%, Average change in Fasting blood glucose value was −6.86 ± 33.8 mg/dl, Average change in Postprandial glucose value was −1.65 ± 74.9 mg/dl	Average change in HbA1c value was −0.31 ± 0.7% ($p<0.05$ vs. control), Average change in Fasting blood glucose value was −14 ± 40.2 mg/dl, Average change in Postprandial glucose value was −18.6 ± 71.4 ($p<0.05$ vs. control)	Average change in BMI value was −0.2 ± 1.28 kg/m2, DTSQ scores were 26.7 ± 5.8	Average change in BMI value was −0.33 ± 0.77 kg/m2, DTSQ scores were 27.9 ± 6.48 ($p<0.05$ vs. control)	Internet-based health gateway device was effective in glucose control, including HbA1c reduction and postprandial glucose level. The intervention did not decrease, patient quality of life.
Welch et al., 2011, USA[17]	Randomized controlled trial	12 months, control group ($n=18$), telemedicine group ($n=21$)	HbA1c value was 7.9 ± 1.4%, Average change in HbA1c value was −0.6 ± 1.1%	HbA1c value was 7.4 ± 1.4% ($p=0.26$ vs. control), Average change in HbA1c value was −1.6 ± 1.4% ($p=0.01$ vs. control)	BMI value was 33.8 ± 6.9 g/cm2	BMI value was 32.6 ± 6.3 g/cm2	The Comprehensive, Diabetes Management Program intervention was more effective than an attention control condition in helping patients meet evidence-based guidelines for diabetes care

(Continued)

Table 2. (Continued)

Author, Year, Country	Study design	Follow-up period and *n* patients last visit	Primary Outcome		Secondary Outcome		Conclusion
			Control	Telemedicine	Control	Telemedicine	
Fortmann et al., 2017, USA[18]	A randomized, nonblinded, parallel-groups clinical trial	6 months, control group ($n=59$), telemedicine group ($n=50$)	HbA1c value was 9.4 ± 2.0%, FBG value was 186.5 ± 68.5 mg/dl	HbA1c value was 8.5 ± 1.2% ($p=0.03$ vs. control), FBG value was 161.3 ± 49.7 mg/dl	BMI value was 32.1 ± 6.6 kg/m2 ($n=58$)	BMI value was 31.9 ± 5.4 kg/m2	Dulce Digital group achieved a significantly greater reduction in HbA1c over time compared with usual care
Yang et al., 2020, Korea[19]	Randomized controlled trial	3 months, control group ($n=94$), telemedicine group ($n=145$)	Average change in HbA1c value was −0.28% (95% CI: −0.42 to −0.13), Average change in FBG value was −2.41 mg/dl (95% CI: −13.64 to 8.82)	Average change in HbA1c value was −0.63% (95% CI: −0.77 to −0.50), Adjusted mean HbA1c difference to control was −0.30 (95% CI: −0.50 to −0.11) ($p=0.003$), Average change in FBG value was −19.11 mg/dl (95% CI: −29.80 to −8.43), Adjusted mean FBG difference to control was −17.29 mg/dl (95% CI: −29.33 to −5.26) ($p=0.005$)	BMI changed −0.41 (95% CI: −1.21 to 0.40) (kg/m2) from baseline	BMI changed −0.26 (95% CI: −0.40 to −0.11) (kg/m2) from baseline	The mobile phone–based glucose-monitoring and feedback system was effective in glycemic control when applied in primary care clinic settings. This system could be utilized effectively with diverse institutions and patients.
Wakefield et al., 2014, Missouri[20]	A single-center randomized controlled clinical trial	3 months, control group ($n=53$), telemedicine group ($n=41$)	HbA1c value was 7.4 ± 0.18% (mean ± SE)	HbA1c value was 7.2 ± 0.2% (mean ± SE)	No data	No data	There were no statistically significant differences in HbA1c between the intervention and control participants
Egede et al., 2018, USA[21]	A randomized controlled trial	12 months, control group ($n=47$), telemedicine group ($n=43$)	HbA1c value was 7.698%	HbA1c value was 6.875%, Difference between telemedicine and same room was −0.82 ($p=0.0061$, 95% CI: −1.405, 0.241)	No data	No data	There was a significant main effect of the treatment group on the mean HbA1c value at the study end
Steventon et al., 2014, United Kingdom[22]	A large cluster randomized trial	12 months, control group ($n=213$), telemedicine group ($n=300$)		The HbA1c value in the telemedicine group was lower than 0.21% control group (95% CI: 0.04% to 0.38%, $p=0.013$)	No data	No data	Telehealth modestly improved glycaemic control in patients with type 2 diabetes over 12 months
Duruturk and Özköslü, 2019, Turkey[23]	A double blind randomized controlled trial	6 weeks, control group ($n=21$), telemedicine group ($n=23$)	HbA1c value was 7.92 ± 2.82% ($p=0.23$ vs. baseline)	HbA1c value was 5.93 ± 1.46% ($p<0.05$ vs. baseline)	No data	No data	Tele-rehabilitation intervention in Patients with T2DM could lead to improvements in glucose control
Cho et al., 2011, Korea[24]	A randomized controlled trial	24 weeks, control group ($n=39$), telemedicine group ($n=36$)		HbA1c ⩽ 6.5% in both groups maintained their HbA1c at <6.5% (6.0 to 6.4% for the SAVE, group; 6.1 to 6.4% for the control group; $p<0.01$ for both), HbA1c was also maintained in patients with baseline, HbA1c >6.5% (7.3 to 7.7% in the SAVE group, $p=0.062$; 7.4 to 7.7% in the control group, $p=0.074$)	No data	No data	The study showed the efficacy, and safety of the software for online communication in diabetes management
Wakefield et al., 2011, USA[25]	Randomized controlled trial	12 months, control group ($n=94$), High−intensity group ($n=73$), Low−intensity group ($n=79$)		There was no significant difference between the change scores for the three groups [F(2, 1027) = 0.43, $p=0.65$]	No data	No data	The intervention groups were comparable with the control group
Kim et al., 2008, South Korea[26]	Quasi-experimental design	12 months, control group ($n=16$), telemedicine group ($n=18$)	HbA1c value was 8.19 ± 0.54%, FBG was 175.8 ± 53.9 mg/dl, Two hours post−meal glucose was 264.7 ± 89.2 mg/dl	HbA1c value was 6.67 ± 0.77% ($p<0.05$ vs. baseline), FBG was 149.6 ± 50.0 mg/dl, Two hours post−meal glucose was 169.7 ± 44.7 mg/dl ($p<0.05$ vs. baseline)	No data	No data	This web-based intervention using SMS of personal cellular phone improved HbA1c in obese type 2 diabetic patients
Katula et al., 2022, USA[27]	Single-blind RCT	12 months, control group ($n=300$), telemedicine group ($n=299$)	Average change in HbA1c value was −0.16% (95% CI: − 0.19 to − 0.12)	Average change in HbA1c value was −0.23% (95% CI: − 0.26 to −0.20), The between−group, difference in change in HbA1c was −0.08 (95% CI: −0.12 to −0.03, $p<0.025$)	Body weight changed from baseline was −2.18 kg (95% CI: −2.97 to −1.39)	Body weight changed from baseline was −5.52 kg (95% CI: −6.30 to −4.75), The between−group, difference in change in BMI was −3.34 kg/m2 (95% CI: −4.39 to −2.29, $p<0.001$)	Digital Diabetes Prevention Programs demonstrated clinical effectiveness and has significant potential for widespread dissemination and impact
Hu et al., 2021, China[28]	A randomized controlled trial	6 months, control group ($n=70$), telemedicine group ($n=72$)	HbA1c value was 8.22 ± 2.04%	HbA1c value was 7.38 ± 1.67% ($p=0.008$ vs. control)	No data	No data	After 6 months of follow-up, the telemedicine group, compared with the control group, showed significant decreases in HbA1c
Warren et al., 2018, Australia[29]	A prospective randomised controlled trial	6 months, control group ($n=63$), telemedicine group ($n=63$)	HbA1c value was 8.1% [7.4−8.9]	HbA1c value was 7.5% [6.9−8.2], The reduction HbA1c values in the intervention group over time was significantly greater than in the control group ($p<0.01$)	BMI value was 33.6 kg/m2 [29.5−38.4]	BMI value was 34.5 kg/m2 , [30.3−39.6]	The Townsville Broadband Diabetes Telehealth trial showed that a positive effect on glycaemic control resulted from participation in a telemonitoring intervention when compared with usual care

(Continued)

Table 2. (Continued)

Author, Year, Country	Study design	Follow-up period and *n* patients last visit	Primary Outcome		Secondary Outcome		Conclusion
			Control	Telemedicine	Control	Telemedicine	
Cho et al., 2011, Korea[30]	A randomized controlled design	3 months, control group ($n=35$), telemedicine group ($n=36$)	HbA1c value was 7.8 ± 1.1 % ($p=0.11$ vs. baseline)	HbA1c value was 7.5 ± 0.9% ($p<0.01$ vs. baseline)	No data	No data	Compared with baseline, HbA1c was significantly reduced at three-month follow-up in the intervention group, but not in the control group
Jia et al., 2021, China[31]	A cluster randomized trial	12 months	No data	Compared with usual care, the intervention led to an absolute improvement in the HbA1c control rate of 7.0% (95% confidence interval [CI] 4.0% to 10.0%)	No data	No data	After 1 year of application and follow-up, HbA1c was significantly reduced in primary care.
Trief et al., 2016, USA[32]	Randomized clinical trial	12 months, diabetes education ($n=78$), individual calls ($n=93$), couples calls ($n=97$)	No data	Significant decreased in HbA1c for all (12 months: cc −0.47%, ic −0.52%, de −0.57%),, with no differences between arms	No data	CC showed significant improvement	Education alone was beneficial, but additional intervention is needed to achieve glycemic targets
Wayne et al., 2015, Canada[33]	Pragmatic randomized controlled trial	6 months, control group ($n=49$), telemedicine group ($n=48$)	HbA1c value was 7.88 ± 1.17%	HbA1c value was 8.13 ± 1.27%	BMI value was 37.21 ± 8.22 kg/m2 ($n=36$)	BMI value was 33.53 ± 6.80 kg/m2 ($n=39$)	There was not statistically significant at 6 months because the control group's mean HbA1c reduction improved between 3 and 6 months while the intervention group's HbA1c level remained stable
Benson et al., 2019, USA[34]	Randomized controlled trial	12 months, control group ($n=58$), telemedicine group ($n=60$)	HbA1c value was 7.7 ± 0.20% (mean ± SE)	HbA1c value was 7.4 ± 0.15 (mean ± SE)	BMI value was 35.7 ± 0.83 kg/m2 (mean ± SE)	BMI value was 37.9 ± 1.32 kg/m2 (mean ± SE)	The magnitude of change for most individual diabetes measures was somewhat similar in both groups
Hee-Sung, 2007, Korea[35]	A control group pretest–post-test design	12 weeks, HbA1c <7.0% at baseline, control group ($n=11$), telemedicine group ($n=13$), HbA1c >= 7.0% at baseline, control group ($n=15$), telemedicine group ($n=12$)	HbA1c <7.0% at baseline: Average change in HbA1c value was 0.43 ± 0.53% ($p=0.034$) , HbA1c ⩾ 7.0% at baseline: Average change in HbA1c value was −0.22 ± 0.88% ($p=0.336$)	HbA1c <7.0% at baseline: Average change in HbA1c value was −0.21 ± 0.57% ($p=0.201$) , HbA1c ⩾7.0% at baseline: Average change in HbA1c value was −2.15 ± 2.25% ($p=0.007$)	No data	No data	There was a significant percentage change in a baseline-glycosylated haemoglobin ⩾ 7.0% for the intervention group; however, no significant change for the control group after 12 weeks.
Xu et al., 2020, Missouri[36]	A randomized controlled trial	12 months, control group ($n=32$), telemedicine group ($n=33$)	Average change in HbA1c value was −0.03 (95% CI: −0.88 to 0.82), FBG increased by 13.0 mg/dL (95% CI: −47.67, to 73.69)	Average change in HbA1c value was −0.69 (95% CI: −1.41 to 0.02), FBG decreased by 21.6 mg/dL (95% CI: −37.56 to −5.639)	No data	No data	EpxDiabetes helps to reduce HbA1c in patients with uncontrolled T2DM
Lu et al., 2021, China[37]	A randomized controlled trial	6 months, control group ($n=59$), telemedicine group ($n=60$)	HbA1c value was 8.17 ± 1.30% ($p=0.001$ vs. baseline), FBG was 7.64 ± 1.13 mmol/L ($p=0.007$ vs. baseline)	HbA1c value was 7.50 ± 0.96% ($p=0.001$ vs. baseline, $p=0.002$ vs. control), FBG was 7.31 ± 0.84 mmol/L ($p=0.001$ vs. baseline, $p=0.077$ vs. control)	No data	No data	The telemedicine group showed significantly lower HbA1c at 6 months compared with the control group
Anderson et al., 2010, USA[38]	A randomized controlled trial	12months, control group ($n=117$), telemedicine group ($n=94$)	HbA1c value was 7.74%	HbA1c value was 7.66%	BMI value was 34.69 kg/m2	BMI value was 34.50 kg/m2	A clinic-based telephonic disease management support for underserved patients with diabetes did not improve clinical or behavioral outcomes at 1 year as compared to patients receiving usual care alone
Agarwal et al., 2019, Canada[39]	Multicenter pragmatic randomized controlled trial	6 months, control group ($n=67$), telemedicine group ($n=72$)	HbA1c value was 8.41% (at 3 months)	HbA1c value was 8.22% (at 3 months)	No data	No data	The results showed no difference between intervention and control arms for the primary clinical outcome of glycemic control measured by HbA1c levels
Cho et al., 2009, Korea[40]	Randomized controlled trial	3 months, Internet group ($n=34$), Phone group ($n=35$)	no control	HbA1c value was 6.9% ($p<0.01$) in internet group, , and 7.1% ($p<0.01$) in phone group, Two−hour postprandial glucose levels also decreased significantly in both groups after three months ($p=0.001$),, but FBG levels did not change ($p=0.07$)	No data	No data	Mobile, bidirectional communication between doctors and patients using the diabetes phone was as effective for glucose control
Quinn et al., 2016, USA[41]	Randomized controlled trial	12 months, control group ($n=56$), telemedicine group ($n=62$)	HbA1c changed by−0.3% (95% CI = [−0.9, 0.3]) in older patients and −1.0% (95% CI = [−1.6, −0.4]) in younger group	HbA1c changed by−1.8% (95% CI = [−2.4, −1.1]) in older patients and −2.0% (95% CI = [−2.5, −1.5]) in younger group. The difference in 12−month changes (intervention − control) was −1.4% (95% CI = [−2.3, 0.6], $p=0.001$) among older patients and −1.0% (95% CI =[−1.6, −0.4], $p=0.02$) in younger group	No data	No data	Mobile PCS can be a useful intervention for those older patients with Type 2 diabetes, which contributed to a significant decrease in HbA1c over the 12-month study period, this could become mainstream in the coming years

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Table 2. (Continued)

Author, Year, Country	Study design	Follow-up period and *n* patients last visit	Primary Outcome		Secondary Outcome		Conclusion
			Control	Telemedicine	Control	Telemedicine	
Sun et al., 2019, China[42]	Randomized controlled trial	6 months, control group ($n=47$), telemedicine group ($n=44$)	HbA1c value was $7.22 \pm 0.87\%$	HbA1c value was $6.84 \pm 0.76\%$ ($p < 0.05$ vs. baseline, $p=0.02$ vs control)	BMI value was 22.62 kg/m2	BMI value was 23.8 kg/m2	Mobile phone–based telemedicine apps help improve glycemic control in older Chinese patients with T2DM
Lim et al., 2016, Korea[43]	Randomized, controlled clinical trial	6 months, control group − SMBG ($n=43$), U−heathcare group ($n=42$)	HbA1c value was 7.9 ± 1.2 % ($p=0.936$ vs. baseline)	HbA1c value was 7.3 ± 0.9 % ($p < 0.001$ vs.baseline)	BMI value was 26.5 ± 3.7 kg/ m2 ($p=0.110$ vs. baseline)	BMI value was 25.7 ± 3.6 kg/m2 ($p=0.002$ vs. baseline)	the patients using the multidisciplinary u-healthcare service showed better glycemic control with less hypoglycemia than those in the SMBG group
Tang et al., 2013, USA[44]	Randomized clinical trial	12 months, control group ($n=193$), telemedicine group ($n=186$)	HbA1c value was 8.33 ± 1.81 %	HbA1c value was 8.1 ± 1.68 % ($p=0.133$ vs.control)	No data	No data	INT patients achieved greater decreases in A1C at 6 months than UC patients, but the differences were not sustained at 12 months
Greenwood et al., 2015, USA[45]	Randomized clinical trial	6 months, control group ($n=41$), telemedicine group ($n=40$)	HbA1c value was 7.46%	HbA1c value was 7.35% ($p=0.55$ vs. control)	No data	No data	An eHealth model incorporating a complete feedback loop with telehealth remote monitoring and paired glucose testing with asynchronous data analysis significantly improved A1c levels compared to usual care.
Williams et al., 2012, Australia[46]	Randomised controlled trial	6 month, control group ($n=60$), telemedicine group ($n=60$)	HbA1c value was 8.7%	HbA1c value was 7.9%		HRQ−mental was significantly different between the, two arms at six months (difference = 3.0, $p=0.007$), No differences, were observed in HRQL−physical ($p=0.7$)	TLC Diabetes program with clinically significant postintervention improvements in both glycaemic control and mental HRQL
Ramadas et al., 2018, Malaysia[47]	Randomized clinical trial	12 months, control group ($n=55$), telemedicine group ($n=63$)	HbA1c value was $8.4 \pm 2.2\%$ ($p=0.001$ vs. baseline), FBG value was 7.7 ± 2.6 mmol/L ($p=0.117$ vs. baseline)	HbA1c value was $8.5 \pm 1.8\%$ ($p=0.004$ vs. baseline), FBG value was 7.9 ± 2.5 mmol/L ($p=0.015$ vs. baseline)	No data	No data	E-intervention can be a feasible method for implementing chronic disease management in developing countries.
Egede et al., 2017, United States[48]	Randomized clinical trial	6 months, control group ($n=44$), telemedicine group ($n=41$)	No data	The levels of HbA1c, in the TACM group were 0.99 points significantly lower compared to the usual care group ($p=0.024$)	No data	No data	Participants in the techtechnology-assisted case management intervention group had significantly lower HbA1c levels at 6 months post randomization compared to participants in the usual care group.
Kim et al., 2016, China[49]	Randomized open-label, parallel group design	6 months, control group ($n=90$), telemedicine group ($n=92$)	HbA1c value was $7.40 \pm 1.30\%$ ($p < 0.001$ vs. baseline), FBG was 7.8 ± 2.4 mmol/L ($p=0.058$ vs. baseline), Post−prandial blood glucose was 12.0 ± 3.0 mmol/L ($p=0.088$ vs. baseline),	HbA1c value was $6.70 \pm 0.70\%$ ($p < 0.001$ vs. baseline, $p < 0.01$ vs. control), FBG was 7.1 ± 1.6 mmol/L ($p=0.005$ vs. baseline), Post−prandial blood glucose was 10.7 ± 2.0 mmol/L ($p < 0.001$ vs. baseline),	BMI value was 25.2 ± 3.6 kg/ m2 ($p=0.564$ vs. baseline)	BMI value was 25.7 ± 2.6 kg/m2 ($p=0.089$ vs. baseline)	The Internet-based glucose monitoring system was effective in improving blood sugar levels among patients with diabetes
Goode et al., 2015, Australia[50]	A randomized trial	24 months , control group ($n=131$), telemedicine group ($n=181$)	no data	Average back transformed from natural log HbA1c was: , − Low: 1.01% (95% CI: 0.96, 1.06), $p=0.69$, − Medium: 0.98% (95% CI: 0.94, 1.03), $p=0.44$, − High: 0.99 % (95% CI: 0.96, 1.03), $p=0.69$	no data	no data	There was no significant difference in the associations of call completion with any outcome
Jeong et al., 2018, Korea[51]	Randomized clinical trial	24 weeks, control group ($n=101$), telemonitoring group ($n=99$), telemedicine group ($n=99$)	HbA1c reduced $0.66 \pm 1.03\%$. ($p < 0.001$ vs. baseline)	HbA1c reduced $0.66\% \pm 1.09\%$ in telemonitoring group, $0.81\% \pm 1.05\%$ in the telemedicine group ($p < 0.001$ vs. baseline)	No data	No data	Telehealthcare was as effective as conventional care at improving glycemia in patients with type 2 diabetes without serious adverse effects.
Nagrebetsky et al., 2013, United Kingdom[52]	Feasibility trial	6 months, control group ($n=7$), telemedicine group ($n=7$)	The median (IOR) change in HbA1c was −0.5% [−1.2% to 0.6%]	The median (IOR) change in HbA1c was −0.9% [−1.9% to 0%]	No data	No data	Self-titration of oral glucose-lowering medication in type 2 diabetes with self-monitoring and remote monitoring of blood glucose levels by clinical staff was feasible in primary care and may improve clinical outcomes
Wild et al., 2016, United Kingdom[53]	Randomized clinical trial	9 months, control group ($n=139$), telemedicine group ($n=146$)	HbA1c value was $8.4 \pm 1.3\%$	HbA1c value was $7.9 \pm 1.4\%$., The absolute mean difference in HbA1c between groups was −0.51% ($p=0.007$)	No data	No data	Supported telemonitoring resulted in clinically important improvements in control of glycaemia in patients with type 2 diabetes in family practice
de Vasconcelos et al., 2018, Brazil[54]	Randomized clinical trial	24 weeks, control group ($n=15$), telemedicine group ($n=16$)	HbA1c value increased from $6.9 \pm 1.31\%$ to $7.33 \pm 1.73\%$	HbA1c value decreased from $8.0 \pm 2.14\%$ to $7.21 \pm 1.19\%$	BMI value was 30.23 ± 5.29 kg/m2	BMI value was 29.96 ± 6.04 kg/m2 ($p=0.92$ vs. control)	Telecoaching is an effective tool for diabetes management

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Table 2. (Continued)

Author, Year, Country	Study design	Follow-up period and *n* patients last visit	Primary Outcome		Secondary Outcome		Conclusion
			Control	Telemedicine	Control	Telemedicine	
Rasmussen et al., 2016, Denmark[55]	Randomised controlled trial	6 months, control group ($n=22$), telemonitoring group ($n=18$)	Average change in HbA1c value was −10.6% (65 to 55 mmol/mol) , Average change in blood glucose levels value was −13.1% (10.3 to 8.7 mmol/l)	Average change in HbA1c value was −14.6% (76 to 61 mmol/mol, p=0.016 vs. control), Average change in blood glucose levels value was −17.6% (11.7 to 9.7 mmol/l, p=0.015 vs. control)	Average change in Weight value was 1.7 kg (88 to 86.7)	Average change in Weight value was 0.6 kg (99.7 to 99.1, p=0.023 vs. control)	In the direct comparison of home video consultations vs standard outpatient treatment in type 2 diabetes mellitus, telemedicine was a safe and available option with favourable outcomes after six months treatment.
Rodríguez-Idígoras et al., 2009, Spain[56]	Randomized controlled parallel-group trial	12 months, control group ($n=151$), telemedicine group ($n=146$)	HbA1c value was 7.35 ± 1.38% ($p=0.303$ vs. baseline)	HbA1c value was 7.4 ± 1.43% ($p=0.027$ vs. baseline)	No data	No data	A teleassistance system using real-time transmission of blood glucose results with an option to make telephone consultations is feasible in the primary care setting as a support tool for family physicians in their follow-up of type 2 diabetes patients.
von Storch et al., 2019, Germany[57]	Prospective study	3 months , control group ($n=55$), telemedicine group ($n=60$)	HbA1c value was 6.95 ± 1.02 % ($p=0.465$ vs. baseline) ($n=54$)	HbA1c value was 6.58 ± 0.723 % ($p<0.05$ vs. baseline, $p<0.05$ vs control) ($n=52$)	BMI value was 29.39 ± 4.37 kg/m2 ($p<0.05$ vs. baseline) (n =55)	BMI value was 31.8 ± 6.98 kg/m2 ($p=0.569$ vs. baseline) ($n=53$)	HbA1c values of the intervention group participants were significantly reduced in comparison to those in the control group after 3 months.
Lee et al., 2020, Malaysia[58]	Cluster-randomized controlled trial	52 weeks, control group ($n=104$), telemedicine group ($n=104$)	HbA1c value was 8.70%	HbA1c value was 8.69%($p=0.226$ vs. control)	No data	No data	The addition of telemedicine in replacement of self-monitoring in diabetes care had limited clinical benefits in improving glycemic control
Lee et al., 2017, Malaysia[59]	Cluster-randomised controlled trial	12 weeks, control group ($n=40$), telemedicine group ($n=45$)	HbA1c value was 8.55 ± 1.86% ($p=0.33$ vs. baseline)	HbA1c value was 7.62 ± 1.61% ($p<0.01$ vs. baseline)	BMI value was 30.49 ± 5.11 kg/m2 ($p=0.02$ vs. baseline), EuroQoL−5D was 0.81 ± 0.26	BMI value was 29.42 ± 5.92 kg/m2 ($p=0.01$ vs. baseline), EuroQoL−5D was 0.87 ± 0.11	Mean HbA1c levels in the telemonitoring group improved by 1.07% compared with 0.24% for usual care group at the end of the study. Diabetes education was also found to be able to improve the patients' quality of life at the end of the study.
Dario et al., 2017, Italy[60]	Randomized controlled trial	12 months, control group ($n=78$), telemedicine group ($n=168$)	Average change in HbA1c was −0.27 ± 0.99%	Average change in HbA1c was −0.26 ± 0.92% ($p=0.76$ vs. control)	No data	No data	There was no statistically, significant difference in HbA1c between the two groups
Egede et al., 2017, USA[61]	Randomized controlled trial	12 months, $n=255$		HbA1c at 12 months for the intervention groups did not differ significantly from that of the control group (knowledge: 0.49, $p=0.123$; skills: 0.23, $p=0.456$; combined: 0.48, $p=0.105$).		Did not show any significant improvement in HRQoL in both groups	Combined education and skills training did not achieve greater reductions in glycemic control at 12 months compared to the control group, education alone, or skills training alone.
Bujnowska-Fedak et al., 2011, Poland[62]	Randomized clinical trial	6 months , control group ($n=48$), telemedicine group ($n=47$)	HbA1c value was 7.43 ± 1.49 %	HbA1c value was 7.37 ± 1.27% ($p=0.72$ vs. control)	BMI value was 26.4 ± 6.1 kg/m2	BMI value was 24.8 ± 6.9 kg/m2 ($p=0.38$ vs. control), The difference in QoL between the two groups was not statistically significant	Telehome monitoring is an effective tool in controlling type 2 diabetes in a primary care setting
Arora et al., 2014, United States[63]	Randomized controlled trial	6 months, control group ($n=64$), telemedicine group ($n=64$)	Hb A1C decreased by 0.60%	Hb A1C decreased by 1.05% ($p=0.230$ vs. control)	No data	No data	The TExT-MED program did not result in a statistically significant improvement in HbA1c.
Kardas et al., 2016, Poland[64]	A feasibility prospective parallelarm randomized controlled trial	6 weeks, control group ($n=30$), telemedicine group ($n=30$)	Average change in FBG (FBG) (mg/dL) was 11.7 ± 36.1 (148.9 ± 43.5 to 137.2 ± 36.6) ($p>0.05$), Average change in HbA1c (%) was 0.01 ± 0.36 (6.84 ± 0.98 to 6.78 ± 0.92) ($p>0.05$)	Average change in FBG (FBG) (mg/dL) was 9.5 ± 22.5 (145.2 ± 40.7 to 135.7 ± +61.6) ($p<0.05$), Average change in HbA1c (%) was 0.04 ± 0.52 (6.78 ± 1.10 to 6.75 ± 0.95) ($p>0.05$)		Health related quality of life, as assessed with cumulative utility measure, improved significantly in COMMODITY12 system users ($p<0.05$)	mHealth solution was well accepted by type 2 diabetes patients taking part in clinical trial, leading to several clinical benefits, and improved quality of life.
McFarland et al., 2012, USA[65]	Nonrandomized, parallel, control group study	6 months, control group ($n=67$), telemedicine group ($n=36$)	Average change in HbA1c (%) was 2.1 ± 1.7 (9.0 ± 1.5 to 6.9 ± 1.0)	Average change in HbA1c (%) was 1.6 ± 1.2 (9.1 ± 1.6 to 7.5 ± 1.1) ($p=0.1987$ vs. control)	No data	No data	No statistically significant difference was demonstrated with respect to change in A1C from baseline to 6 months
Hansen et al., 2017, Denmark[66]	Cross-sectional randomized controlled trial	8 months , control group ($n=77$), telemedicine group ($n=69$)	Average change in HbA1c was 0.18% ($p=0.22$ vs. baseline)	Average change in HbA1c was 0.69% ($p<0.000001$ vs. baseline)	No data	No data	Video consultations preceded by uploading relevant measurements can lead to clinically and statistically significant improvements in glycemic control among patients who have not responded to standard regimens

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Table 2. (Continued)

Author, Year, Country	Study design	Follow-up period and *n* patients last visit	Primary Outcome		Secondary Outcome		Conclusion
			Control	Telemedicine	Control	Telemedicine	
Zhou et al., 2014, China[67]	Prospective randomized study	3 months, control group (*n* = 55), telemedicine group (*n* = 53)	HbA1c decreased from 8.22±1.58 to 7.60±1.57%. ($p = 0.001$ vs. baseline), FBG decreased from 8.73±2.60 to 8.02±2.38 mmol/L ($p = 0.007$ vs. baseline)	HbA1c decreased from 8.44±1.58 to 6.84±1.20% ($p < 0.001$ vs. baseline), FBG decreased from 8.73±2.61 to 7.06±1.49 mmol/L ($p < 0.001$ vs. baseline)	BMI value was 23.75±2.93 kg/m2	BMI value was 24.72±3.36 kg/m2	Telemedicine system can provide a tighter glycemic control for the treatment of Patients with T2DM
Luley et al., 2011, Germany[68]	Randomized clinical trial	6 months, control group (*n* = 35), telemedicine group (*n* = 33)	HbA1c increased by 0.2% ($p = 0.053$ vs. baseline)	HbA1c decreased by 0.8% ($p < 0.0125$ vs. basseline)	BMI decreased by 0.1 kg/m2 (no significant)	BMI decreased by 4.1 kg/m2 ($p < 0.0125$ vs. basseline)	The ABC program effectively lowers body weight, Hb1Ac in patients with type 2 diabetes.
Hsu et al., 2016, USA[69]	A randomized controlled study	12 weeks, control group (*n* = 16), telemedicine group (*n* = 19)	Average change in HbA1c was 2.0 ± 2.0%	Average change in HbA1c was 3.2 ± 1.5% ($p = 0.048$ vs. control)	No data	No data	Mobile health technology could be an effective tool in sharing data, enhancing communication, and improving glycemic control while enabling collaborative decision making in diabetes care.
Kleinman et al., 2017, India[70]	A randomized clinical trial	6 months , control group (*n* = 46), telemedicine group (*n* = 44)	Average change in HbA1c was −0.8 ± 1.6%, Average change in FBS was −23.5 ± 70.0 mg/dL	Average change in HbA1c was −1.5 ± 1.1% ($p = 0.02$ vs. control), Average change in FBS was −32.6 ± 66.4 mg/dL ($p = 0.55$ vs. control)	Average change in BMI was 0.1 ± 1.1 kg/m2	Average change in BMI was −0.1 ± 1.0 kg/m2 ($p = 0.53$ vs. control)	This tool could be an effective way to expand access to quality chronic disease care and improve outcomes
Orsama et al., 2013, Finland[71]	A randomized controlled trial	10 months, control group (*n* = 24), telemedicine group (*n* = 24)	Average change in HbA1c was 0.036%	Average change in HbA1c was −0.4% ($p = 0.022$ vs. control)	Average change in weight was 0.4 kg	Average change in weight was −2.1 kg ($p = 0.021$ vs. control)	Results showed that the automated feedback intervention had significant effects on HbA1c and on weight, which declined reliably in intervention compared with control participants with type 2 diabetes or type 2 diabetes and hypertension.
Kim et al., 2007, Korea[72]	A randomized controlled trial	12 weeks, control group (*n* = 26), telemedicine group (*n* = 25)	Average change in HbA1c was 0.07% (7.59 ± 1.09 to 7.66 ± 0.91), 2HPMG was 13.77 ± 4.2 mmol/l	Average change in HbA1c was −1.15% (8.09 ± 1.72 to 6.94 ± 1.04) ($p < 0.05$ vs. baseline), 2HPMG was 9.5 ± 4.4 mmol/l ($p < 0.05$ vs. baseline)	No data	No data	This educational intervention using the Internet and an SMS by cellular phone improved levels of HbA1c and 2HPMG
Bender et al., 2017, USA[73]	A randomized controlled trial	6 months, control group (*n* = 23), telemedicine group (*n* = 22)	Average change in HbA1c was −0.3% (7.4 ± 0.93 to 7.1 ± 1.2), Average change in Fasting glucose was −5.4 mg/dL (137.4 ± 30.1 to 132.0 ± 33.0)	Average change in HbA1c was −0.3% (7.4 ± 0.82 to 7.1 ± 0.98), Average change in Fasting glucose was −4.3 mg/dL (133 ± 20.8 to 128.7 ± 30.6)	Average change in BMI was −0.1 kg/m2 (31.5 ± 5.1 to 30.5 ± 5.6), Average change in weight was −2.4 kg (78.8 ± 18.6 to 76.4 ± 19.8)	Average change in BMI was −0.3 kg/m2 (28.5 ± 3.6 to 27.5 ± 3.6), Average change in weight was −1.6 kg (72.6 ± 10.8 to 70.8 ± 11.0)	Improvements in fasting glucose and HbA1c give promise to the efficacy of the PilAm Go4Health mHealth intervention to enhance diabetes self-management.
Blackberry et al., 2013, Australia[74]	Prospective, cluster randomised controlled trial	18 months, control group (*n* = 222), telemedicine group (*n* = 220)	Average change in HbA1c was −0.22% (8.13 ± 1.34 to 7.91 ± 1.42)	Average change in HbA1c was −0.13% (7.98 ± 1.22 to 7.85 ± 1.24) ($p = 0.84$ vs. control)	Average change in weight was 0.5 kg (92.2 ± 20.5 to 92.7 ± 21.0)	Average change in weight was −0.3 kg (91.0 ± 19.5 to 90.7 ± 21.0) ($p = 0.89$ vs. control)	At 18 months' follow-up the effect on glycaemic control did not differ significantly between the intervention and control groups
Borhani et al., 2013, Kerman[75]	A quasi-experimental study	3 months, control group (*n* = 25), telemedicine group (*n* = 25)	Average change in HbA1c was −0.16% (9.38 ± 1.53 to 9.14 ± 1.59), Average change in FBS was −26.34 mg/dl (188.38 ± 54.20 to 162.04 ± 47.66), Average change in PPG was −16.48 mg/dl (247.43 ± 74.06 to 263.91 ± 69.84)	Average change in HbA1c was −1.83% (9.98 ± 1.34 to 8.15 ± 0.97) ($p < 0.001$ vs. baseline), Average change in FBS was −38 mg/dl (173.56 ± 54.77 to 135.12 ± 37.54), Average change in PPG was −54.92 mg/dl (257.64 ± 67.48 to 202.72 ± 45.21) ($p < 0.001$ vs. baseline)	Average change in BMI was −0.77 (30.69 ± 6.67 to 29.92 ± 9.05)	Average change in BMI was −0.2 (27.93 ± 4.84 to 28.13 ± 4.88)	The results showed that phone follow-ups can improve the process of self-care and the control of Glycemic index in patients with type II diabetes
Faridi et al., 2008, USA[76]	A pilot controlled trial	3 months, control group (*n* = 15), telemedicine group (*n* = 15)	Average change in HbA1c was 0.3 ± 1.0% ($p = 0.3813$ vs. baseline)	Average change in HbA1c was −0.1 ± 0.3% ($p = 0.1534$ vs. baseline)	Average change in BMI was 2.2 ± 7.7 kg/m2, Average change in weight was −3.1 ± 7.5 lbs	Average change in BMI was 0.0 ± 0.9 kg/m2, Average change in weight was −0.1 ± 5.4 lbs	The results indicate the intervention had a positive impact on some clinical outcome and self-efficacy

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Table 2. (Continued)

Author, Year, Country	Study design	Follow-up period and *n* patients last visit	Primary Outcome		Secondary Outcome		Conclusion
			Control	Telemedicine	Control	Telemedicine	
Hallberg et al., 2018, USA[77]	An open-label, nonrandomized, controlled, before-and-after 1-year study	1 year, control group ($n=72$), telemedicine group ($n=204$)	Average change in HbA1c was 0.20 ± 1.35)% ($p=0.21$ vs. baseline)	Average change in HbA1c was − 1.29 ± 1.32% ($p<0.05$ vs. baseline)	Average change in weight was 0.04 ± 5.94 kg ($p=0.95$ vs. baseline)	Average change in weight was − 14.24 ± 10.29 ($p<0.05$ vs. baseline)	These results demonstrate that a novel metabolic and continuous remote care model can support adults with T2D to safely improve HbA1c, weight
Holmen et al., 2014, Norway[78]	A 3-arm prospective randomized controlled trial	12 months, control group ($n=41$), FTA ($n=49$), FTA−HC ($n=40$)	Average change in HbA1c was –0.16% (95% CI: –0.50, 0.1)	FTA: Average change in HbA1c was –0.31% (95% CI: –0.67, 0.05), FTA−HC: Average change in HbA1c was –0.15% (95% CI: –0.58, 0.29)	Average change in weight was –1.2 kg (95% CI: –2.75, 0.54)	FTA: Average change in weight was –1.3 kg (95% CI: –3.05, 0.43), FTA−HC: Average change in weight was –0.7 kg (95% CI: –2.29, 0.84)	Although HbA1c level declined in all groups, the change did not differ significantly between either of the intervention groups and the control group after 1 year
Lim et al., 2011, Korea[79]	A randomized controlled trial	6 months, control group ($n=48$), u−healthcare ($n=49$), SMBG ($n=47$)	HbA1c decreased from 7.9 ± 0.8% to 7.8 ± 1.0% ($p=0.274$)	HbA1c level was significantly decreased from 7.8 ± 1.3% to 7.4 ± 1.0% ($p<0.001$) in the u−healthcare group and from 7.9 ± 1.0% to 7.7 ± 1.0% ($p=0.020$) in the SMBG group	BMI was 25.8 ± 3.4 kg/m2 ($p=0.005$ vs. baseline)	u−healthcare group: BMI was 24.4 ± 2.5 kg/m2 ($p=0.009$ vs. baseline), SMBG group: BMI was 25.0 ± 3.2 kg/m2 ($p=0.303$ vs. baseline)	The CDSS-based u-healthcare service achieved better glycemic control with less hypoglycemia than SMBG and routine care and may provide effective and safe diabetes management in the elderly diabetic patient
Odnoletkova et al., 2016, Belgium[80]	A parallel-group, randomized controlled trial	18 months, control group ($n=246$), telemedicine group ($n=240$)	HbA1c level was 7.0 ± 1.1%	HbA1c level was 6.9 ± 1.0% ($p=0.046$ vs. control)	BMI was 30.4 ± 5.1 kg/m2 ($n=246$)	BMI was 29.9 ± 5.0 kg/m2 ($p=0.602$ vs. control) ($n=238$)	Twelve months after the intervention completion, there were sustained improvements in glycaemic control
Quinn et al., 2011, USA[81]	A cluster-randomized clinical trial	12 months, control group ($n=51$), CO group ($n=21$), CPP group (n =21), CPDS group ($n=56$)	Average change in HbA1c was −0.7% (95% CI: −1.1, −0.3)	CO: Average change in HbA1c was −1.6 (95% CI: −2.3, −1.0), CPP: Average change in HbA1c was −1.2 (95% CI: −1.8, −0.5), CPDS: Average change in HbA1c was −1.9 (95% CI: −2.3, −1.5)	No data	No data	The mean declines in glycated hemoglobin were 1.9% in the maximal treatment group and 0.7% in the usual care group, a difference of 1.2% ($p=0.001$) over 12 months
Rothman et al., 2005, USA[82]	A randomized controlled trial	12 months, control group ($n=95$), telemedicine group ($n=99$)	Average change in HbA1c was −1.6%	Average change in HbA1c was −2.5% (difference, 0.8%; 95% CI: 0% to 1.7%; p <, 0.05 vs. control)	No data	No data	The comprehensive disease management program reduced HbA1c levels among patients with type 2 diabetes and poor glycemic control.
Varney et al., 2014, Australia[83]	A random controlled trial	12 months, control group ($n=36$), telemedicine group ($n=35$)	HbA1c level was 8.4% (95% CI: 8.0, 8.7)	HbA1c level was 8.2% (95% CI: 7.9, 8.6)	BMI was 31.7 kg/m2	BMI was 31.6 kg/m2	Telephone coaching improved glycaemic control and adherence to complication screening in people with type 2 diabetes, for the duration of its delivery, but these effects were not maintained on withdrawal of the intervention
Waki et al., 2014, Japan[84]	A nonblinded randomized controlled study	3 months , control group ($n=27$), telemedicine group ($n=27$)	Average change in HbA1c was 0.1 %, Average change in FBS was 16.9 mg/dl	Average change in HbA1c was −0.4% ($p=0.015$ vs. control), Average change in FBS was −5.5 ($p=0.019$ vs. control)	BMI was 27.1 ± 7.5 kg/m2	BMI was 25.9 ± 5.9 kg/m2	HbA1c and FBS values declined significantly in the DialBetics group
Wang et al., 2019, China[85]	A random controlled trial	6 months, control group ($n=60$), telemedicine group ($n=60$)	HbA1c value was 7.92 ± 2.15% ($p<0.05$ vs. baseline), FBG was 7.96 ± 3.63 mmol/l ($p<0.05$ vs. baseline), Two hours post−meal glucose was 12.67 ± 3.42 mmol/l ($p<0.05$ vs. baseline)	HbA1c value was 7.12 ± 2.01% ($p<0.05$ vs. baseline and control), FBG was 6.58 ± 3.02 mmol/l ($p<0.05$ vs. baseline and control), Two hours post−meal glucose was 10.43 ± 3.12 mmol/l ($p<0.05$ vs. baseline and control)	No data	No data	After the intervention, levels of FPG, 2-hour postprandial blood glucose, and HbA1c were lower in the test group than in the control group; the differences were statistically significant
Kusnanto et al., 2019, Indonesia[86]	A randomized experimental study	3 months , control group ($n=15$), telemedicine group ($n=15$)	HbA1c value was 7.91 ± 0.88% ($p=0.208$ vs. baseline)	HbA1c value was 7.64 ± 1.29% ($p=0.001$ vs. baseline, $p=0.005$ vs. control)	No data	No data	The HbA1c values in the experimental group was significant and was not significant in the control group. Independent t-tests also showed significant value comparison between two groups
Yoo et al., 2009, Korea[87]	A randomized, controlled clinical trial	12 months, control group ($n=54$), telemedicine group ($n=57$)	HbA1c value was 7.6 ± 1.0% ($p=0.033$ vs. baseline)	HbA1c value was 7.1 ± 0.8% ($p<0.001$ vs. baseline)	BMI was 25 ± 3.3 kg/m2	BMI was 25.1 ± 3.5 kg/m2	After 12 weeks, there were significant improvements in HbA1c in the intervention group compared with the control group
Meigs et al., 2003, USA[88]	A group randomized controlled trial	12 months, control group ($n=291$), telemedicine group ($n=307$)	Average change in HbA1c was 0.14%	Average change in HbA1c was −0.23% ($p=0.09$ vs. control)	No data	No data	Web-based patient-specific decision support has the potential to improve evidence-based parameters of diabetes care

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Table 2. (Continued)

Author, Year, Country	Study design	Follow-up period and *n* patients last visit	Primary Outcome		Secondary Outcome		Conclusion
			Control	Telemedicine	Control	Telemedicine	
Tutino et al., 2017, China[89]	A multicentre randomized nonblinded study	12 months, DIAMOND group (n = 1176), JADE group (n = 1383)	No data	DIAMOND: Average change in HbA1c was −0.69% (95% CI: −0.81, −0.57), JADE: Average change in HbA1c was −0.62% (95% CI: −0.73, −0.50)	No data	No data	Integrated care augmented by information technology improved cardiometabolic control, with additional nurse contacts reducing the default rate and enhancing self-care
Graziano et al., 2009, USA[90]	A randomized controlled trial	3 months, control group (n = 58), telemedicine group (n = 61)	Average change in HbA1c was −0.767 ± 1.14%	Average change in HbA1c was −0.834 ± 1.09% (p = 0.84 vs. baseline)	No data	No data	there were no significant differences between the telephone and control groups on mean change HbA1c level
Middleton et al., 2021, Australisa[91]	A randomized controlled trial	12 months, control group (n = 15), telemedicine group (n = 20)	HbA1c value was 6.6 ± 1.7%	HbA1c value was 7.1 ± 1.1% (p = 0.37 vs. control)	BMI was 31.8 ± 5.8 kg/m2	BMI was 30.4 ± 8.4 kg/m2 (p = 0.57 vs. control)	There was no difference in mean HbA1c between groups
Smith et al., 2008, USA[92]	A randomized controlled trial	12 months, control group (n = 271), telemedicine group (n = 342)	HbA1c value was 6.7% (range: 4.8−13.7)	HbA1c value was 6.7% (range: 4.5−12.8)	No data	No data	Specialty telemedicine did not significantly enhance the value of CCM (the chronic care model) in primary care
Farmer et al., 2021, UK[93]	Two parallel-arm, individually randomised controlled trial	12 months, control group (n = 511), telemedicine group (n = 510)	Average change in HbA1c was −13.0 ± 31.27 mmol/mmol	Average change in HbA1c was −12.5 ± 30.72 mmol/mmol (p = 0.537 vs. control)	No data	No data	Whilst SMS text messages do not lead to improved glycaemia in these low-resource settings
Vinitha et al., 2019, India[94]	A multicentric, randomised controlled trial	24 months, control group (n = 122), telemedicine group (n = 126)	HbA1c value was 7.6 ± 1.3% (p < 0.0001), FBG was 142.4 ± 37.1 mg/dl (p < 0.0001)	HbA1c value was 7.2 ± 1.2% (p < 0.0001), FBG was 128.9 ± 32.2 mg/dl (p < 0.0001)	BMI was 27.7 ± 4.6 kg/m2 (n.s)	BMI was 27.2 ± 4.4 kg/m2 (n.s)	At 24 months, both groups showed significant reduction in blood pressure and glycaemic variables in comparison to the baseline values
Peimani et al., 2016, Iran[95]	A three-arm randomized controlled trial	3 months, control group (n = 50), Tailored−SMS group (n = 50), Non−tailored−SMS group (n =50)	HbA1c value was 7.55 ± 1.44% (p = 0.847), FBS was 165.32 ± 57.85 mg/dl (p = 0.850),	Tailored−SMS group: , HbA1c value was 7.06 ± 1.31% (0.050 vs. baseline), FBS was 152.54 ± 81.09 mg/dl (p = 0.003 vs. baseline), Non−tailored−SMS group:, HbA1c value was 7.26 ± 1.32% (p = 0.075 vs. baseline), FBS was 147.82 ± 47.27 mg/dl (p = 0.026 vs. baseline)	BMI was 28.21 ± 5.15 kg/m2 (p = 0.045)	Tailored−SMS group: BMI was 27.14 ± 5.51 kg/m2 (p < 0.001 vs. baseline), Non−tailored−SMS group: BMI was 26.90 ± 4.57 kg/m2 (p = 0.002 vs. baseline)	Although there were significant differences in the outcomes between the intervention groups and the control one, the differences between intervention groups (tailored and nontailored SMS groups) were not significant
Schillinger et al., 2009, USA[96]	A three-arm practical clinical trial	12 months , control group (n = 103), ATSM group (n = 101), GMV group (n =96)	HbA1c value was 9.0 ± 2.2%	ATSM: HbA1c value was 8.7 ± 1.9%, GMV: HbA1c value was 9.0 ± 2.0%	No data	No data	Glycemic control improved across all three arms, but there were no statistically significant differences in A1C change between three groups
Kim et al., 2014, Korea[97]	Clinical trial	3 months, control group (n = 35), telemedicine group (n = 35)	HbA1c value was 7.7±0.7% (p =0.973 vs. baseline)	HbA1c value was 7.5 ± 0.7% (p = 0.077 vs. baseline)	BMI was 24.3±3.1 kg/m2 (p = 0.066 vs. baseline)	BMI was 25.0±3.4 kg/m2 (p = 0.804 vs. baseline)	Both the smartphone group and the control group showed a tendency towards a decrease in the HbA1c level after 3 months
Iljaž et al., 2017, Slovenia[98]	A randomized controlled trial	6 months, control group (n = 54), telemedicine group (n = 53)	HbA1c value was 6.7 ± 1.5%	HbA1c value was 6.4 ± 0.9% (p < 0.05 vs. baseline)	BMI was 31.8 ± 5.1 kg/m2	BMI was 32.0 ± 4.7 kg/m2	The significant reduction of HbA1c values in the interventional group confirmed the application's potential to improve the regulation of DM type 2 in patients who are not using insulin.
Kwon et al., 2004, Korea[99]	A randomized controlled trial	3 months, control group (n = 50), telemedicine group (n = 51)	Average change in HbA1c was 0.33%	Average change in HbA1c was −0.54% (p < 0.05 vs. baseline)	no data	No data	The intervention group showed a marked decrease in HbA1c levels after 12 weeks of follow-up versus the baseline levels, whereas the control group showed slightly increased HbA1c levels after the same period
Lee et al., 2017, Korea[100]	A subanalysis of clinical trial	6 months, control group (n = 91), Infrequent users (n = 54), Frequent users (n = 53)	Average change in HbA1c was −1.8 ± 1.7%	Infrequent users: Average change in HbA1c was −1.5±1.5%, Frequent users: Average change in HbA1c was −2.4 ± 1.6% (p < 0.05 vs. control and infrequent users)	Average change in BMI was −0.02 ± 1.2 kg/m2	Infrequent users: Average change in BMI was 0.0±1.5 kg/m2, Frequent users: Average change in BMI was −0.1 ±2.4 kg/m2	Initial active engagement in self-monitoring with a telemonitoring device could provide incremental improvement of glycemic control over 6 months
Kim et al., 2010, Korea[101]	Clinical trial	12 weeks , control group (n = 45), telemedicine group (n = 47)	HbA1c value was , 7.8 ± 0.8%	HbA1c value was 7.4 ± 0.7% (p = 0.023 vs. control)	Body weight increased 2.2 ± 2.8 kg	Body weight increased 2.4 ± 3.0 kg (p = 0.653 vs. control)	The significant decrease in HbA1C was accomplished with a minimal incidence of hypoglycemia and a small increase in body weight

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Table 2. (Continued)

Author, Year, Country	Study design	Follow-up period and *n* patients last visit	Primary Outcome		Secondary Outcome		Conclusion
			Control	Telemedicine	Control	Telemedicine	
Song et al., 2009, Korea[102]	A randomized two-group pretest/posttest experimental study	12 weks, control group (n=24), telemedicine group (n=25)	HbA1c value was 8.6 ± 1.3%	HbA1c value was 7.1 ± 1.2% ($p<0.05$ vs. baseline)	No data	No data	hese findings indicate that the DOIMP can improve HbA1c levels in patients with type 2 diabetes
McKay et al., 2002, USA[103]	A randomized design study	3 months	Information−only condition: HbA1c value was 7.37 ± 1.49% (n= 33)	Peer support condition: HbA1c value was 7.59 ± 1.66% (n=30), Personal self−management coach condition: HbA1c value was 7.73 ± 1.42% (n=37), Combined condition: HbA1c value was 7.28 ± 1.28% (n=33)	No data	No data	There was no significant between-condition differences
Cho et al., 2006, Korea[104]	A randomized controlled trial	30 months, control group (n=40), telemedicine group (n=40)	HbA1c value was 7.4 ± 1.3%	HbA1c value was 6.7 ± 0.9% ($p<0.05$ vs. baseline)	No data	no data	The mean A1C were significantly lower in the intervention group than in the control group
Eakin et al., 2013, Australia[105]	A two-arm randomized controlled trial	6 months, control group (n=151), telemedicine group (n=151)	HbA1c value was 7.5 ± 1.6%	HbA1c value was 7.5 ± 1.7%	Weight value was 95.3 ± 20.9 kg	Weight value was 93.3 ± 19.0 kg	The intervention effects showed, relative to usual care, that the intervention group achieved more weight loss. there was no substantial or statistically significant difference, between groups in HbA1c
Agboola et al., 2016, USA[106]	A randomized controlled trial	6 months, control group (n=62), telemedicine group (n=64)	Average change in HbA1c was −0.21%	Average change in HbA1c was −0.43% (p =0.29 vs. control)	No data	No data	Personalized text messaging can be used to improve outcomes in patients with T2DM by employing optimal patient engagement measures
Glasgow et al., 2012, USA[107]	A patient-randomized practical effectiveness trial	12 months	HbA1c value was 8.04 ± 0.14%	HbA1c value was 8.16 ± 0.09%	BMI was 34.8 ± 0.6 kg/m2	BMI was 34.6 ± 0.4 kg/m2	The Internet intervention meets the reach and feasibility criteria for a potentially broad public health impact
Ralston et al., 2009, USA[108]	A pilot randomized trial	12 months, control group (n=35), telemedicine group (n=39)	Average change in HbA1c was 0.2%	Average change in HbA1c was −0.9% ($p<0.01$ vs. control)	No data	No data	GHb declined significantly in the intervention group compared with the usual care group
Noh et al., 2010, Korea[109]	A randomized controlled trial	6 months, control group (n=20), telemedicine group (n=20)	Average change in HbA1c was −0.49% (p=0.257 vs. baseline)	Average change in HbA1c was −1.53% (p=0.031 vs. baseline)	Average change in BMI was 0 kg/m2 (p=1 vs. baseline)	Average change in BMI was 0.65 kg/m2 (p=0.657 vs. baseline)	The improvement in A1C for the intervention group, compared with no difference in the control group after 6 months
Murray et al., 2017, England[110]	A multicentre, two-arm individually randomised controlled trial	12 months, control group (n=163), telemedicine group (n=155)	Average change in HbA1c was 0.16 ± 0.07%	Average change in HbA1c was −0.08 ± 0.07% (p=0.014 vs. control)	Average change in BMI was −0.04 ± 0.2 kg/m2	Average change in BMI was 0.12 ± 0.2 kg/m2 (p=0.498 vs. control)	Participants in the intervention group had lower HbA1c than those in the control
Bingham et al., 2021, USA[111]	A retrospective study	3 months, (n=444)	No data	HbA1c value was 7.1% [4.5−13.6] (p=0.009 vs. baseline)	No data	No data	There was a significant difference between median HbA1c values pre- and postcomprehensive medication review
Michaud et al., 2020, Nebraska[112]	Retrospective observational study	3 months, (n=1103)	No data	HbA1c value was 7.1 ± 1.5% ($p<0.001$ vs. baseline)	No data	No data	There were significant differences in HbA1C at baseline and HbA1C at the end of remote patient monitoring (RPM)
Kesavadev et al., 2012, India[113]	A retrospective cohort study	6 months, (n=1000)	No data	HbA1c value was 6.3 ± 0.6%, HbA1c decreased by 2.2% ($p<0.0001$ vs. baseline), FBG decreased by 67 mg/dl (p=0.01 vs. baseline)	No data	BMI decreased by 0.3 (kg/m2) ($p<0.01$ vs. baseline)	The Diabetes Tele Management System was successful in achieving glycemic controls at par with internationally accepted treatment
Su et al., 2019, USA[114]	Cohort study	3 months , (n=1336)	No data	HbA1c value was 7.1 ± 1.5% ($p<0.001$ vs. baseline)	No data	No data	Higher levels of patient activation and engagement with remote patient monitoring technology were associated with better glycemic control outcomes
Musacchio et al., 2011, Italy[115]	Cohort study	12 months, telemedicine group (n=1004)	No data	Patients, HbA1c ≤ 7.0% increased from 32.7 to 45.8% ($p<0.0001$), while those, HbA1c ≥ 9% decreased from 10.5 to 4.3% ($p<0.0001$)	No data	No data	The SINERGIA model is effective in improving metabolic control and major cardiovascular risk factors
Turner et al., 2009, USA[116]	Exploratory study	3 months, telemedicine group (n=23)	No data	The decrease in HbA1c was 0.52 ± 0.91%	No data	No data	The technology improved the support available for T2D patients commencing insulin treatment.

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Table 2. (Continued)

Author, Year, Country	Study design	Follow-up period and n patients last visit	Primary Outcome		Secondary Outcome		Conclusion
			Control	Telemedicine	Control	Telemedicine	
Bergenstal et al., 2021, USA[117]	Cohort study	10.2 ± 4.0 months, telemedicine group (n = 372)	no data	Significant reductions in HbA1c from baseline (−0.6 ± 1.5%, p < 0.001)	no data	no data	Intermittent use of rtCGM was well-received by adults with T2D and was associated with improvement in HbA1c
Michaud et al., 2018, USA[118]	Retrospective, observational study	3 months, telemedicine group (n = 955)	no data	HbA1c value was 7.09 ± 1.44% (p < 0.001 vs. baseline)	no data	BMI value was 35.23 ± 7.74 kg/m2 (p < 0.001 vs. baseline)	This study found significant differences in clinical outcomes, especially HbA1c, at pre and post the 3-month remote patient monitoring intervention
Cheng et al., 2021[119]	Cross-sectional study	1 month , control group (n = 207), telemedicine group (n = 168)	Average change in FPG value was −38.82% (170 ± 6.1 mg/dL to 104 ± 26.1 mg/dL) , Average change in 2−h PPG value was −29.29% (239 ± 35.5 mg/dL to 169 ± 44.7 mg/dL), Glucose variability value was 65.4 ± 35.1 mg/dL	Average change in FPG value was −41.72% (169 ± 6.3 mg/dL to 98.5 ± 21.1 mg/dL, p=0.027 vs. control) , Average change in 2−h PPG value was −54.32% (243 ± 34.6 mg/dL to 111 ± 22.8 mg/dL, p<0.001 vs. control), Glucose variability value was 12.8 ± 7.3 mg/dL (p<0.001 vs. control)	No data	No data	Telemedicine may be a complementary option to assist in the management of glucose variability in diabetes
Shane-McWhorter et al., 2014, USA[120]	A nonrandomized prospective observational preintervention–postintervention, Study	6 months, (n = 95)	No data	Average change in HbA1c was −1.92% (9.73 to 7.81) (p < 0.0001 vs. baseline)	No data	No data	Telemonitoring improved clinical outcomes and may be a useful tool to help enhance disease management
Yu et al., 2014, Canada[121]	A single-arm pre–post cohort study	9 months	No data	Average change in HbA1c was 0.37% in general (no seperated)	No data	No data	A self-management website for patients with type 2 diabetes did not improve self-efficacy
Berman et al., 2018, USA[122]	Cohort study	12 weeks, (n = 101)	No data	Average change in HbA1c was −0.8 ± 1.3% (p < 0.001 vs. baseline)	No data	No data	Clinically meaningful reductions in HbA1c were observed with use of the FareWell digital therapeutic
Shane-McWhorter et al., 2015, USA[123]	Cohort study	9 months, control group (n = 75), telemedicine group (n = 75)	Average change in HbA1c was −0.66 ± 1.99% (p = 0.009 vs. baseline)	Average change in HbA1c was −2.07 ± 2.36% (p < 0.001 vs. baseline, p < 0.001 vs. control)	Average change in BMI was 0.07 ± 1.13 kg/m2 (p = 0.577 vs. baseline)	Average change in BMI was 0.11 ± 1.55 kg/m2 (p = 0.535 vs. baseline)	Compared with usual care, a pharmacist-driven telemonitoring program showed a significant improvement in patients' A1C levels.
Dixon et al., 2020, United States[124]	Technology report	The mean follow−up time period was 4.2 months (125.6 ± 22.4 days) , (n = 740)	No data	HbA1c decreased by 2.3 ± 1.9%, 0.7 ± 1.0%, and 0.2 ± 0.8% across the baseline categories of > 9.0%, 8.0% to 9.0%, and 7.0% to < 8.0%, respectively (all p < 0.001)	No data	No data	Virtual Diabetes Clinic may be associated with, related to improving HbA1c
Majithia et al., 2020, USA[125]	Prospective single-arm study	4 months, telemedicine group (n = 55)	No data	HbA1c decreased 1.6 ± 1.0% (p < 0.001 vs. baseline)	No data	BMI decreased 1.34 ± 1.5 kg/m2 (p < 0.001 vs. baseline) (n = 54)	After 4 months, there was a decrease in the HbA1C of the participating patients from baseline
Kim et al., 2006, Korea[126]	Pre–post test	12 weeks, telemedicine group (n = 33)	No data	HbA1c value was 7.0 ± 1.1%, average change value was −1.1 ± 2.1 % (p= 0.006)	No data	No data	SMS intervention improved HbA1c level
Mayes et al., 2010, USA[127]	Pre–post test	3.5 years, telemedicine group (n = 16)	no control	The difference between the last and first value for HbA1c (mean 7.2% vs. 9.6%, respectively) was −2.4% (a decrease of 21%)	No data	No data	Video conferencing via the Internet can provide a useful tool to assure that patients who adopt and utilize ADA protocols for diabetes will improve their glucose control
McGloin et al., 2020, Ireland[128]	An observational, pre–post, multimethod, and triangulation design	12 weeks, telemedicine group (n = 39)	No data	HbA1c value was 8.01%, HbA1c (mmol/mol) decreased significantly −17.13 mmol/mol; p < 0.001)	No data	BMI value was 30.15 ± 6.82 kg/m2	The mean HbA1c (mmol/mol) decreased significantly with no significant impact on weight
Bollyky et al., 2018, USA[129]	Pre–posttest	90 days, telemedicine group (n = 275)	no data	HbA1c value was 7.1 ± 1.4%	no data	no data	Livongo participation significantly improves BG control in people with T2D

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Table 2. (Continued)

Author, Year, Country	Study design	Follow-up period and *n* patients last visit	Primary Outcome		Secondary Outcome		Conclusion
			Control	Telemedicine	Control	Telemedicine	
McGloin et al., 2015, Ireland[130]	A longitudinal mixed method case study	12 months, ($n=8$)	No data	HbA1c level was 7.63 ± 1.5%	No data	BMI was 35.6 ± 6.6 kg/m2	The change of HbA1c was not significant
Carter et al., 2011, USA[131]	Not reported	9 months, control group ($n=21$), telemedicine group ($n=26$)	HbA1c value was 7.9 % ($p<0.05$ vs. baselime)	HbA1c value was 6.82 % ($p<0.05$ vs. baseline)	BMI value was 26.5 ($p<0.05$ vs. baselime)	BMI value was 23.8 ($p<0.05$ vs. baselime)	Treatment group participants were more likely to achieve positive outcomes in terms of lowered hemoglobin A1c and body mass index measurements than were control group members
King et al., 2009, USA[132]	Initial pilot program	12 months, control group ($n=43$), telemedicine group ($n=14$)	HbA1c decreased by 0.06% ($p=0.395$)	HbA1c decreased by 0.46% (p =0.095)	No data	No data	Reductions in HbA1c did not achieve statistical significance potentially
Carallo et al., 2015, Singapore[133]	Not reported	1 year, control group ($n=208$), telemedicine group ($n=104$)	The change was not statistically significant	HbA1c value was 54 ± 8 mmol/mol ($p=0.01$)	The change was not statistically significant	BMI value was 30.5 ± 4.6 kg/m2 ($p=0.03$)	Health care program based on GPs empowerment and taking care plus remote consultation with Consultants is at least as effective as standard outpatient management
Chen et al., 2011, Taiwan[134]	Not reported	1 year, control group ($n=47$), telemedicine group ($n=44$)	HbA1c changed by −0.6 ± 2.6% ($p=0.202$ vs. baseline)	HbA1c changed by −1.4 ± 1.5% ($p<0.001$ vs. baseline)	No data	No data	The intensive diabetes management program with the telehealth system is a useful education method to improve blood sugar control in poorly controlled T2D patients receiving insulin injections
Myers et al., 2021, USA[135]	Pilot study	3 months, Telephone ($n=13$), Telehealth ($n=9$)	The telephone arm had a 0.50% greater reduction in HbA1c (2.07% vs 2.57%, $p=0.70$) than the telehealth group		No data	No data	The change in HbA1c was not statistically different across arms
Istepanian et al., 2014, Iraq[136]	Case study	6 month, control group ($n=6$), telemedicine group ($n=6$)	HbA1c decreased from 8.95 ± 2.17% to 8.7 ± 1.7% ($p=0.448$)	HbA1c decreased from 8.95 ± 0.73% to 8.05 ± 1.31% ($p=0.115$)	No data	No data	The key outcome of this study is the effectiveness of the mobile management systems and intervention in lowering the HbA1c level.
Lim et al., 2009, Korea[137]	Not reported	3 months, control group ($n=34$), telemedicine group ($n=67$)	HbA1c value was 8.6 ± 0.3 %, FBS value was 166.4 ± 7.4 mg/dl	HbA1c value was 7.3 ± 0.2% ($p<0.001$ vs. baseline), FBS value was 136.0 ± 4.3 mg/dl ($p<0.001$ vs. baseline)	BMI was 24.9 ± 0.5 kg/m2	BMI was 23.7 ± 0.4 kg/m2 ($p<0.001$ vs. baseline)	Subjects in the telephone follow-up group showed a decrease in BMI, FBS, and HbA1c
Yoon et al., 2008, Korea[138]	Not reported	12 months, control group ($n=26$), telemedicine group ($n=25$)	HbA1c value was 8.40 ± 1.04% (increased 0.81%, $p<0.05$ vs. baseline)	HbA1c value was 6.77 ± 0.77% (decrease 1.32%, $p<0.05$ vs. baseline)	No data	No data	Participants in the intervention group had lower HbA1c over 12 months when compared with the control group
Nesari et al., 2010, Iran[139]	Not reported	3 months, control group ($n=30$), telemedicine group ($n=30$)	HbA1c value was 8.60 ± 1.88% ($p=0.150$ vs. baseline)	HbA1c value was 7.04 ± 1.18% ($p<0.001$ vs. baseline, $p<0.001$ vs. control)	No data	No data	A nurse-led telephone follow-up was effective in enhancing the level of adherence to a diabetes therapeutic regimen, such that the HbA1c level decreased
McIlhenny et al., 2011, USA[140]	Not reported	6 months, control group ($n=50$), telemedicine group ($n=48$)	HbA1c value was 7.49 ± 1.79%, Glucose level was 131.8 ± 45.6 mg/dl	HbA1c value was 6.52 ± 0.99% ($p=0.197$ vs control), Glucose level was 102.4 ± 31.9 mg/dl ($p=0.008$ vs. control)	Average weight was 98.1 ± 23.2 kg	Average weight was 97.2 ± 20.0 kg ($p=0.378$ vs. control)	There was a significant difference in glucose levels between groups at 6 months
Kim et al., 2006, Korea[141]	Not reported	12 weeks, control group ($n=23$), WB group ($n=28$), PM group ($n=22$)	Average change in HbA1c was 0.43 ± 0.81%, Average change in FBS was 4.26 ± 4.48 mg/dl	WB:, Average change in HbA1c was −0.59 ± 0.61% ($p=0.01$ vs. control), Average change in FBS was −14.14 ± 14.21 mg/dl ($p=0.01$ vs. control), PM:, Average change in HbA1c was −0.51 ± 1.30 ($p=0.01$ vs. control), Average change in FBS was −15.91 ± 13.23 mg/dl ($p=0.01$ vs. control)	No data	No data	The findings of this study clearly indicate that both the WB and PM interventions were effective in enhancing the levels of physical activity and better in controlling FBS and HbA1c in Korean adults with type 2 diabetes

lifestyle adjustments, including maintaining a healthy diet, engaging in regular physical activity, monitoring blood sugar levels, and taking medications as prescribed.[143] These ongoing requirements can impact the quality of life, limiting social activities, causing emotional distress, and reducing overall well-being.[144,145] The risk of complications associated with uncontrolled diabetes further adds to the burden on individuals living with the condition.[146] Comprehensive efforts, including public health campaigns, health education, increased access to healthcare services, and policies promoting healthy behavior, can play a crucial role in preventing type 2 diabetes and its complications.[147,148] Several studies have shown that patients are satisfied with telemedicine services and that managing type 2 diabetes with telemedicine has a positive effect on quality of life scores.[46,11,64,104]

Type 2 diabetes places a considerable economic burden on healthcare systems.[149] The costs associated with managing diabetes and its related complications, such as cardiovascular disease, kidney disease, and blindness, are substantial.[150,151] These costs include medications, hospitalizations, and long-term care, leading to increased healthcare expenditure for individuals, families, and society.[152,153] Telemedicine allows healthcare providers to monitor patients' health conditions remotely; this real-time data can help identify potential issues or trends requiring intervention.[31,117,124] Moreover, technology-enabled telemedicine platforms provide tools such as mobile apps or web portals that empower patients to participate in their care management actively.[36,39,57] In conclusion, applying technology through telemedicine in outpatient treatment management for patients with type 2 diabetes offers numerous benefits, including remote monitoring, improved access to care, enhanced patient engagement, timely intervention, cost savings, continuity of care, and data-driven decision-making. This integration can significantly improve the overall management and outcomes for individuals with type 2 diabetes.

Our limitation is that the study only focused on evaluating blood sugar index, while comorbidities of hypertension and hyperlipidemia can include many other factors such as cholesterol, triglycerides, HbA1c. These additional factors may provide a more comprehensive view of the intervention's impact on QoL. In addition, the study examined telemedicine strategies and follow-up duration but did not evaluate intervention frequency. The frequency of intervention can significantly influence the effectiveness of disease management strategies. Future research should consider intervention frequency as an important variable.

Conclusion

This systematic review proved telemedicine in diabetes based-evidence by summarizing 134 studies from 2002 to 2022. Most articles showed that telemedicine, in various ways, could positively impact different aspects of diabetes management. In the end, we strongly agreed that telemedicine could bring benefits to education and the management of diabetes patients. More field research is needed, especially in developing countries, to solidify and prove the effectiveness of telemedicine.

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Author contributions

TVD provided ideas, organized tasks, and gave instructions. Other authors searched papers and selected relevant ones, extracted data, made tables and figures, and wrote the manuscript under the supervision of TVD, PDL, and LTKA. TVD revised the manuscript and made the final version.

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ORCID iD

Truong Van Dat https://orcid.org/0000-0002-0018-8336

Supplemental material

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