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The Effectiveness of Telemedicine Solutions for the Management of Type 2 Diabetes: A Systematic Review, Meta-Analysis, and Meta-Regression

Stine Hangaard, PhD, MSc[1,2], Sisse H. Laursen, PhD, MSc[1,3], Jonas D. Andersen, MSc[1], Thomas Kronborg, PhD, MSc[1,2], Peter Vestergaard, PhD, MD[2,4,5], Ole Hejlesen, PhD, MSc[1], and Flemming W. Udsen, PhD, MSc[1]

Abstract

Background: Previous systematic reviews have aimed to clarify the effect of telemedicine on diabetes. However, such reviews often have a narrow focus, which calls for a more comprehensive systematic review within the field. Hence, the objective of the present systematic review, meta-analysis, and meta-regression is to evaluate the effectiveness of telemedicine solutions versus any comparator without the use of telemedicine on diabetes-related outcomes among adult patients with type 2 diabetes (T2D). **Methods:**This review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. We considered telemedicine randomized controlled trials (RCT) including adults (≥18 years) diagnosed with T2D. Change in glycated hemoglobin (HbA1c, %) was the primary outcome. PubMed, EMBASE, and the Cochrane Library Central Register of Controlled Trials (CENTRAL) were searched on October 14, 2020. An overall treatment effect was estimated using a meta-analysis performed on the pool of included studies based on the mean difference (MD). The revised Cochrane risk-of-bias tool was applied and the certainty of evidence was graded using the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) approach. **Results:**The final sample of papers included a total of 246, of which 168 had sufficient information to calculate the effect of HbA1c%. The results favored telemedicine, with an MD of −0.415% (95% confidence interval [CI] = −0.482% to −0.348%). The heterogeneity was great (I^2 = 93.05%). A monitoring component gave rise to the higher effects of telemedicine. **Conclusions:** In conclusion, telemedicine may serve as a valuable supplement to usual care for patients with T2D. The inclusion of a telemonitoring component seems to increase the effect of telemedicine.

Keywords

telemedicine, diabetes mellitus, type 2, systematic review, meta-analysis, meta-regression, Denmark

Introduction

Diabetes is one of the most common chronic diseases and a major health care problem worldwide.[1,2] In 2017, an estimated 8.4% of the adult global population had diabetes, which is expected to increase to approximately 9.9% (700 million) in 2045, primarily due to an increase in unhealthy dietary habits, obesity, and sedentary lifestyle.[1,2] The global prevalence is predicted to increase mostly in low- and middle-income countries.[3] The economic impact of diabetes is considerable, spans health care services, and affects individuals, families, and national productivity.[1,4]

Type 2 diabetes (T2D) constitutes approximately 90% to 95% of diabetes cases.[1,5] The T2D is a progressive disease associated with significant premature mortality, morbidity, and several complications, such as cardiovascular disease, nephropathy, neuropathy, and retinopathy.[6,7] Diabetes patient care is a multifaceted and complex process, mainly aimed at attaining optimal glycemic control to prevent and control diabetes-related complications.[8] However, sustaining optimal glycemic control for people with diabetes is

[1]Department of Health Science and Technology, Aalborg University, Aalborg, Denmark
[2]Steno Diabetes Center North Denmark, Aalborg, Denmark
[3]Department of Nursing, University College of Northern Denmark, Aalborg, Denmark
[4]Department of Endocrinology, Aalborg University Hospital, Aalborg, Denmark
[5]Department of Clinical Medicine, Aalborg University, Aalborg, Denmark

Corresponding Author:
Stine Hangaard, PhD, MSc, Department of Health Science and Technology, Aalborg University, Fredrik Bajers Vej 7E, 9220 Aalborg, Denmark.
Email: svh@hst.aau.dk

both demanding and challenging because it requires numerous daily self-management decisions and care activities.[9] These challenges include estimating the appropriate diabetes medication dosage to avoid hypoglycemic and hyperglycemic events and adherence to obstacles in terms of following the recommended guidelines.[8,9] Adherence to the complex T2D treatment regimen is difficult to maintain[10] and medial adherence rates have been reported to range from 36% to 93%.[11]

Self-management strategies are considered an essential part of diabetes treatment and are associated with improvements in health-related outcomes.[9] A potential solution to support ongoing diabetes self-management support is the use of telemedicine,[12] which has been suggested as a promising but unproven approach to support people with diabetes in the management of their disease.[13] Telemedicine can be defined as the delivery of health care services over a distance using information and communication technologies.[14] However, no definitive definition exists.[14] Telemedicine solutions may include a variety of different technologies and various delivery forms, including monitoring, education, consultative services, coaching, and counseling tasks.[13,15-17] Telemedicine interventions constitute different constellations, such as simple reminders via text messaging, video consultation, and transmission of patient data (eg, blood glucose, blood pressure, dietary and medication intake, and physical activity) with feedback from health care professionals via web portals or via telephone.[13,15,16] As diabetes predominantly needs to be managed outside health care facilities and to a large extent requires self-management, telemedicine holds the potential to provide sufficient self-management support to people with T2D.[18,19]

Previous systematic reviews have aimed to clarify the effect of telemedicine on diabetes.[15-17,20-28] However, these previous reviews have often focused on a specific type of telemedicine, a specific outcome, and/or a specific comparator, which calls for a more comprehensive and inclusive systematic review seeking to compare and synthesize findings for treatment outcomes while adjusting for different study characteristics. In addition, the field of telemedicine is developing rapidly; thus, a large number of studies likely have been published recently, calling for an updated review.[29] Hence, the objective of the present systematic review, meta-analysis, and meta-regression was to evaluate the effectiveness of telemedicine solutions versus any comparator without the use of telemedicine on diabetes-related outcomes among adult patients with T2D.

Methods

Study Design

This systematic review, meta-analysis, and meta-regression was conducted and reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.[30] A comprehensive search protocol was published elsewhere[31] and PROSPERO-registered with identification CRD42020123565 on April 2020. The search was part of a comprehensive search that included T2D as well as type 1 diabetes (T1D) and gestational diabetes[31], which will be reported separately.

Eligibility Criteria

Studies were considered if they included adults (≥18 years) diagnosed with T2D. Studies that included mixed populations (eg, T1D and T2D) were only included if the data for the T2D population were reported separately. Studies were excluded if only participants at risk of diabetes or participants with prediabetes were included. Furthermore, the studies must have included telemedicine interventions that were substituted for usual practice or served as an alternative to usual practice. The telemedicine interventions had to include remote feedback/communication between a patient and health care professional(s). Alternatively, feedback/communication could occur between the patient and a trained peer. Telemedicine interventions that were wholly automatic were also considered.

Studies that reported on any relevant patient diabetes-related outcome were included. The primary outcome was change in glycated hemoglobin (HbA1c, %).

We only considered randomized controlled trials (RCTs)—both parallel and crossover designs. Studies published in English, Danish, Norwegian, and Swedish as peer-reviewed full-text papers were included. All studies published before October 14, 2020, were considered.

Information Sources

The search was performed in PubMed, EMBASE, the Cochrane Library Central Register of Controlled Trials (CENTRAL), and CINAHL. Two authors performed the database searches (S.H.L. and S.H.). A research librarian assisted. Additional citation searches were performed in the Web of Science, SCOPUS, and Google Scholar.

Search Strategy

Initially, an unstructured search was performed in PubMed, CINAHL, and Google Scholar to identify relevant search terms and thus qualify the systematic search. The systematic search followed the initial search. The search strategy was adapted for each database. The search terms included various synonyms, near-synonyms, acronyms, and spellings for all keywords and index terms. A variety of search functions were applied, including thesaurus, Boolean operators, abstract/title/keywords, phrase, truncation, free text, and advanced search. Citation searches were applied to identify additional studies.

Selection Process

First, all of the identified papers were uploaded into RefWorks (ProQuest RefWorks 2.0, 2010). Second, duplicates were removed using the functions *Exact duplicates* and *Close duplicates*. Third, titles and abstracts were screened by two authors with respect to the eligibility criteria of the review (S.H. and S.H.L.). Fourth, the remaining studies underwent full review by three authors with respect to the eligibility criteria of the review (S.H., S.H.L., and J.D.A.). Disagreement between the authors was resolved through discussion by the three authors alone or by inclusion of other authors. During the full review, the reasons for exclusion of studies were recorded, and afterward, a final sample of papers was identified.

Data Extraction

Data were extracted by three independent authors (S.H., S.H.L., and J.D.A.) using a standardized sheet in Microsoft Excel (2016). Extracted data included trial characteristics (author, publication year, country, sample size, and study duration), patient characteristics (age, sex, and body mass index [BMI]), and HbA1c outcomes. In addition, the characteristics of the telemedicine interventions were extracted, including the frequency of contact, implementation setting (primary care, hospital, specialized outpatient clinic, university, community or cross-sectional), peripherals (eg, glucometers, pedometers, blood pressure monitors, and scales), and the general purpose of intervention components (monitoring, consultation, counseling, coaching, education, mentoring, and reminding). Disagreements between the authors were resolved through discussion. Additional authors were included in the discussions when necessary.

Risk of Bias Assessment

The revised Cochrane risk-of-bias tool was applied.[32] Four reviewers (J.D.A., S.H., T.K., and F.W.U.) assessed the included studies independently and resolved potential disagreements by discussion.

Data Synthesis

All statistical analyses were performed in Stata 16 (*Stata Statistical Software: Release 16*, StataCorp 2019.; StataCorp LLC, College Station, Texas). Reported medians, interquartile ranges, ranges, and confidence intervals were transformed to means and standard deviations by traditional methods[33,34] and scaled to HbA1c% when relevant (eg, if outcome was reported as mmol/mol). An overall treatment effect was estimated with a meta-analysis of the pool of included studies based on the mean difference (MD). Heterogeneity was assessed statistically using I^2 tests. The results were combined with a random-effects model (due to heterogeneity, ie, an I^2 statistic $> 50\%$). Univariate a priori subgroup analyses based on meta-regression of the telemedicine characteristics were conducted and combined with post hoc analyses of the association of study and patient characteristics with the treatment effect of telemedicine. Publication bias was evaluated using visual inspection of the funnel plot and Egger test.

Certainty Assessment

The Grading of Recommendations, Assessment, Development and Evaluations (GRADE) approach was applied. A summary of findings (SoF) table was created using GRADEPro GDT 2015 (McMaster University, Ontario, Canada),[35,36] which presents the absolute risks for the groups (treatment and control), estimates of relative risk, and ranking of the quality of the evidence, which is based on the risk of bias,[37] indirectness,[38] imprecision,[39] inconsistency,[40] and risk of publication bias.[41]

Results

The flowchart in Figure 1 describes our selection of studies. In the literature search, 16 309 studies were found and 1125 eligible studies were assessed by full-text reading after screening titles and abstracts. After full-text assessment, 246 articles met our inclusion criteria.

The characteristics of the individual studies are presented in Table 1. One study was multinational, 88 articles were conducted in North America (36%), 84 in Asia (35%), 44 in Europe (18%), 16 in Australia/New Zealand (7%), five in Africa (2%), and five in South America (5%). Four studies were published before 2000 (2%), 50 in the 2000s (21%), 165 in the 2010s (68%), and 24 (10%) in 2020. Sample sizes ranged from 17 to 4078, with an average of 251 participants per study. The study duration ranged from one to 96 months, with a study average of 8.5 months. Across studies, the mean proportion of men was 50.4% (range = 15%-100%), the average age at baseline was 57 (range = 37-73) years, and the baseline mean BMI was 30 (range = 22-40). The average baseline HbA1c% levels ranged from 5.70% to 11.05%, with an average of 8.33%.

Table 2 illustrates the telemedicine technologies implemented across studies. Seventy-one studies (29%) were conducted in a hospital setting, 58 studies (24%) in the primary care sector, 37 in communities (15%), 34 in specialized outpatient clinics (14%), 14 in a university setting (6%), and four in cross-sectorial implementations (2%). The frequency of contact with patients across studies was daily (30 studies, 12%), weekly (83 studies, 34%), every two weeks (26 studies, 11%), monthly (40 studies, 16%), and more rarely (12 studies, 5%). Twenty-four (10%) of the studies reported a "tailored" number of contacts with participants (10%). Across studies, the explicitly reported peripherals were scales (13 studies, 5%), glucometers (45 studies, 19%), blood

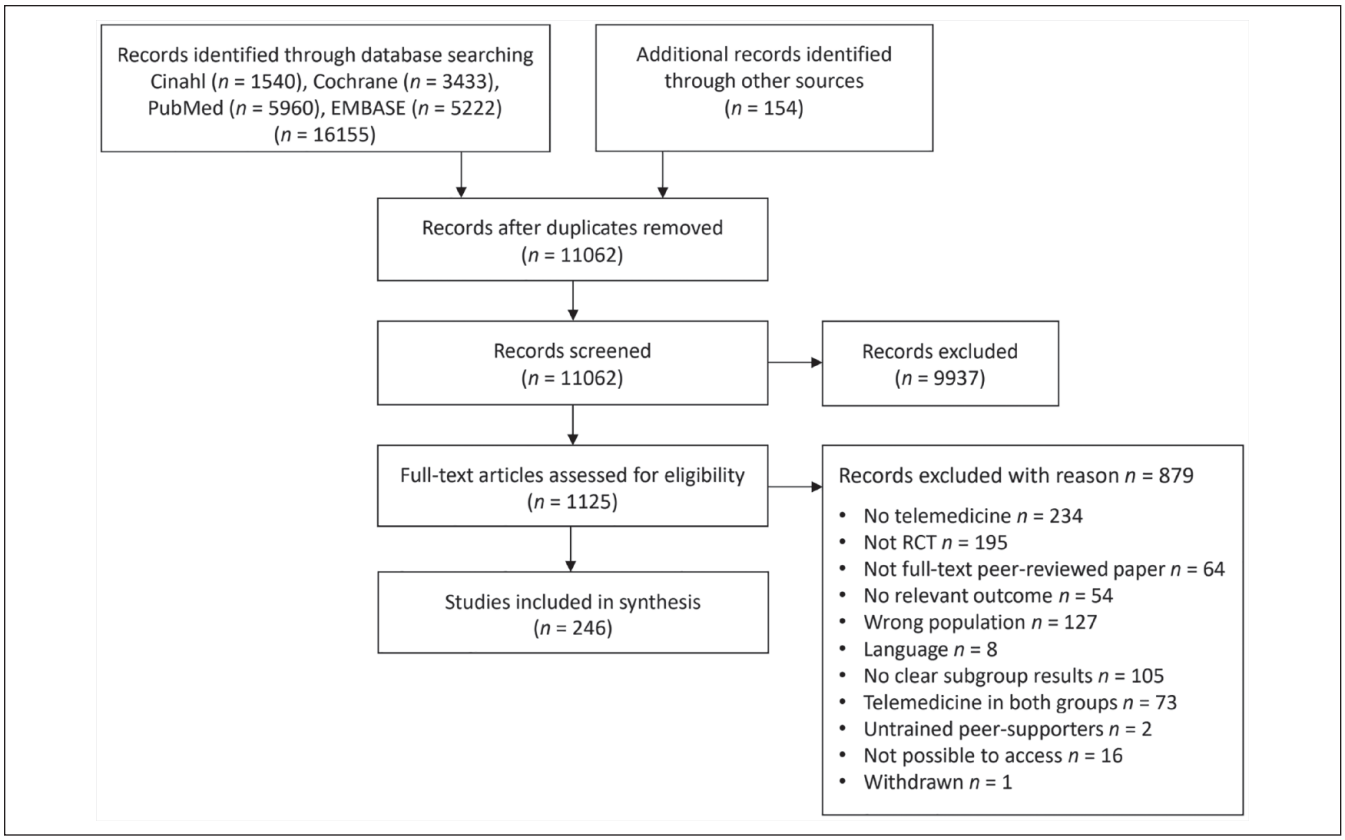

Figure 1. Flowchart.
Abbreviation: RCT, randomized controlled trial.

pressure monitors (19 studies, 8%), and pedometers (16 studies, 7%).

The final sample included 86 studies (35%) with a monitoring component in the telemedicine intervention, 22 studies with a consultation opportunity (9%), 53 studies with a counseling purpose (22%), 63 studies with an opportunity for patients to receive coaching (26%), 81 studies with a patient education component (33%), and eight studies with the possibility of mentoring (3%). Furthermore, 38 studies were able to send reminders (16%).

The evaluation of risk of bias is described for each study in Online Appendix 1 and across studies in Figure 2. Overall, there was a high risk of bias in 45% of the included studies, a moderate risk in 38% and a low risk in 17%. This result was largely attributed to two factors. First were missing outcomes at follow-up, where a high proportion of studies (43%) only reported results of a complete case or per-protocol analysis without appropriate consideration of the relationship with covariates and missingness (ie, tests for missing completely at random or an assumption of missing at random with imputation and/or tests for association with baseline variables and missingness and/or adjusted analyses). Second, there were some concerns regarding the risk of selecting published results, especially due to a lack of registered or published research protocols in the majority of studies (72%).

Effect on HbA1c%

Of the 243 studies, 168 had sufficient information to calculate an MD with standard errors for the effect on HbA1c% and reported treatment effects of telemedicine from one to 96 months. Figure 3 and Table 3 present the results from the individual studies and the meta-analysis. Overall, the results favored telemedicine, with an MD of −0.415%, which was statistically significant (95% confidence interval [CI] = −0.482% to −0.348%). The heterogeneity was great (I^2 = 93.05%).

A series of univariate meta-regressions are illustrated in Table 4 and were assessed with a 5% significance level. Compared with North American studies (the reference), Asian studies reported larger effects of telemedicine (difference in MD = −0.287, P = .000), as did studies with higher baseline HbA1c% levels (difference in MD = −0.086 per %, P = .008). Compared with primary care settings (reference), hospital settings were also associated with an increase in the effect of telemedicine (difference in MD = −0.290, P = .004). Furthermore, a monitoring component gave rise to greater effects of telemedicine (difference in MD = −0.195, P = .004). Treatment effects of telemedicine were lesser for studies with longer duration (difference in MD = 0.008 per month, P = .015) and for

Table 1. Study and Participant Characteristics.

Study	Publication year	Country	Sample size	Duration (months)	Mean age years	Male %	Baseline BMI	Baseline HbA1c
Abaza and Marschollek[42]	2017	Egypt	90	3	52	44	NA	9.66
Agarwal et al[43]	2019	Canada	50	4	64	55	NA	7.44
Agarwal et al[44]	2019	Canada	240	3	52	52	NA	8.96
Aguiar et al[45]	2018	Brazil	80	12	62	67	NA	8.95
Akinci et al[46]	2018	Turkey	66	2	52	36	32	8.34
Al Omar et al[47]	2020	United Arab Emirates	218	6	42	42	NA	8.45
Alanzi et al[48]	2018	Saudi Arabia	20	6	NA	75	NA	8.53
Albikawi et al[49]	2016	Jordan	168	3	51	46	NA	NA
Alghafri et al[50]	2018	Oman	232	3	44	43	33	7.96
Ali et al[51]	2016	India & Pakistan	1146	30	54	46	27	9.90
Ali et al[52]	2020	India	404	24	53	41	27	9.15
Aliha et al[53]	2013	Iran	61	3	53	50	28	9.70
Alonso-Domínguez et al[54]	2019	Spain	204	3	61	54	30	6.85
Alotaibi et al[55]	2016	Saudi Arabia	20	6	45	NA	NA	8.55
Anderson et al[56]	2009	USA	310	24	56	41	34	7.48
Anderson et al[57]	2010	USA	295	12	NA	42	35	8.00
Anderson-Loftin et al[58]	2005	USA	97	6	57	23	35	7.90
Andreae et al[59]	2020	USA	230	3	59	20	NA	8.29
Anzaldo-Campos et al[60]	2016	Mexico	301	10	52	38	31	11.05
Arora et al[61]	2014	USA	128	6	51	36	NA	10.10
Asante et al[62]	2020	Ghana	60	3	56	22	28	8.95
Avdal et al[63]	2011	Turkey	122	6	52	49	NA	8.07
Azizi et al[64]	2016	Iran	72	4	55	50	NA	NA
Benson et al[65]	2018	USA	120	12	60	55	37	8.20
Blackberry et al[66]	2013	Australia	473	18	63	57	NA	8.06
Bluml et al[67]	2019	USA	446	3	54	41	37	10.25
Boels et al[12]	2019	Netherlands	230	6	59	60	32	8.20
Bogner et al[68]	2012	USA	182	3	57	32	34	7.10
Bohingamu Mudiyanselage et al[69]	2018	Australia	177	12	70	53	NA	5.70
Lashkari et al[70]	2013	Iran	50	3	NA	NA	29	9.68
Browning et al[71]	2016	China	711	12	64	52	26	10.45
Bujnowska-Fedak et al[72]	2011	Poland	100	6	55	54	25	7.65
Buysse et al[73]	2019	Belgium	153	24	37	50	NA	8.30
Capozza et al[74]	2015	USA	156	6	53	37	NA	9.11
Carter et al[75]	2011	USA	47	9	51	36	36	8.91
Castelnuovo et al[76]	2011	Italy	72	12	52	52	NA	NA
Chao et al[77]	2019	Taiwan	121	3	NA	NA	25	8.70
Chen et al[78]	2008	Taiwan	78	6	59	44	26	9.61
Chen et al[79]	2018	China	233	NA	59	51	NA	NA
Chiu et al[80]	2016	Taiwan	182	8	65	52	26	7.65
Cho et al[81]	2006	Korea	80	30	53	54	23	7.60
Cho et al[82]	2017	Korea	484	6	53	64	26	7.84
Choe et al[83]	2005	USA	80	14	52	47	NA	10.15
Choudhry et al[84]	2018	USA	4078	12	60	55	NA	9.65
Clark et al[85]	2004	UK	100	12	60	58	31	8.42
Crowley et al[86]	2013	USA	369	12	61	28	NA	8.00
Crowley et al[87]	2016	USA	50	6	60	96	NA	10.45
Dale et al[88]	2009	UK	231	6	NA	60	NA	8.56
Dario et al[89]	2017	Italy	299	12	73	56	NA	7.94
Davis et al[90]	2010	USA	165	12	60	25	37	8.96

(continued)

Table 1. (continued)

Study	Publication year	Country	Sample size	Duration (months)	Mean age years	Male %	Baseline BMI	Baseline HbA1c
Del Prato et al[91]	2012	Italy	291	5.5	58	52	30	8.86
Delahanty et al[92]	2019	USA	211	12	62	45	35	7.70
Doupis et al[7]	2019	Greece	457	8	63	51	31	7.85
Dugas et al[93]	2018	USA	27	3	NA	89	NA	9.23
Duruturk and Özköslü[94]	2019	Turkey	50	1.5	53	NA	31	7.36
Döbler et al[95]	2018	Germany	249	12	52	70	36	7.70
Eakin et al[96]	2013	Australia	302	6	58	56	33	7.45
Eakin et al[97]	2014	Australia	302	24	58	56	33	7.45
Egede et al[98]	2017	USA	113	6	54	19	36	10.10
Egede et al[99]	2018	USA	90	12	63	98	NA	7.11
Estey et al[100]	1990	Canada	60	4	NA	46	NA	6.21
Faridi et al[101]	2008	USA	30	3	56	37	36	6.45
Farsaei et al[102]	2011	Iran	172	3	53	34	NA	9.10
Fernandes et al[103]	2016	Brazil	219	6	63	31	29	8.07
Fortmann et al[104]	2017	USA	126	6	48	25	32	9.55
Fottrell et al[105]	2019	Bangladesh	2470	18	NA	47	22	NA
Fountoulakis et al[106]	2015	Greece	80	12	62	69	30	9.80
Franc et al[107]	2020	France	665	12	39	48	26	9.10
Franciosi et al[108]	2011	Italy	62	6	49	74	31	7.90
Frosch et al[109]	2011	USA	201	6	55	52	33	9.60
García et al[110]	2015	USA	72	6	50	33	36	8.60
Garg et al[111]	2017	USA	184	12	64	60	35	9.05
Gagliardino et al[112]	2013	Argentina	198	12	61	49	33	7.21
Wasif Gillani[113]	2016	Malaysia	150	6	53	55	28	9.89
Gimbel et al[114]	2020	USA	240	12	63	62	33	7.55
Glasgow et al[115]	2006	USA	327	2	62	50	32	7.45
Glasgow et al[116]	2006	USA	327	2	61	55	33	7.25
Glasgow and Toobert[117]	2000	USA	320	6	59	39	NA	7.60
Glasgow et al[118]	2002	USA	320	12	59	39	NA	7.59
Glasgow et al[119]	2005	USA	886	12	63	49	NA	7.32
Goodarzi et al[120]	2012	Iran	100	3	54	22	28	7.87
Goodarzi et al[121]	2018	Iran	76	3	57	100	NA	NA
Graziano and Gross[122]	2009	USA	120	3	62	55	NA	8.65
Griffin et al[123]	2014	UK	478	12	60	62	33	7.12
Gupta et al[124]	2020	India	81	4	50	52	28	8.45
Haider et al[125]	2019	Australia	229	6	59	83	31	NA
Hansen et al[126]	2017	Denmark	165	8	58	64	34	9.30
Hare et al[127]	2011	Australia	223	33	55	56	32	7.55
Hee-Sung[128]	2007	South Korea	60	3	50	42	24	6.82
Heisler et al[129]	2019	USA	290	6	63	98	NA	9.10
Hidrus et al[130]	2020	Malaysia	100	3	NA	50	NA	NA
Hokanson et al[131]	2006	USA	114	6	54	57	33	8.60
Holbrook et al[132]	2009	Canada	511	6	61	51	32	7.05
Holmen et al[133]	2014	Norway	151	12	57	55	31	8.25
Hordern et al[134]	2009	Australia	223	12	56	55	32	7.55
Huang et al[135]	2019	Singapore	50	3	52	49	29	8.65
Huizinga et al[136]	2010	USA	165	24	56	60	34	6.64
Hunt et al[137]	2014	USA	17	3	NA	41	NA	6.59
Iljaž et al[138]	2017	Slovenia	120	12	55	30	32	6.95
Islam et al[139]	2019	Bangladesh	239	6	48	46	NA	NA
Jahangard-Rafsanjani et al[140]	2015	Iran	101	5	57	50	29	7.56

(continued)

Table 1. (continued)

Study	Publication year	Country	Sample size	Duration (months)	Mean age years	Male %	Baseline BMI	Baseline HbA1c
Jain et al[141]	2018	India	299	6	57	57	24	8.16
Jarab et al[142]	2012	Jordan	171	6	64	57	33	8.45
Jennings et al[143]	2014	Australia	436	8	58	52	33	NA
Jeong et al[144]	2018	Korea	338	6	53	67	25	8.30
Jiwani et al[145]	2020	USA	26	6	58	30	39	9.30
Kardas et al[146]	2016	Poland	62	1.5	59	60	31	6.81
Kassavou et al[147]	2020	UK	135	3	NA	54	NA	NA
Kempf et al[148]	2017	Germany	202	12	59	54	36	8.30
Keogh et al[149]	2011	Ireland	121	6	59	63	32	9.18
Kim and Utz[150]	2019	South Korea	155	3	51	48	NA	9.14
Kim[151]	2007	Korea	60	3	47	43	24	7.84
Kim and Jeong[152]	2007	Korea	60	6	47	43	24	7.84
Kim and Song[153]	2008	Korea	40	12	47	47	25	7.85
Kim and Kim[154]	2008	Korea	40	6	47	47	25	7.85
Kim and Oh[155]	2003	Korea	50	3	60	30	24	8.50
Kim et al[156]	2005	Korea	35	3	61	36	24	8.60
Kim and Kang[157]	2006	Korea	73	3	55	53	NA	7.94
Kim et al[158]	2009	USA	83	6.5	56	56	26	9.25
Kim et al[159]	2010	Korea	100	3	48	50	24	9.80
Kim et al[160]	2015	Korea	70	6	66	50	25	8.55
Kim et al[161]	2016	China	220	6	54	48	26	7.95
King et al[162]	2006	USA	335	2	61	49	32	NA
Kirkman et al[163]	1994	USA	275	12	64	99	NA	10.70
Kleinman et al[164]	2017	India	91	6	48	70	29	9.25
Krein et al[165]	2004	USA	246	18	61	97	NA	9.25
Ku et al[166]	2020	Australia	40	3	50	35	28	8.95
Kusnanto et al[167]	2019	Indonesia	30	3	NA	43	NA	8.46
Kwon et al[168]	2004	Korea	110	3	54	61	24	7.39
Lauffenburger et al[169]	2019	USA	1400	12	55	63	NA	9.35
Lazo-Porras et al[170]	2020	Peru	172	18	61	37	28	8.55
Lee et al[171]	2017	Malaysia	85	3	53	51	30	8.74
Lee et al[172]	2020	South Korea	72	6	NA	NA	26	7.44
Lee et al[173]	2019	Malaysia	240	12	56	54	NA	9.00
Li et al[174]	2016	China	53	6	62	53	24	7.73
Liebreich et al[175]	2009	Canada	49	3	54	41	34	NA
Lim et al[176]	2011	Korea	154	6	68	21	25	7.85
Lim et al[177]	2016	Korea	100	6	65	75	26	8.00
Lorig et al[178]	2010	USA	761	6	54	29	NA	6.41
Lujan et al[179]	2007	USA	150	6	58	22	NA	7.96
Luley et al[180]	2011	Germany	70	6	58	49	35	7.55
Lutes et al[181]	2017	USA	200	12	53	NA	38	9.09
Lynch et al[182]	2014	USA	61	6	54	33	36	7.65
MacPhail et al[183]	2014	Australia	87	4	68	NA	31	NA
Marios et al[184]	2012	Australia	39	6	63	53	33	7.73
Maslakpak et al[185]	2017	Iran	90	3	50	60	29	8.00
Mayberry et al[186]	2020	USA	379	6	57	46	NA	8.13
McEwen et al[187]	2017	USA	157	9	54	35	33	9.93
McKay et al[188]	2001	USA	78	2	52	47	NA	NA
McKay et al[189]	2002	USA	160	3	59	45	NA	7.48
McKee et al[190]	2011	USA	55	6	60	33	33	8.22
McMahon et al[191]	2012	USA	152	12	61	93	34	9.85
Mease[192]	2000	USA	28	3	63	39	NA	9.50

(continued)

Table 1. (continued)

Study	Publication year	Country	Sample size	Duration (months)	Mean age years	Male %	Baseline BMI	Baseline HbA1c
Mons et al[193]	2013	Germany	204	18	68	61	NA	8.10
Moriyama et al[194]	2009	Japan	75	12	66	46	NA	7.47
Mwangi et al[195]	2020	Kenya	104	3	62	32	25	NA
Namjoo Nasab et al[196]	2017	Iran	64	3	52	48	27	NA
Nesari et al[197]	2010	Iran	61	3	51	28	28	9.26
Nicolucci et al[198]	2015	Italy	302	12	58	65	29	7.95
Niswender et al[199]	2014	Several	611	6	57	51	34	7.95
O'Neil et al[200]	2016	USA	563	12	NA	29	NA	8.32
Odegard and Christensen[201]	2012	USA	165	12	63	48	NA	NA
Odnoletkova et al[202]	2016	Belgium	574	18	63	62	30	7.00
Oh et al[203]	2003	Korea	50	3	61	36	25	8.55
Orsama et al[204]	2013	Finland	56	10	62	54	32	6.98
Owolabi et al[205]	2019	South Africa	216	6	NA	16	32	NA
Parsons et al[206]	2019	UK	446	12	62	57	33	8.60
Patja et al[207]	2012	Finland	1535	12	65	57	32	7.57
Peasah et al[208]	2019	USA	78	3	62	53	35	8.20
Peimani et al[209]	2016	Iran	150	3	52	53	28	7.41
Piette et al[210]	2011	USA	339	12	56	49	38	7.60
Plotnikoff et al[211]	2013	Canada	287	12	62	51	30	7.16
Presley et al[212]	2020	USA	120	6	55	28	35	9.98
Quinn et al[213]	2017	USA	142	12	52	51	35	9.59
Quinn et al[214]	2011	USA	213	12	53	51	35	9.24
Raj and Mathews[215]	2020	India	50	6	69	54	NA	10.26
Ralston et al[216]	2009	USA	83	12	57	51	NA	8.05
Ramadas et al[217]	2018	Malaysia	132	12	51	69	NA	9.00
Rasmussen et al[218]	2016	Denmark	40	6	63	68	32	8.55
Rodríguez-Idígoras et al[219]	2009	Spain	328	12	64	52	NA	7.51
Ruggiero et al[220]	2014	USA	270	12	53	32	33	8.63
Sacco et al[221]	2009	USA	62	6	52	42	36	8.50
Sacco et al[222]	2012	USA	62	6	52	42	36	8.50
Samuel-Hodge et al[223]	2009	USA	201	12	59	36	35	7.78
Sarayani et al[224]	2018	Iran	100	9	55	58	30	7.95
Saslow et al[225]	2020	USA	64	12	NA	NA	NA	NA
Sazlina et al[226]	2015	Malaysia	69	8	64	57	27	8.20
Schillinger et al[227]	2009	USA	339	12	56	39	31	9.35
Shahid et al[228]	2015	Pakistan	440	4	49	61	27	9.97
Shahsavari and Bakhshandeh Bavarsad[229]	2020	Iran	60	3	NA	15	29	8.93
Shetty et al[230]	2011	India	215	12	50	NA	27	9.00
Shreck et al[231]	2014	USA	526	12	56	33	NA	8.65
Sigurdardottir et al[232]	2009	Iceland	58	6	61	68	32	7.99
Skelly et al[233]	2009	USA	180	9	67	NA	NA	8.37
Sone et al[234]	2002	Japan	2205	36	59	55	23	7.74
Sone et al[235]	2010	Japan	2033	96	59	46	23	7.85
Song and Kim[236]	2009	Korea	49	3	50	43	25	9.20
Spencer et al[237]	2018	USA	222	6	49	39	33	7.93
Steventon et al[238]	2014	England	513	12	65	58	31	8.42
Sun et al[239]	2019	China	91	6	68	46	23	7.86
Sunil Kumar et al[240]	2020	India	300	6	65	60	NA	7.60

(continued)

Table 1. (continued)

Study	Publication year	Country	Sample size	Duration (months)	Mean age years	Male %	Baseline BMI	Baseline HbA1c
Takenga et al[241]	2014	Democratic Republic of Congo	40	2	NA	73	NA	8.63
Tamban et al[242]	2013	Philippines	104	6	50	27	28	7.84
Tan et al[243]	2018	Singapore	142	2	62	NA	NA	9.72
Tang et al[244]	2013	USA	415	12	54	60	NA	9.26
Teston et al[245]	2017	Brazil	134	5	NA	32	NA	NA
Thom et al[246]	2013	USA	299	6	55	48	34	9.99
Torbjørnsen et al[247]	2014	Norway	164	4	58	59	32	7.85
Tu et al[248]	1993	USA	31	3	65	33	NA	NA
Van Dyck et al[249]	2013	Belgium	92	12	62	69	30	7.30
Van Dyck et al[250]	2011	Belgium	92	12	62	NA	30	NA
Van Vugt et al[251]	2016	The Netherlands	132	6	68	53	30	6.59
Varney et al[252]	2014	Australia	94	12	62	68	32	8.35
Vaughan et al[253]	2020	USA	89	6	55	28	34	8.86
Vervloet et al[254]	2014	The Netherlands	604	24	55	55	NA	NA
Vinithia et al[255]	2019	India	248	24	43	68	27	9.50
Von Storch et al[256]	2019	Germany	2441	3	59	81	31	6.99
Wakefield et al[257]	2011	USA	302	12	68	94	33	7.15
Wakefield et al[258]	2012	USA	302	12	68	94	33	7.15
Wakefield et al[259]	2014	USA	108	6	60	44	NA	7.30
Waki et al[260]	2014	Japan	54	3	57	76	27	7.05
Walker et al[261]	2011	USA	527	12	56	33	31	8.65
Wang et al[262]	2020	Mongolia	171	12	55	48	26	9.15
Wang et al[263]	2019	China	120	6	45	32	NA	8.65
Wang et al[264]	2017	China	212	6	54	55	25	7.95
Warren et al[265]	2018	Australia	157	6	61	55	34	8.27
Weinberger et al[266]	1995	USA	275	12	64	99	NA	10.70
Whittemore et al[267]	2004	USA	53	6	58	NA	35	7.65
Wichit et al[268]	2017	Thailand	140	3	58	27	27	6.65
Wild et al[269]	2016	UK	321	9	61	67	33	8.85
Williams et al[270]	2012	Australia	120	6	57	65	33	8.55
Williams et al[271]	2017	New Zealand	138	6	55	38	40	8.15
Wolever et al[272]	2010	USA	56	6	53	23	NA	7.93
Wolf et al[273]	2004	USA	147	12	53	40	38	7.70
Wu et al[274]	2017	Australia & Taiwan	181	1	66	61	NA	NA
Yang et al[275]	2020	South Korea	401	3	56	51	26	7.96
Yasmin et al[276]	2020	Bangladesh	320	12	52	23	NA	NA
Yoo et al[277]	2009	Korea	123	3	58	59	26	7.50
Yoon and Kim[278]	2008	South Korea	60	12	47	43	24	7.83
Young et al[279]	2005	UK	591	12	67	58	30	7.93
Yu et al[280]	2019	China	185	6	52	28	26	8.60
Zamanzadeh et al[281]	2017	Iran	66	3	49	41	NA	NA
Zhou et al[282]	2014	China	114	3	NA	NA	24	8.33

Abbreviations: BMI, body mass index; HbA1c, glycated hemoglobin; NA, not available.

studies with higher proportions of men (difference in MD = 0.005 per %, $P = .035$) and higher age (difference in MD = 0.022 per year, $P = .000$). A coaching component led to a lower effect (difference in MD = 0.215, $P = .007$). There were no statistically significant associations between the effect of telemedicine on HbA1c% levels and publication date, baseline BMI, contact frequency, the included peripherals, or risk of bias.

Table 2. Telemedicine Intervention Characteristics.

Study	Publication year	Setting	Frequency of contact	Included peripherals				Intervention components						
				Glucometer	Pedometer	BP monitor	Scale	Monitoring	Consultation	Counseling	Coaching	Education	Mentoring	Reminding
Abaza and Marschollek[42]	2017	Hospital	Daily	×			×					×		×
Agarwal et al[43]	2019	Community	Weekly									×		
Agarwal et al[44]	2019	Hospital	Daily									×		×
Aguiar et al[45]	2018	Hospital	Once						×					
Akinci et al[46]	2018	University												×
Al Omar et al[47]	2020	Primary	Daily									×		
Alanzi et al[48]	2018	Community		×				×						
Albikawi et al[49]	2016	Specialized	Once						×					
Alghafri et al[50]	2018	Primary	Monthly									×		
Ali et al[51]	2016	Specialized	Monthly						×					
Ali et al[52]	2020	Hospital	Weekly					×						
Aliha et al[53]	2013	Specialized	Weekly						×					
Alonso-Domínguez et al[54]	2019	Primary	Daily					×						
Alotaibi et al[55]	2016	Hospital	Weekly	×				×				×		
Anderson et al[56]	2009	Community	Monthly								×			
Anderson et al[57]	2010	Community	Tailored						×		×			
Anderson-Loftin et al[58]	2005	Primary	Weekly								×	×		
Andreae et al[59]	2020	Community	Weekly									×		
Anzaldo-Campos et al[60]	2016	Primary		×				×				×		
Arora et al[61]	2014	Hospital	Daily									×		×
Asante et al[62]	2020	Specialized	Weekly									×		
Avdal et al[63]	2011	University		×				×						
Azizi et al[64]	2016	Specialized						×						×
Benson et al[65]	2018	Primary	Monthly								×	×		
Blackberry et al[66]	2013	Primary	Monthly								×			
Bluml et al[67]	2019	Primary	Weekly						×			×		
Boels et al[12]	2019	Hospital	Daily									×		
Bogner et al[68]	2012	Primary	Twice					×				×		
Bohingamu Mudiyanselage et al[69]	2018	Community	Daily					×						
Lashkari et al[70]	2013		Weekly							×				
Browning et al[71]	2016	Community	Monthly								×			
Bujnowska-Fedak et al[72]	2011	Primary	Weekly	×				×						
Buysse et al[73]	2019	Hospital	Monthly					×						
Capozza et al[74]	2015	Primary	Daily									×		×
Carter et al[75]	2011	Primary	Weekly	×		×	×	×	×					
Castelnuovo et al[76]	2011	Hospital	Fortnight		×			×		×				
Chao et al[77]	2019	Hospital										×		
Chen et al[78]	2008	Hospital	Weekly											×
Chen et al[79]	2018	Hospital	Weekly									×		
Chiu et al[80]	2016	Community	Weekly								×			
Cho et al[81]	2006	Hospital	Weekly					×						
Cho et al[82]	2017	Specialized	Weekly	×		×		×						
Choe et al[83]	2005	University	Monthly									×		
Choudhry et al[84]	2018	Primary							×					
Clark et al[85]	2004	Specialized	Fortnight								×			
Crowley et al[86]	2013	Primary	Monthly									×		
Crowley et al[87]	2016	Hospital	Fortnight					×	×					
Dale et al[88]	2009	Primary	Tailored						×				×	
Dario et al[89]	2017		Tailored	×				×						
Davis et al[90]	2010	Community	Monthly		×							×		
Del Prato et al[91]	2012			×				×						

(continued)

Table 2. (continued)

Study	Publication year	Setting	Frequency of contact	Included peripherals				Intervention components						
				Glucometer	Pedometer	BP monitor	Scale	Monitoring	Consultation	Counseling	Coaching	Education	Mentoring	Reminding
Delahanty et al[92]	2019	Community	Weekly									×		
Doupis et al[7]	2019	Specialized	Weekly									×		
Dugas et al[93]	2018	Specialized	Daily		×			×					×	
Duruturk and Özköslü[94]	2019	Hospital	Weekly					×						
Döbler et al[95]	2018	Specialized	Monthly							×				
Eakin et al[96]	2013	Primary	Fortnight		×		×			×				
Eakin et al[97]	2014	Primary	Fortnight		×		×			×				
Egede et al[98]	2017	Community	Weekly	×		×		×						
Egede et al[99]	2018	Community												
Estey et al[100]	1990	University	Fortnight							×		×		
Faridi et al[101]	2008	Community	Daily					×						×
Farsaei et al[102]	2011	Specialized	Weekly									×		
Fernandes et al[103]	2016	Primary	Monthly								×			
Fortmann et al[104]	2017	Community	Daily					×				×		×
Fottrell et al[105]	2019	Community	Weekly									×		
Fountoulakis et al[106]	2015	Hospital	Tailored	×				×						
Franc et al[107]	2020	Primary	Daily					×						
Franciosi et al[108]	2011	Specialized	Monthly	×								×		
Frosch et al[109]	2011	Primary	Tailored								×			
García et al[110]	2015	Community	Fortnight	×							×			
Garg et al[111]	2017	Hospital	Weekly	×						×				
Gagliardino et al[112]	2013	Specialized	Tailored										×	
Wasif Gillani[113]	2016	Hospital	Twice	×				×						
Gimbel et al[114]	2020	Primary	Daily			×		×						
Glasgow et al[115]	2006	Primary care	Twice								×			
Glasgow et al[116]	2006		Twice								×			
Glasgow and Toobert[117]	2000	Specialized	Fortnight							×				
Glasgow et al[118]	2002	Specialized	Fortnight						×					
Glasgow et al[119]	2005	Primary care								×				
Goodarzi et al[120]	2012		Tailored									×		
Goodarzi et al[121]	2018	University	Weekly									×		
Graziano and Gross[122]	2009	Cross-sectional	Daily					×		×				
Griffin et al[123]	2014	Primary	Monthly								×			
Gupta et al[124]	2020	Hospital	Weekly								×	×		
Haider et al[125]	2019	Hospital	Weekly									×		
Hansen et al[126]	2017	Hospital	Monthly					×	×					
Hare et al[127]	2011	Hospital	Tailored							×				
Hee-Sung[128]	2007	Hospital	Monthly					×				×		×
Heisler et al[129]	2019	Hospital	Monthly									×		
Hidrus et al[130]	2020	Hospital	Daily								×			
Hokanson et al[131]	2006	Specialized	Tailored							×				
Holbrook et al[132]	2009	Primary												×
Holmen et al[133]	2014	Primary	Monthly					×		×				
Hordern et al[134]	2009	Hospital	Tailored					×		×				
Huang et al[135]	2019	Specialized	Daily									×		
Huizinga et al[136]	2010	University	Monthly							×				
Hunt et al[137]	2014	Specialized	Weekly					×						
Iljaž et al[138]	2017	Primary	Tailored					×		×				×
Islam et al[139]	2019	Hospital	Daily								×			

(continued)

Table 2. (continued)

Study	Publication year	Setting	Frequency of contact	Included peripherals				Intervention components						
				Glucometer	Pedometer	BP monitor	Scale	Monitoring	Consultation	Counseling	Coaching	Education	Mentoring	Reminding
Jahangard-Rafsanjani et al[140]	2015	Community	Monthly							×				
Jain et al[141]	2018	Community	Weekly								×	×		
Jarab et al[142]	2012	Specialized	Weekly							×				
Jennings et al[143]	2014									×				
Jeong et al[144]	2018	Hospital	Twice	×				×	×					
Jiwani et al[145]	2020	Community	Weekly									×		
Kardas et al[146]	2016	Primary		×	×	×	×	×						
Kassavou et al[147]	2020	Primary	Weekly									×		
Kempf et al[148]	2017	Specialized	Weekly								×			
Keogh et al[149]	2011	Specialized	Once								×			
Kim and Utz[150]	2019	Hospital	Weekly								×	×		
Kim[151]	2007	Hospital	Weekly					×						×
Kim and Jeong[152]	2007	Hospital	Weekly					×						×
Kim and Song[153]	2008	Hospital	Weekly					×						×
Kim and Kim[154]	2008	Hospital	Weekly					×						×
Kim and Oh[155]	2003	Hospital	Weekly							×		×		
Kim et al[156]	2005	Hospital	Weekly							×		×		
Kim and Kang[157]	2006	Hospital	Tailored							×				
Kim et al[158]	2009	Community	Monthly	×		×		×		×				
Kim et al[159]	2010	Hospital	Daily	×				×						×
Kim et al[160]	2015	Hospital						×						
Kim et al[161]	2016	Hospital	Tailored					×						
King et al[162]	2006	Primary	Twice								×			
Kirkman et al[163]	1994	Primary	Monthly							×				
Kleinman et al[164]	2017	Specialized						×						×
Krein et al[165]	2004	Specialized								×				
Ku et al[166]	2020	Hospital	Weekly	×				×			×			
Kusnanto et al[167]	2019	Primary	Daily								×			
Kwon et al[168]	2004	Hospital	Tailored					×						×
Lauffenburger et al[169]	2019		Weekly								×	×		
Lazo-Porras et al[170]	2020	Hospital	Weekly					×			×			
Lee et al[171]	2017	Community		×				×		×				×
Lee et al[172]	2020	Hospital	Weekly					×				×		
Lee et al[173]	2019	Primary	Weekly	×				×						
Li et al[174]	2016	Hospital	Monthly								×	×		
Liebreich et al[175]	2009		Weekly							×		×		
Lim et al[176]	2011	Hospital		×				×						
Lim et al[177]	2016	Hospital		×	×			×						
Lorig et al[178]	2010		Weekly										×	
Lujan et al[179]	2007	Community	Fortnight							×		×		
Luley et al[180]	2011	Hospital	Weekly		×		×	×						
Lutes et al[181]	2017	Primary	Monthly	×	×		×			×				
Lynch et al[182]	2014	Community	Weekly										×	
MacPhail et al[183]	2014	Primary	Twice								×			
Marios et al[184]	2012	Primary	Weekly					×		×				

(continued)

Table 2. (continued)

Study	Publication year	Setting	Frequency of contact	Included peripherals				Intervention components						
				Glucometer	Pedometer	BP monitor	Scale	Monitoring	Consultation	Counseling	Coaching	Education	Mentoring	Reminding
Maslakpak et al[185]	2017		Weekly									×		
Mayberry et al[186]	2020	Primary	Monthly								×			
McEwen et al[187]	2017	Community	Tailored								×			
McKay et al[188]	2001		Weekly					×			×			
McKay et al[189]	2002	Primary	Weekly								×			
McKee et al[190]	2011	Community		×		×		×			×			
McMahon et al[191]	2012		Tailored					×		×				×
Mease[192]	2000	Primary	Weekly			×		×						
Mons et al[193]	2013	Primary	Monthly							×				
Moriyama et al[194]	2009	Hospital	Fortnight								×	×		
Mwangi et al[195]	2020	Hospital	Monthly									×		×
Namjoo Nasab et al[196]	2017	Community	Weekly							×				
Nesari et al[197]	2010	Specialized	Weekly							×		×		
Nicolucci et al[198]	2015	Primary	Monthly	×		×	×	×						×
Niswender et al[199]	2014	Cross-sectional	Fortnight						×					
O'Neil et al[200]	2016	University	Weekly							×		×		
Odegard and Christensen[201]	2012	Community	Monthly							×		×		
Odnoletkova et al[202]	2016		Fortnight								×			
Oh et al[203]	2003	Hospital	Weekly							×		×		
Orsama et al[204]	2013	Community	Tailored	×	×	×	×	×						
Owolabi et al[205]	2019	Primary	Daily								×	×		×
Parsons et al[206]	2019	Primary	Weekly						×			×		
Patja et al[207]	2012	Primary	Monthly								×			
Peasah et al[208]	2019	Primary	Weekly								×			×
Peimani et al[209]	2016	Hospital	Weekly									×		
Piette et al[210]	2011	Community	Weekly							×				
Plotnikoff et al[211]	2013	Community	Tailored								×			
Presley et al[212]	2020	Community	Weekly					×			×			
Quinn et al[213]	2017	Community	Tailored					×				×		
Quinn et al[214]	2011	Community	Tailored					×				×		
Raj and Mathews[215]	2020	Hospital	Weekly								×			×
Ralston et al[216]	2009	Hospital	Weekly					×						
Ramadas et al[217]	2018	Hospital								×				×
Rasmussen et al[218]	2016	Specialized							×					
Rodríguez-Idígoras et al[219]	2009	Community	Tailored	×				×						
Ruggiero et al[220]	2014	Primary	Monthly								×			
Sacco et al[221]	2009	University	Weekly								×			
Sacco et al[222]	2012	University	Weekly								×			
Samuel-Hodge et al[223]	2009	Community	Monthly							×				
Sarayani et al[224]	2018		Weekly									×		
Saslow et al[225]	2020	University	Daily									×		
Sazlina et al[226]	2015	Primary			×								×	
Schillinger et al[227]	2009		Weekly									×		
Shahid et al[228]	2015	Specialized	Weekly	×				×		×				
Shahsavari and Bakhshandeh Bavarsad[229]	2020	Specialized	Weekly								×			
Shetty et al[230]	2011	Specialized	Weekly											×
Shreck et al[231]	2014		Fortnight							×				
Sigurdardottir et al[232]	2009	Specialized	Weekly								×			

(continued)

Table 2. (continued)

Study	Publication year	Setting	Frequency of contact	Included peripherals				Intervention components						
				Glucometer	Pedometer	BP monitor	Scale	Monitoring	Consultation	Counseling	Coaching	Education	Mentoring	Reminding
Skelly et al[233]	2009	Cross-sectional	Fortnight							×		×		
Sone et al[234]	2002	Specialized	Fortnight		×					×				
Sone et al[235]	2010	Specialized	Fortnight		×					×		×		
Song and Kim[236]	2009	Specialized	Weekly							×		×		
Spencer et al[237]	2018	Community	Fortnight								×		×	
Steventon et al[238]	2014	Cross-sectional	Daily	×		×		×				×		
Sun et al[239]	2019	Hospital	Daily	×				×	×					×
Sunil Kumar et al[240]	2020	Hospital	Daily					×				×		×
Takenga et al[241]	2014	Hospital						×						
Tamban et al[242]	2013		Weekly											×
Tan et al[243]	2018	Primary	Fortnight									×		
Tang et al[244]	2013			×				×				×		
Teston et al[245]	2017		Fortnight								×			
Thom et al[246]	2013	Community	Fortnight								×		×	
Torbjørnsen et al[247]	2014		Monthly	×						×				
Tu et al[248]	1993	Hospital	Weekly							×		×		
Van Dyck et al[249]	2013	Hospital	Fortnight		×					×	×			
Van Dyck et al[250]	2011	Hospital	Fortnight		×					×	×			
Van Vugt et al[251]	2016	Primary									×			×
Varney et al[252]	2014	Hospital	Monthly								×			
Vaughan et al[253]	2020	Primary	Weekly						×		×			
Vervloet et al[254]	2014													×
Vinithia et al[255]	2019	Hospital	Weekly								×	×		
Von Storch et al[256]	2019		Weekly	×				×			×			
Wakefield et al[257]	2011	Primary	Daily	×		×		×				×		
Wakefield et al[258]	2012	Primary	Daily	×		×		×				×		
Wakefield et al[259]	2014	University	Tailored	×		×		×						
Waki et al[260]	2014	University	Tailored	×	×	×	×	×						
Walker et al[261]	2011	Specialized	Monthly								×			
Wang et al[262]	2020	Hospital	Weekly									×		
Wang et al[263]	2019	Hospital	Weekly					×	×					
Wang et al[264]	2017	Hospital	Fortnight	×				×						×
Warren et al[265]	2018	Primary	Daily	×		×		×	×					
Weinberger et al[266]	1995	Primary	Monthly							×		×		
Whittemore et al[267]	2004	Specialized	Monthly								×			
Wichit et al[268]	2017	Hospital	Once								×	×		
Wild et al[269]	2016	Primary		×		×	×	×						
Williams et al[270]	2012	Hospital	Weekly					×						
Williams et al[271]	2017	Primary	Monthly							×				
Wolever et al[272]	2010		Weekly								×			
Wolf et al[273]	2004	Primary	Monthly								×	×		
Wu et al[274]	2017	University	Once								×			×
Yang et al[275]	2020	Primary	Daily					×	×					
Yasmin et al[276]	2020	Hospital	Fortnight								×	×		×
Yoo et al[277]	2009	University	Tailored	×		×	×	×				×		
Yoon and Kim[278]	2008	Hospital	Weekly					×						×
Young et al[279]	2005	Primary	Monthly							×		×		
Yu et al[280]	2019	Hospital	Daily						×			×		
Zamanzadeh et al[281]	2017		Daily									×		
Zhou et al[282]	2014	Hospital	Fortnight	×		×	×	×						×

Abbreviation: BP, blood pressure.

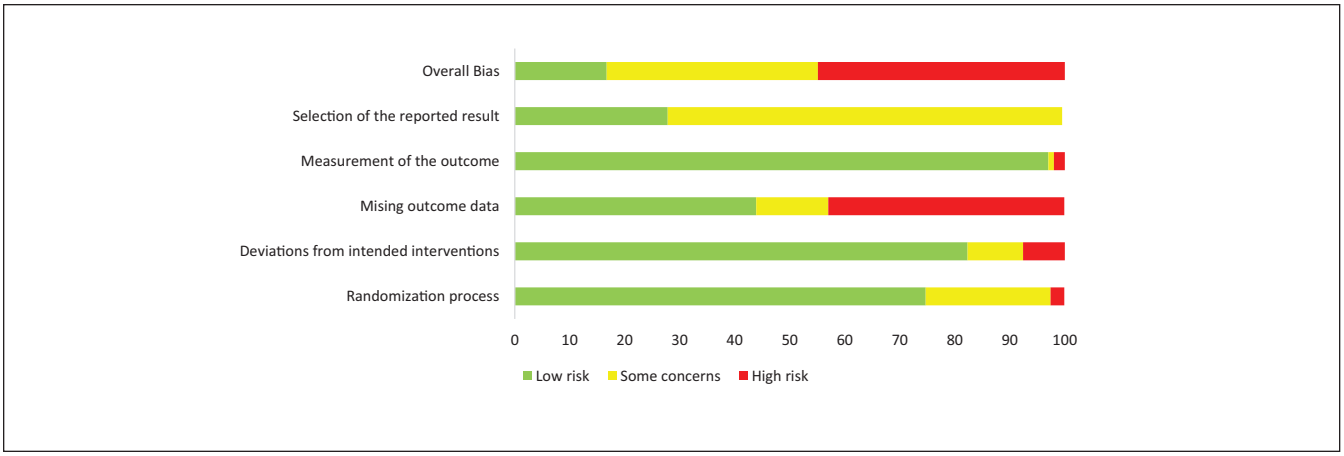

Figure 2. Summary of risk of bias assessment.

Certainty of the Evidence

Table 5 summarizes the findings. Overall, the certainty of evidence of the calculated effect on HbA1c% was judged as low due to serious problems with the risk of bias and inconsistency.

Discussion

This review aimed to evaluate the effectiveness of telemedicine solutions among adult patients with T2D. Overall, the results favored telemedicine. Asian studies, studies with higher baseline HbA1c% levels, and studies in hospital settings reported larger effects of telemedicine. Moreover, inclusion of a monitoring component in the telemedicine solution gave rise to a higher effect of telemedicine, whereas inclusion of a coaching component led to a lower effect. The results reflect the findings from previous systematic reviews, which have found significant reductions in HbA1c favoring telemedicine.[13,22,283,284] In line with our findings, Faruque et al and Wu et al found a larger effect among studies with a higher baseline HbA1c.[13,283] In contrast to our findings, Faruque et al found a larger effect in studies that used web portals or text messaging.[13] In terms of telemonitoring, Hanlon et al found improved glycemic control in studies that included telemonitoring with feedback[17] and Jaana et al found significantly reduced HbA1 through telemonitoring.[22] Hence, the ideal telemedicine setup remains to be determined, although the inclusion of a telemonitoring component seems advisable.

The heterogeneity of the included studies was large ($I^2 = 93.05\%$), which is often seen in reviews of telemedicine.[13,15,284-286] In the before-mentioned systematic review by Faruque et al, the heterogeneity (I^2) ranged from 58% to 75% depending on the time point Hba1c was measured.[13] A systematic review and meta-analysis by Tchero found a heterogeneity (I^2) of 99% in studies comparing telemedicine with usual care in T2D.[284] Hence, the large heterogeneity found in the present review is not unusually large when compared with similar reviews. The large heterogeneity found in the present review may be explained by differences in the inclusion criteria and context of studies that vary greatly in terms of patient subgroup, provider, technology, organization, communication frequency, outcome, and so on. Moreover, the inclusion of studies from the 1990s and 2000s may have added to the heterogeneity. Telemedicine interventions in diabetes have evolved significantly during the last decades due to technological advances and differences in the interventions are thus expected to have affected heterogeneity. However, the inclusion of studies from the 1990s and 2000s has maintained the broad and inclusive scope that was intended for the present review.

The certainty of the evidence was judged as poor. First, most of the evidence (45%) stems from studies with a high risk of bias and only 17% stems from studies with a low risk of bias. However, the size of the review implies that no single study contributed dominant weights in the meta-analysis, where study weights ranged from 0.26 to 0.77. The correlation between effect size, that is, the MD, and risk of bias across studies was low and nonsignificant (Spearman $\rho = -0.06$, $P = .3961$). Taken together, the certainty of evidence was downgraded one level due to risk of bias. Second, imprecision was assessed as not serious, as the effect size was statistically significant, and the MD and lower confidence limit (MD = −0.415, 95% CI = −0.482% to −0.348%) were both clinically relevant, and all were comparable with expected effects for other quality improvement strategies,[287] which is also why no upgrading due to large effects was conducted. The total number of patients (N = 57 136) included in the

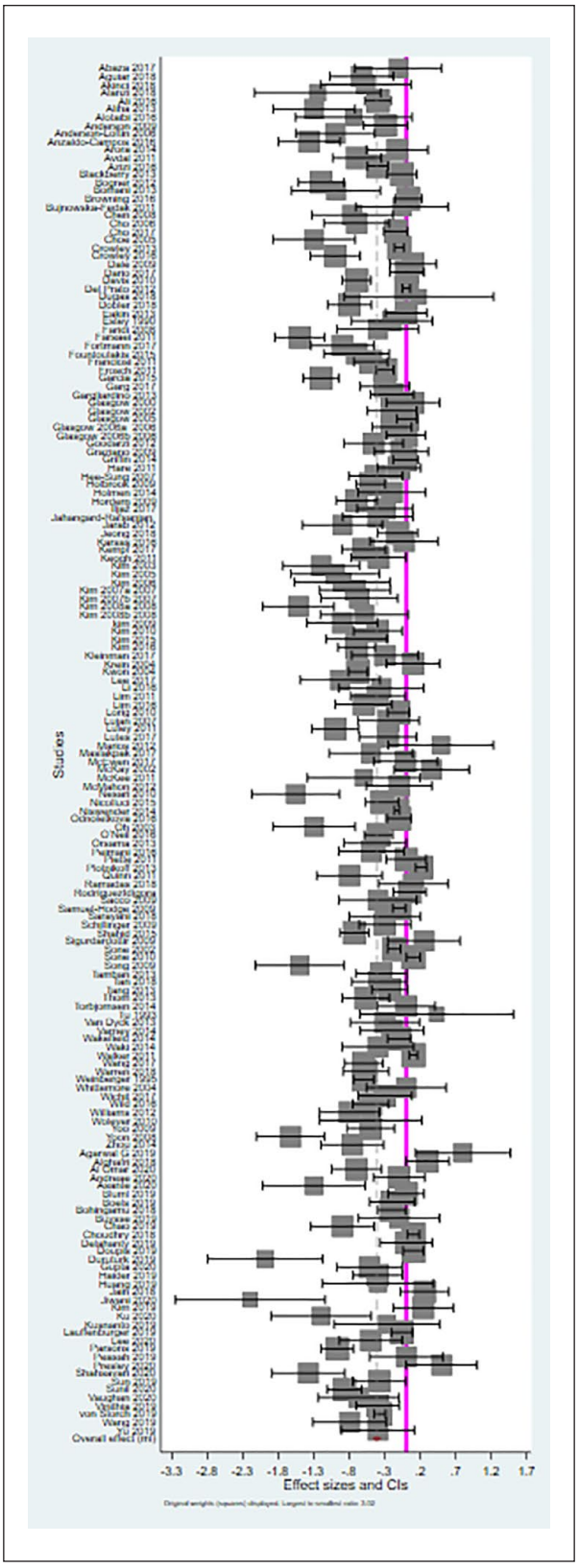

Figure 3. Forest plot of the meta-analysis (magenta line is effect size difference of 0).

review was also much higher than the optimal information size threshold (the OIS criterion). Third, inconsistency was assessed as serious. Although confidence intervals overlap considerably, effect size point estimates vary widely between studies, with significant effects favoring both alternatives. I^2 was high both with and without controlling for statistically significant study covariates simultaneously in the meta-regression ($I^2 = 87.8\%$ and $I^2 = 93\%$). Fourth, indirectness was not serious in this review, as all included studies were head-to-head experimental trials assessing the same outcome, and the inclusion criteria for both the population and type of intervention were broad. Fifth, although publication bias cannot be rejected with high confidence, the risk of publication bias was evaluated as undetected. Less than 100 participants were included in 35% of the studies. The Egger test for small-study effects was statistically significant ($P < .000$) and the funnel plot in Figure 4 reveals studies reporting both significant and insignificant positive and negative effects. The funnel plot is somewhat asymmetrical, with more studies demonstrating significant effects favoring telemedicine than negative effects. Of the 243 included studies, 32 reported industry sponsorship and 44 studies did not report whether there were sponsorships or other relevant conflicts of interest. However, the relationship between disclosed industry sponsorship and/or undisclosed relationships with both study size (above/below 100 participants) and MD (above/below mean effect across studies) was statistically nonsignificant (Fisher exact test = 0.31 and 0.11, respectively). Finally, no dose-response gradient was detected, as the contact frequency was insignificant in the meta-regression (Table 4).

The present systematic review has some limitations. First, more baseline data, such as diabetes years, blood pressure, cholesterol levels, and medication, could have been extracted. However, due to differences in reporting style, such an extraction would have resulted in a high proportion of missing data in the analysis. Second, we could have contacted the authors of the individual studies to minimize the amount of missing HbA1c data. However, due to the large sample of included papers, such a search for data was deemed too time-consuming. Third, relevant studies may have been overlooked. Although a very broad search was conducted, the search was still limited to English and Scandinavian.

Conclusion

Telemedicine may serve as an effective supplement to usual care for patients with T2D. The inclusion of a telemonitoring component seems to increase the effect of telemedicine. It seems that those with a higher HbA1c are more likely to benefit from telemedicine. Patients with poor glycemic control may benefit more from telemedicine interventions, as a high

Table 3. Meta-Analysis Summary.

Study	MD	Lower 95% CI	Higher 95% CI	Weight
Abaza and Marschollek[42]	−0.11	−0.72	0.50	0.47
Aguiar et al[45]	−0.63	−1.08	−0.18	0.57
Akinci et al[46]	−0.57	−1.21	0.07	0.45
Alanzi et al[48]	−1.25	−2.14	−0.36	0.33
Ali et al[51]	−0.40	−0.59	−0.22	0.73
Aliha et al[53]	−1.30	−1.88	−0.72	0.49
Alotaibi et al[55]	−0.74	−1.56	0.08	0.36
Anderson et al[56]	−0.29	−0.60	0.02	0.66
Anderson-Loftin et al[58]	−1.00	−1.56	−0.44	0.50
Anzaldo-Campos et al[60]	−1.37	−1.81	−0.94	0.58
Arora et al[61]	−0.13	−0.56	0.31	0.58
Avdal et al[63]	−0.69	−1.04	−0.35	0.64
Azizi et al[64]	−0.40	−0.55	−0.25	0.74
Blackberry et al[66]	−0.06	−0.27	0.15	0.72
Bogner et al[68]	−1.20	−1.52	−0.88	0.65
Lashkari et al[70]	−0.99	−1.62	−0.36	0.46
Browning et al[71]	0.03	−0.16	0.22	0.73
Bujnowska-Fedak et al[72]	−0.06	−0.71	0.59	0.45
Chen et al[78]	−0.76	−1.33	−0.19	0.49
Cho et al[81]	−0.70	−1.16	−0.24	0.56
Cho et al[82]	−0.15	−0.32	0.02	0.74
Choe et al[83]	−1.30	−1.88	−0.72	0.49
Crowley et al[86]	−0.10	−0.17	−0.04	0.76
Crowley et al[87]	−1.00	−1.35	−0.65	0.64
Dale et al[88]	0.10	−0.23	0.43	0.65
Dario et al[89]	0.01	−0.23	0.25	0.70
Davis et al[90]	−0.70	−0.90	−0.50	0.72
Del Prato et al[91]	0.00	−0.06	0.06	0. 77
Dugas et al[93]	0.18	−0.87	1.23	0.27
Döbler et al[95]	−0.80	−1.11	−0.49	0.66
Eakin et al[96]	0.00	−0.29	0.29	0.67
Estey et al[100]	−0.20	−0.77	0.37	0.49
Faridi et al[101]	−0.40	−0.98	0.18	0.49
Farsaei et al[102]	−1.50	−1.85	−1.15	0.64
Fortmann et al[104]	−0.90	−1.34	−0.46	0.58
Fountoulakis et al[106]	−0.70	−1.16	−0.24	0.56
Franciosi et al[108]	−0.50	−0.74	−0.26	0.70
Frosch et al[109]	−0.30	−0.42	−0.18	0.75
García et al[110]	−1.20	−1.45	−0.95	0.69
Garg et al[111]	−0.30	−0.65	0.05	0.64
Gagliardino et al[112]	−0.20	−0.51	0.11	0.66
Glasgow and Toobert[117]	0.10	−0.27	0.47	0.62
Glasgow et al[118]	−0.20	−0.55	0.15	0.64
Glasgow et al[119]	0.01	−0.13	0.15	0.74
Glasgow et al[115]	−0.20	−0.48	0.08	0.68
Glasgow et al[116]	0.00	−0.27	0.27	0.68
Goodarzi et al[120]	−0.46	−0.88	−0.04	0.59
Graziano and Gross[122]	−0.07	−0.45	0.31	0.62
Griffin et al[123]	−0.01	−0.18	0.16	0.73
Hare et al[127]	−0.10	−0.41	0.21	0.66
Hee-Sung[128]	−0.43	−0.81	−0.05	0.62
Holbrook et al[132]	−0.50	−0.71	−0.30	0.72
Holmen et al[133]	−0.20	−0.68	0.28	0.55
Hordern et al[134]	−0.70	−0.99	−0.41	0.67
Iljaž et al[138]	−0.30	−0.69	0.09	0.61
Jahangard-Rafsanjani et al[140]	−0.40	−0.89	0.09	0.54
Jarab et al[142]	−0.90	−1.46	−0.34	0.50
Jeong et al[144]	−0.12	−0.40	0.16	0.68

(continued)

Table 3. (continued)

Study	MD	Lower 95% CI	Higher 95% CI	Weight
Kardas et al[146]	−0.03	−0.51	0.45	0.55
Kempf et al[148]	−0.60	−0.91	−0.29	0.66
Keogh et al[149]	−0.39	−0.78	0.00	0.61
Kim and Oh[155]	−1.20	−1.74	−0.66	0.51
Kim et al[156]	−1.00	−1.63	−0.38	0.46
Kim and Kang[157]	−0.90	−1.58	−0.22	0.43
Kim[151]	−0.72	−1.22	−0.22	0.54
Kim and Jeong[152]	−0.66	−1.20	−0.12	0.51
Kim and Song[153]	−1.52	−2.02	−1.02	0.54
Kim and Kim[154]	−0.59	−1.21	0.03	0.46
Kim et al[158]	−0.90	−1.40	−0.40	0.54
Kim et al[159]	−0.40	−0.74	−0.06	0.64
Kim et al[160]	−0.70	−1.13	−0.27	0.58
Kim et al[161]	−0.70	−0.96	−0.44	0.69
Kleinman et al[164]	−0.30	−0.77	0.17	0.56
Krein et al[165]	0.10	−0.28	0.48	0.62
Kwon et al[168]	−0.68	−0.82	−0.55	0.75
Lee et al[171]	−0.93	−1.49	−0.37	0.50
Li et al[174]	−0.35	−0.95	0.25	0.48
Lim et al[176]	−0.40	−0.79	−0.01	0.61
Lim et al[177]	−0.60	−1.00	−0.20	0.60
Lorig et al[178]	−0.11	−0.26	0.05	0.74
Lujan et al[179]	−0.25	−0.68	0.18	0.58
Luley et al[180]	−1.00	−1.33	−0.67	0.65
Lutes et al[181]	−0.26	−0.66	0.14	0.60
Marios et al[184]	0.49	−0.25	1.23	0.40
Maslakpak et al[185]	−0.50	−1.09	0.09	0.48
McEwen et al[187]	−0.01	−0.46	0.44	0.57
McKay et al[189]	0.36	−0.17	0.89	0.52
McKee et al[190]	−0.60	−1.39	0.19	0.37
McMahon et al[191]	−0.10	−0.56	0.36	0.56
Nesari et al[197]	−1.56	−2.18	−0.94	0.46
Nicolucci et al[198]	−0.34	−0.57	−0.11	0.71
Niswender et al[199]	−0.13	−0.17	−0.10	0.77
Odnoletkova et al[202]	−0.10	−0.27	0.07	0.73
Oh et al[203]	−1.30	−1.88	−0.72	0.49
O'Neil et al[200]	−0.39	−0.59	−0.19	0.72
Orsama et al[204]	−0.44	−0.88	0.01	0.58
Peimani et al[209]	−0.49	−0.95	−0.03	0.56
Piette et al[210]	0.00	−0.28	0.28	0.68
Plotnikoff et al[211]	0.21	0.13	0.29	0.76
Quinn et al[214]	−0.80	−1.26	−0.34	0.56
Ramadas et al[217]	0.10	−0.39	0.59	0.55
Rodríguez-Idígoras et al[219]	0.05	−0.18	0.28	0.70
Sacco et al[221]	−0.40	−0.95	0.15	0.51
Samuel-Hodge et al[223]	−0.10	−0.19	−0.01	0.76
Sarayani et al[224]	−0.30	−0.80	0.20	0.54
Schillinger et al[227]	−0.30	−0.66	0.06	0.63
Shahid et al[228]	−0.73	−0.94	−0.52	0.72
Sigurdardottir et al[232]	0.25	−0.26	0.76	0.53
Sone et al[234]	−0.17	−0.26	−0.08	0.76
Sone et al[235]	0.10	0.01	0.20	0.76
Song and Kim[236]	−1.50	−2.13	−0.87	0.46
Tamban et al[242]	−0.35	−0.71	0.01	0.63
Tan et al[243]	−0.38	−0.77	0.01	0.61
Tang et al[244]	−0.23	−0.48	0.02	0.69
Thom et al[246]	−0.57	−0.90	−0.24	0.65
Torbjørnsen et al[247]	0.00	−0.41	0.41	0.60

(continued)

Table 3. (continued)

Study	MD	Lower 95% CI	Higher 95% CI	Weight
Tu et al[248]	0.43	−0.65	1.51	0.26
Van Dyck et al[249]	−0.30	−0.79	0.19	0.55
Varney et al[252]	−0.20	−0.65	0.25	0.57
Wakefield et al[259]	−0.10	−0.26	0.06	0.74
Waki et al[260]	−0.40	−0.91	0.11	0.53
Walker et al[261]	0.10	0.04	0.16	0.77
Wang et al[264]	−0.60	−0.87	−0.33	0.68
Warren et al[265]	−0.57	−0.89	−0.24	0.65
Weinberger et al[266]	−0.60	−0.74	−0.46	0.74
Whittemore et al[267]	0.00	−0.56	0.56	0.50
Wichit et al[268]	−0.30	−0.68	0.08	0.62
Wild et al[269]	−0.50	−0.75	−0.25	0.69
Williams et al[270]	−0.80	−1.22	−0.38	0.59
Wolever et al[272]	−0.50	−1.22	0.22	0.41
Yoo et al[277]	−0.50	−0.84	−0.17	0.65
Yoon and Kim[278]	−1.63	−2.11	−1.15	0.55
Zhou et al[282]	−0.76	−1.20	−0.32	0.58
Agarwal et al[43]	0.80	0.13	1.47	0.44
Alghafri et al[50]	0.30	−0.01	0.61	0.66
Al Omar et al[47]	−0.70	−1.05	−0.35	0.63
Andreae et al[59]	−0.10	−0.46	0.26	0.63
Asante et al[62]	−1.30	−2.02	−0.58	0.41
Bluml et al[67]	0.00	−0.25	0.25	0.69
Boels et al[12]	−0.20	−0.52	0.12	0.66
Bohingamu Mudiyanselage et al[69]	−0.21	−0.41	−0.01	0.72
Buysse et al[73]	−0.10	−0.67	0.47	0.49
Chao et al[77]	−0.90	−1.35	−0.45	0.57
Choudhry et al[84]	0.10	0.02	0.19	0.76
Delahanty et al[92]	0.00	−0.37	0.37	0.62
Doupis et al[7]	0.10	−0.04	0.24	0.74
Duruturk and Özköslü[94]	−1.99	−2.80	−1.18	0.36
Gupta et al[124]	−0.52	−0.98	−0.06	0.56
Haider et al[125]	−0.40	−0.75	−0.05	0.64
Huang et al[135]	−0.40	−1.18	0.38	0.37
Jain et al[141]	0.26	−0.08	0.60	0.64
Jiwani et al[145]	−2.20	−3.26	−1.14	0.26
Kim and Utz[150]	0.24	−0.18	0.66	0.59
Ku et al[166]	−1.20	−1.91	−0.49	0.41
Kusnanto et al[167]	−0.27	−1.02	0.48	0.39
Lauffenburger et al[169]	−0.06	−0.21	0.09	0.74
Lee et al[172]	−0.50	−0.94	−0.06	0.58
Parsons et al[206]	−0.97	−1.20	−0.74	0.71
Peasah et al[208]	0.00	−0.52	0.52	0.53
Presley et al[212]	0.50	0.00	1.00	0.54
Shahsavari and Bakhshandeh Bavarsad[229]	−1.38	−1.89	−0.87	0.53
Sun et al[239]	−0.38	−0.75	−0.01	0.62
Sunil Kumar et al[240]	−0.87	−1.11	−0.63	0.70
Vaughan et al[253]	−0.67	−1.24	−0.10	0.49
Vinithia et al[255]	−0.40	−0.71	−0.10	0.66
Von Storch et al[256]	−0.37	−0.45	−0.29	0.76
Wang et al[263]	−0.80	−1.32	−0.28	0.53
Yu et al[280]	−0.40	−0.92	0.12	0.53
Overall	−0.42	−0.48	−0.35	100.00

Abbreviations: CI, confidence interval; MD, mean difference.

Table 4. Association Between Study Covariates and Effect of Telemedicine on HbA1c% (Meta-Regression).

Covariate	N	Difference in MD (SE)	*P* value	I^2 (%)
Study characteristics				
Publication decade				
Before 2020	4	Reference		92.86
2020s	50	−0.175 (0.287)	.542	
2010s	165	−0.082 (0.281)	.769	
2020	24	−0.418 (0.312)	.180	
Continent				
North America	88	Reference		91.15
Europe	44	−0.037 (0.095)	.696	
South America	5	−0.104 (0.303)	.731	
Africa	5	−0.366 (0.362)	.312	
Asia	84	−0.287 (0.078)	.000*	
Australia/New Zealand	16	−0.040 (0.140)	.773	
Study duration (range = 1-96 months)	168	0.008 per month (0.003)	.015*	92.60
Proportion of men (range = 15%-100%)	159	0.005 per % (0.002)	.035*	93.05
Age (range = 37-73 years)	157	0.022 per year (0.006)	.000*	92.64
Baseline BMI (range = 22-40)	123	0.018 per score (0.010)	.066	92.51
Baseline HbA1c% (range = 5.70%-11.05%)	165	−0.093 per % (0.035)	.007*	92.80
Telemedicine characteristics				
Setting				
Primary care	58	Reference		90.25
Community	37	−0.019 (0.116)	.868	
Hospital	71	−0.290 (0.100)	.004*	
Specialized outpatient clinic	34	−0.148 (0.114)	.194	
University	14	−0.180 (0.169)	.287	
Cross-sectorial	4	0.203 (0.301)	.500	
Contact frequency				
Daily	30	Reference		91.42
Weekly	83	−0.150 (0.129)	.246	
Every two weeks	26	0.045 (0.157)	.776	
Monthly	40	0.101 (0.144)	.481	
More seldom	12	−0.006 (0.199)	.977	
Tailored	24	0.076 (0.148)	.611	
Included peripherals				
Glucometer	45	−0.052 (0.081)	.523	92.81
Pedometer	16	0.102 (0.132)	.440	92.96
BP monitor	19	−0.008 (0.132)	.953	93.09
Scale	13	0.014 (0.137)	.919	93.12
Intervention components				
Monitoring	86	−0.195 (0.068)	.004*	92.30
Consultation	22	−0.015 (0.114)	.895	92.25
Counseling	53	−0.030 (0.083)	.720	92.95
Coaching	63	0.215 (0.080)	.007*	92.44
Education	81	−0.125 (0.072)	.085	92.76
Mentoring	8	0.265 (0.201)	.188	93.03
Reminding	38	−0.151 (0.092)	.100	92.87
Risk of bias				
Low	33	Reference		92.82
Some concerns	76	−0.101 (0.100)	.310	
High	88	−0.067 (0.100)	.492	

Abbreviations: HbA1c%, glycated hemoglobin; MD, mean difference; BMI, body mass index; BP, blood pressure.
*Statistically significant at a 5% level.

Table 5. Summary of Findings Table.

Certainty assessment							No of patients		Effect			
No of studies	Study design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	Telemedicine	Usual practice	Relative (95% CI)	Absolute (95% CI)	Certainty	Importance
HbA1c%												
243	Randomized trials	Serious[a]	Serious[b]	Not serious	Not serious	None	29671	27465	–	MD 0.415 lower (0.482 lower to 0.348 lower)	⊕⊕◯◯ LOW	IMPORTANT

Abbreviations: CI, confidence interval; HbA1c%, glycated hemoglobin; MD, mean difference.
[a]The size of the review implies that no single study contributes dominant weights in the meta-analysis. Indeed, study weights range from 0.26 to 0.77. The correlation between effect size, that is, the MD, and risk of bias across studies was low and insignificant (Spearman $\rho = -0.06$, $P = .3961$). However, only 17% of the studies were evaluated to have a low risk of bias. Consequently, the risk of bias was downgraded to one level and assessed as serious.
[b]Effect size point estimates vary widely between studies, with significant effects favoring both alternatives. I^2 was high, both with and without controlling for statistically significant study covariates simultaneously in the meta-regression ($I^2 = 87.8\%$ and $I^2 = 93\%$).

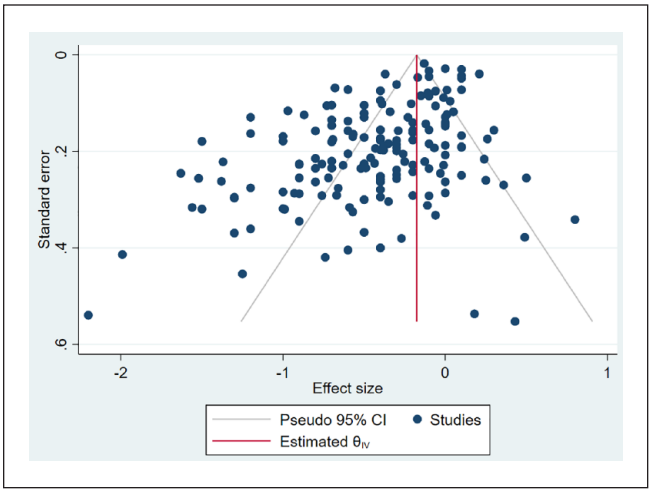

Figure 4. Funnel plot.
Abbreviation: CI, confidence interval.

HbA1c level leaves further room for improvement. However, the ideal glycemic target group for telemedicine in T2D remains to be determined.

Abbreviations

GRADE, The Grading of Recommendations, Assessment, Development and Evaluation; HbA1c, glycated hemoglobin A1c; MD, mean difference; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; RCT, randomized controlled trial; T1D, type 1 diabetes; T2D, type 2 diabetes.

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ORCID iDs

Stine Hangaard https://orcid.org/0000-0003-0395-3563
Jonas D. Andersen https://orcid.org/0000-0001-6619-9161
Flemming W. Udsen https://orcid.org/0000-0003-2293-9169

Supplemental Material

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References

1. Cho NH, Shaw JE, Karuranga S, et al. IDF Diabetes Atlas: global estimates of diabetes prevalence for 2017 and projections for 2045. *Diabetes Res Clin Pract*. 2018;138:271-281. doi:10.1016/j.diabres.2018.02.023.
2. Hu FB. Globalization of diabetes: the role of diet, lifestyle, and genes. *Diabetes Care*. 2011;34(6):1249-1257.
3. World Health Organization. *Global Status Report on Noncommunicable Diseases 2014*. World Health Organization; 2014. http://apps.who.int/iris/bitstream/handle/10665/148114/9789241564854_eng.pdf?sequence=1. Accessed November 26, 2021.
4. Zheng Y, Ley SH, Hu FB. Global aetiology and epidemiology of type 2 diabetes mellitus and its complications. *Nat Rev Endocrinol*. 2018;14:88-98. doi:10.1038/nrendo.2017.151.
5. Xu G, Liu B, Sun Y, et al. Prevalence of diagnosed type 1 and type 2 diabetes among US adults in 2016 and 2017: population based study. *BMJ*. 2018;362:k1497.
6. Bonora E, DeFronzo RA. *Diabetes Complications, Comorbidities and Related Disorders*. Springer; 2018. doi:10.1007/978-3-319-44433-8.
7. Doupis J, Alexandrides T, Elisaf M, et al. Influence of supervised disease understanding and diabetes self-management on adherence to oral glucose-lowering treatment in patients with type 2 diabetes. *Diabetes Ther*. 2019;10:1407-1422. doi:10.1007/s13300-019-0648-9.

8. American Diabetes Association. Standards of medical care in diabetes—2020 abridged for primary care providers. *Clin Diabetes*. 2020;38:10-38. doi:10.2337/cd20-as01.
9. Powers MA, Bardsley J, Cypress M, et al. Diabetes self-management education and support in type 2 diabetes: a joint position statement of the American Diabetes Association, the American Association of Diabetes Educators, and the Academy of Nutrition and Dietetics. *Diabetes Care*. 2015;38:1372-1382. doi:10.2337/dc15-0730.
10. Edelman S, Polonsky W. Type 2 diabetes in the real world: the elusive nature of glycemic control. *Diabetes Care*. 2017;40:1425-1432. doi:10.2337/dc16-1974.
11. Cramer JA. A systematic review of adherence with medications for diabetes. *Diabetes Care*. 2004;27:1218-1224.
12. Boels AM, Vos RC, Dijkhorst-Oei LT, Rutten GEHM. Effectiveness of diabetes self-management education and support via a smartphone application in insulin-treated patients with type 2 diabetes: results of a randomized controlled trial (TRIGGER study). *BMJ Open Diabetes Res Care*. 2019;7:e000981. doi:10.1136/bmjdrc-2019-000981.
13. Faruque LI, Wiebe N, Ehteshami-Afshar A, et al. Effect of telemedicine on glycated hemoglobin in diabetes: a systematic review and meta-analysis of randomized trials. *Cmaj*. 2017;189:E341-E364. doi:10.1503/cmaj.150885.
14. WHO Global Observatory for eHealth. Telemedicine: opportunities and developments in member states. *Observatory*. 2010;2:96.
15. Baron J, Mcbain H, Newman S, Psych D, Hons M. The impact of mobile monitoring technologies on glycosylated. *J Diabetes Sci Technol*. 2012;6:1185-1196.
16. Holtz B, Lauckner C. Diabetes management via mobile phones: a systematic review. *Telemed J E Health*. 2012;18(3):175-184.
17. Hanlon P, Daines L, Campbell C, McKinstry B, Weller D, Pinnock H. Telehealth interventions to support self-management of long-term conditions: a systematic metareview of diabetes, heart failure, asthma, chronic obstructive pulmonary disease, and cancer. *J Med Internet Res*. 2017;19(5):e172.
18. Crico C, Renzi C, Graf N, et al. mHealth and telemedicine apps: in search of a common regulation. *Ecancermedicalscience*. 2018;12:853.
19. Mahar JH, Rosencrance GJ, Rasmussen PA. Telemedicine: past, present, and future. *Cleve Clin J Med*. 2018;85(12):938-942.
20. Greenwood DA, Young HM, Quinn CC. Telehealth remote monitoring systematic review. *J Diabetes Sci Technol*. 2014;8(2):378-389.
21. Jaana M, Paré G. Home telemonitoring of patients with diabetes: a systematic assessment of observed effects. *J Eval Clin Pract*. 2007;13:242-253. doi:10.1111/j.1365-2753.2006.00686.x.
22. Pare G, Janna M, Sicotte C. Systematic review of home telemonitoring for chronic diseases: the evidence base home telemonitoring: a definition. *J Am Med Informatics Assoc*. 2007;14(3):269-277.
23. Wu L, Forbes A, Griffiths P, Milligan P, While A. Telephone follow-up to improve glycaemic control in patients with type 2 diabetes: systematic review and meta-analysis of controlled trials. *Diabet Med*. 2010;27(11):1217-1225.
24. Yun JE, Park JE, Park HY, Lee HY, Park DA. Comparative effectiveness of telemonitoring versus usual care for heart failure: a systematic review and meta-analysis. *J Card Fail*. 2018;24(1):19-28.
25. Cassimatis M, Kavanagh DJ. Effects of type 2 diabetes behavioural telehealth interventions on glycaemic control and adherence: a systematic review. *J Telemed Telecare*. 2012;18(8):447-450.
26. Lee SWH, Ooi L, Lai YK. Telemedicine for the management of glycemic control and clinical outcomes of type 1 diabetes mellitus: a systematic review and meta-analysis of randomized controlled studies. *Front Pharmacol*. 2017;8:330.
27. Kongstad MB, Valentiner LS, Ried-Larsen M, Walker KC, Juhl CB, Langberg H. Effectiveness of remote feedback on physical activity in persons with type 2 diabetes: a systematic review and meta-analysis of randomized controlled trials. *J Telemed Telecare*. 2019;25(1):26-34.
28. Hu Y, Wen X, Wang F, et al. Effect of telemedicine intervention on hypoglycaemia in diabetes patients: a systematic review and meta-analysis of randomised controlled trials. *J Telemed Telecare*. 2019;25(7):402-413.
29. European Commission. Tools and methodologies to assess the efficiency of health care services in Europe. An overview of current approaches and opportunities for improvement. *Luxembourg;* 2019. https://op.europa.eu/en/publication-detail/-/publication/27d2db38-76bc-11e9-9f05-01aa75ed71a1. Accessed November 26, 2021.
30. Moher D, Liberati A, Tetzlaff J, Altman DG, Group TP. Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Med*. 2009;6:e1000097. doi:10.1371/journal.pmed.1000097.
31. Laursen S, Hangaard S, Udsen F, Vestergaard P, Hejlesen O. Effectiveness of telemedicine solutions for the management of patients with diabetes: protocol for a systematic review and meta-analysis. *JMIR Res Protoc*. 2020;9:e22062. doi:10.2196/22062.
32. Sterne JAC, Savović J, Page MJ, et al. RoB 2: a revised tool for assessing risk of bias in randomised trials. *BMJ*. 2019;366:l4898. doi:10.1136/bmj.l4898.
33. Wan X, Wang W, Liu J, Tong T. Estimating the sample mean and standard deviation from the sample size, median, range and/or interquartile range. *BMC Med Res Methodol*. 2014;14:135. doi:10.1186/1471-2288-14-135.
34. Hozo SP, Djulbegovic B, Hozo I. Estimating the mean and variance from the median, range, and the size of a sample. *BMC Med Res Methodol*. 2005;5:13. doi:10.1186/1471-2288-5-13.
35. Guyatt GH, Thorlund K, Oxman AD, et al. GRADE guidelines: 13. Preparing Summary of Findings tables and evidence profiles—continuous outcomes. *J Clin Epidemiol*. 2013;66:173-183. doi:10.1016/j.jclinepi.2012.08.001.
36. Guyatt G, Oxman AD, Sultan S, et al. GRADE guidelines: 11. Making an overall rating of confidence in effect estimates for a single outcome and for all outcomes. *J Clin Epidemiol*. 2013;66:151-157. doi:10.1016/j.jclinepi.2012.01.006.
37. Guyatt GH, Oxman AD, Vist G, et al. GRADE guidelines: 4. Rating the quality of evidence—study limitations (risk of bias). *J Clin Epidemiol*. 2011;64:407-415. doi:10.1016/j.jclinepi.2010.07.017.

38. Guyatt GH, Oxman AD, Kunz R, et al. GRADE guidelines: 8. Rating the quality of evidence—indirectness. *J Clin Epidemiol*. 2011;64:1303-1310. doi:10.1016/j.jclinepi.2011.04.014.
39. Guyatt GH, Oxman AD, Kunz R, et al. GRADE guidelines 6. Rating the quality of evidence—imprecision. *J Clin Epidemiol*. 2011;64:1283-1293. doi:10.1016/j.jclinepi.2011.01.012.
40. Guyatt GH, Oxman AD, Kunz R, et al. GRADE guidelines: 7. Rating the quality of evidence—inconsistency. *J Clin Epidemiol*. 2011;64:1294-1302. doi:10.1016/j.jclinepi.2011.03.017.
41. Guyatt GH, Oxman AD, Montori V, et al. GRADE guidelines: 5. Rating the quality of evidence—publication bias. *J Clin Epidemiol*. 2011;64:1277-1282. doi:10.1016/j.jclinepi.2011.01.011.
42. Abaza H, Marschollek M. SMS education for the promotion of diabetes self-management in low & middle income countries: a pilot randomized controlled trial in Egypt. *BMC Public Health*. 2017;17:962. doi:10.1186/s12889-017-4973-5.
43. Agarwal G, Gaber J, Richardson J, et al. Pilot randomized controlled trial of a complex intervention for diabetes self-management supported by volunteers, technology, and interprofessional primary health care teams. *Pilot Feasibility Stud*. 2019;5:118. doi:10.1186/s40814-019-0504-8.
44. Agarwal P, Mukerji G, Desveaux L, et al. Mobile app for improved self-management of type 2 diabetes: multicenter pragmatic randomized controlled trial. *JMIR Mhealth Uhealth*. 2019;7:e10321. doi:10.2196/10321.
45. Aguiar PM, da Silva CHP, Chiann C, Dórea EL, Lyra DP, Storpirtis S. Pharmacist-physician collaborative care model for patients with uncontrolled type 2 diabetes in Brazil: results from a randomized controlled trial. *J Eval Clin Pract*. 2018;24:22-30. doi:10.1111/jep.12606.
46. Akinci B, Yeldan I, Satman I, Dirican A, Ozdincler AR. The effects of Internet-based exercise compared with supervised group exercise in people with type 2 diabetes: a randomized controlled study. *Clin Rehabil*. 2018;32:799-810. doi:10.1177/0269215518757052.
47. Al Omar M, Hasan S, Palaian S, Mahameed S. The impact of a self-management educational program coordinated through WhatsApp on diabetes control. *Pharm Pract (Granada)*. 2020;18:1841. doi:10.18549/PharmPract.2020.2.1841.
48. Alanzi T, Alanazi NR, Istepanian R, Philip N. Evaluation of the effectiveness of mobile diabetes management system with social networking and cognitive behavioural therapy (CBT) for T2D. *Mhealth*. 2018;4:35-35. doi:10.21037/mhealth.2018.06.05.
49. Albikawi ZF, Petro-Nustas W, Abuadas M. Self-care management intervention to improve psychological wellbeing for Jordanian patients with type two diabetes mellitus. *Issues Ment Health Nurs*. 2016;37:190-201. doi:10.3109/01612840.2015.1122118.
50. Alghafri TS, Alharthi SM, Al-Farsi Y, et al. "MOVEdiabetes": a cluster randomized controlled trial to increase physical activity in adults with type 2 diabetes in primary health in Oman. *BMJ Open Diabetes Res Care*. 2018;6:e000605. doi:10.1136/bmjdrc-2018-000605.
51. Ali MK, Singh K, Kondal D, et al. Effectiveness of a multicomponent quality improvement strategy to improve achievement of diabetes care goals a randomized, controlled trial. *Ann Intern Med*. 2016;165:399-408. doi:10.7326/M15-2807.
52. Ali MK, Chwastiak L, Poongothai S, et al. Effect of a collaborative care model on depressive symptoms and glycated hemoglobin, blood pressure, and serum cholesterol among patients with depression and diabetes in India: the INDEPENDENT randomized clinical trial. *JAMA*. 2020;324:651-662. doi:10.1001/jama.2020.11747.
53. Aliha JM, Asgari M, Khayeri F, Ramazani M, Farajzadegan Z, Javaheri J. Group education and nurse-telephone follow-up effects on blood glucose control and adherence to treatment in type 2 diabetes patients. *Int J Prev Med*. 2013;4:797-802.
54. Alonso-Domínguez R, Patino-Alonso MC, Sánchez-Aguadero N, García-Ortiz L, Recio-Rodríguez JI, Gómez-Marcos MA. Effect of a multifactorial intervention on the increase in physical activity in subjects with type 2 diabetes mellitus: a randomized clinical trial (EMID Study). *Eur J Cardiovasc Nurs*. 2019;18:399-409. doi:10.1177/1474515119835048.
55. Alotaibi MM, Istepanian R, Philip N. A mobile diabetes management and educational system for type-2 diabetics in Saudi Arabia (SAED). *Mhealth*. 2016;2:33-33. doi:10.21037/mhealth.2016.08.01.
56. Anderson RM, Funnell MM, Aikens JE, et al. Evaluating the efficacy of an empowerment-based self-management consultant intervention: results of a two-year randomized controlled trial. *Ther Patient Educ*. 2009;1:3-11. doi:10.1051/tpe/2009002.
57. Anderson DR, Christison-Lagay J, Villagra V, Liu H, Dziura J. Managing the space between visits: a randomized trial of disease management for diabetes in a community health center. *J Gen Intern Med*. 2010;25:1116-1122. doi:10.1007/s11606-010-1419-5.
58. Anderson-Loftin W, Barnett S, Bunn P, Sullivan P, Hussey J, Tavakoli A. Soul food light: culturally competent diabetes education. *Diabetes Educ*. 2005;31:555-563. doi:10.1177/0145721705278948.
59. Andreae SJ, Andreae LJ, Richman JS, Cherrington AL, Safford MM. Peer-delivered cognitive behavioral training to improve functioning in patients with diabetes: a cluster-randomized trial. *Ann Fam Med*. 2020;18:15-23. doi:10.1370/afm.2469.
60. Anzaldo-Campos MC, Contreras S, Vargas-Ojeda A, Menchaca-Díaz R, Fortmann A, Philis-Tsimikas A. Dulce wireless Tijuana: a randomized control trial evaluating the impact of project Dulce and short-term mobile technology on glycemic control in a family medicine clinic in Northern Mexico. *Diabetes Technol Ther*. 2016;18:240-251. doi:10.1089/dia.2015.0283.
61. Arora S, Peters AL, Burner E, Lam CN, Menchine M. Trial to examine text message-based mhealth in emergency department patients with diabetes (TExT-MED): a randomized controlled trial. *Ann Emerg Med*. 2014;63:745-754.e6. doi:10.1016/j.annemergmed.2013.10.012.
62. Asante E, Bam V, Diji AKA, et al. Pilot mobile phone intervention in promoting type 2 diabetes management in an

urban area in Ghana: a randomized controlled trial. *Diabetes Educ*. 2020;46:455-464. doi:10.1177/0145721720954070.
63. Avdal EÜ, Kizilci S, Demirel N. The effects of web-based diabetes education on diabetes care results: a randomized control study. *Comput Informatics Nurs*. 2011;29:101-106. doi:10.1097/NCN.0b013e3181fcbdc6.
64. Azizi A, Aboutorabi R, Mazloum-Khorasani Z, Afzal-Aghaea M, Tabesh H, Tara M. Evaluating the effect of web-based Iranian diabetic personal health record app on self-care status and clinical indicators: randomized controlled trial. *JMIR Med Informatics*. 2016;4:e32. doi:10.2196/medinform.6433.
65. Benson GA, Sidebottom A, Hayes J, et al. Impact of ENHANCED (diEtitiaNs Helping pAtieNts CarE for Diabetes) telemedicine randomized controlled trial on diabetes optimal care outcomes in patients with type 2 diabetes. *J Acad Nutr Diet*. 2019;119:585-598. doi:10.1016/j.jand.2018.11.013.
66. Blackberry ID, Furler JS, Best JD, et al. Effectiveness of general practice based, practice nurse led telephone coaching on glycaemic control of type 2 diabetes: the Patient Engagement and Coaching for Health (PEACH) pragmatic cluster randomised controlled trial. *BMJ*. 2013;347:f5272. doi:10.1136/bmj.f5272.
67. Bluml BM, Kolb LE, Lipman R. Evaluating the impact of year-long, augmented diabetes self-management support. *Popul Health Manag*. 2019;22:522-528. doi:10.1089/pop.2018.0175.
68. Bogner H, Morales KH, de Vries HF, Cappola AR. Integrated management of type 2 diabetes mellitus and depression treatment to improve medication adherence: a randomized controlled trial. *Ann Fam Med*. 2012;10:15-22. doi:10.1370/afm.1344.
69. Bohingamu Mudiyanselage S, Stevens J, Watts JJ, et al. Personalised telehealth intervention for chronic disease management: a pilot randomised controlled trial. *J Telemed Telecare*. 2019;25:343-352. doi:10.1177/1357633X18775850.
70. Lashkari T, Borhani F, Sabzevari S, Abbaszadeh A. Effect of telenursing (telephone follow-up) on glycemic control and body mass index (BMI) of type 2 diabetes patients. *Iran J Nurs Midwifery Res*. 2013;18:451-456.
71. Browning C, Chapman A, Yang H, et al. Management of type 2 diabetes in China: the Happy Life Club, a pragmatic cluster randomised controlled trial using health coaches. *BMJ Open*. 2016;6:e009319. doi:10.1136/bmjopen-2015-009319.
72. Bujnowska-Fedak MM, Puchała E, Steciwko A. The impact of telehome care on health status and quality of life among patients with diabetes in a primary care setting in Poland. *Telemed J E Health*. 2011;17:153-163. doi:10.1089/tmj.2010.0113.
73. Buysse H, Coremans P, Pouwer F, Ruige J. Sustainable improvement of HbA1c and satisfaction with diabetes care after adding telemedicine in patients on adaptable insulin regimens: results of the TeleDiabetes randomized controlled trial. *Health Informatics J*. 2020;26:628-641. doi:10.1177/1460458219844369.
74. Capozza K, Woolsey S, Georgsson M, et al. Going mobile with diabetes support: a randomized study of a text message-based personalized behavioral intervention for type 2 diabetes self-care. *Diabetes Spectr*. 2015;28:83-91. doi:10.2337/diaspect.28.2.83.
75. Carter EL, Nunlee-Bland G, Callender C. A patient-centric, provider-assisted diabetes telehealth self-management intervention for urban minorities. *Perspect Health Inf Manag*. 2011;8:1b.
76. Castelnuovo G, Manzoni GM, Cuzziol P, et al. TECNOB study: ad interim results of a randomized controlled trial of a multidisciplinary telecare intervention for obese patients with type-2 diabetes. *Clin Pract Epidemiol Ment Heal*. 2011;7:44-50. doi:10.1186/1471-2458-10-204.
77. Chao DY, Lin TM, Ma W-Y. Enhanced self-efficacy and behavioral changes among patients with diabetes: cloud-based mobile health platform and mobile app service. *JMIR Diabetes*. 2019;4:e11017. doi:10.2196/11017.
78. Chen HS, Wu TE, Jap TS, Lin SH, Hsiao LC, Lin HD. Improvement of glycaemia control in subjects with type 2 diabetes by self-monitoring of blood glucose: comparison of two management programs adjusting bedtime insulin dosage. *Diabetes Obes Metab*. 2008;10:34-40. doi:10.1111/j.1463-1326.2006.00676.x.
79. Chen T, Zhu W, Tang B, et al. A mobile phone informational reminder to improve eye care adherence among diabetic patients in rural China: a randomized controlled trial. *Am J Ophthalmol*. 2018;194:54-62. doi:10.1016/j.ajo.2018.07.006.
80. Chiu CJ, Hu YH, Wray LA, et al. Dissemination of evidence-base minimal psychological intervention for diabetes management in Taiwan adults with type 2 diabetes. *Int J Clin Exp Med*. 2016;9:14489-14498.
81. Cho JH, Chang SA, Kwon HS, et al. Long-term effect of the Internet-based glucose monitoring system on HbA1c reduction and glucose stability: a 30-month follow-up study for diabetes management with a ubiquitous medical care system. *Diabetes Care*. 2006;29:2625-2631. doi:10.2337/dc05-2371.
82. Cho JH, Kim H, Yoo SH, et al. An Internet-based health gateway device for interactive communication and automatic data uploading: clinical efficacy for type 2 diabetes in a multi-centre trial. *J Telemed Telecare*. 2017;23:595-604. doi:10.1177/1357633X16657500.
83. Choe HM, Mitrovich S, Dubay D, Hayward RA, Krein SL, Vijan S. Proactive case management of high-risk patients with type 2 diabetes mellitus by a clinical pharmacist: a randomized controlled trial. *Am J Manag Care*. 2005;11:253-260.
84. Choudhry NK, Isaac T, Lauffenburger JC, et al. Effect of a remotely delivered tailored multicomponent approach to enhance medication taking for patients with hyperlipidemia, hypertension, and diabetes the STIC2IT cluster randomized clinical trial. *JAMA Intern Med*. 2018;178:1190-1198. doi:10.1001/jamainternmed.2018.3189.
85. Clark M, Hampson SE, Avery L, Simpson R. Effects of a brief tailored intervention on the process and predictors of lifestyle behaviour change in patients with type 2 diabetes. *Psychol Heal Med*. 2004;9:440-449. doi:10.1080/13548500412331292250.
86. Crowley MJ, Powers BJ, Olsen MK, et al. The Cholesterol, Hypertension, and Glucose Education (CHANGE) study:

results from a randomized controlled trial in African Americans with diabetes. *Am Heart J*. 2013;166:179-186. doi:10.1016/j.ahj.2013.04.004.
87. Crowley MJ, Edelman D, McAndrew AT, et al. Practical telemedicine for veterans with persistently poor diabetes control: a randomized pilot trial. *Telemed J E Health*. 2016;22:376-384. doi:10.1089/tmj.2015.0145.
88. Dale J, Caramlau I, Sturt J, Friede T, Walker R. Telephone peer-delivered intervention for diabetes motivation and support: the telecare exploratory RCT. *Patient Educ Couns*. 2009;75:91-98. doi:10.1016/j.pec.2008.09.014.
89. Dario C, Toffanin R, Calcaterra F, et al. Telemonitoring of type 2 diabetes mellitus in Italy. *Telemed J E Health*. 2017;23:143-152. doi:10.1089/tmj.2015.0224.
90. Davis RM, Hitch AD, Salaam MM, Herman WH, Zimmer-Galler IE, Mayer-Davis EJ. TeleHealth improves diabetes self-management in an underserved community: diabetes TeleCare. *Diabetes Care*. 2010;33:1712-1717. doi:10.2337/dc09-1919.
91. Del Prato S, Nicolucci A, Lovagnini-Scher AC, Turco S, Leotta S, Vespasiani G. Telecare provides comparable efficacy to conventional self-monitored blood glucose in patients with type 2 diabetes titrating one injection of insulin glulisine—the ELEONOR study. *Diabetes Technol Ther*. 2012;14:175-182. doi:10.1089/dia.2011.0163.
92. Delahanty LM, Levy DE, Chang Y, et al. Effectiveness of lifestyle intervention for type 2 diabetes in primary care: the REAL HEALTH-diabetes randomized clinical trial. *J Gen Intern Med*. 2020;35:2637-2646. doi:10.1007/s11606-019-05629-9.
93. Dugas M, Crowley K, Gao GG, et al. Individual differences in regulatory mode moderate the effectiveness of a pilot mHealth trial for diabetes management among older veterans. *PLoS One*. 2018;13:e0192807. doi:10.1371/journal.pone.0192807.
94. Duruturk N, Özköslü MA. Effect of tele-rehabilitation on glucose control, exercise capacity, physical fitness, muscle strength and psychosocial status in patients with type 2 diabetes: a double blind randomized controlled trial. *Prim Care Diabetes*. 2019;13:542-548. doi:10.1016/j.pcd.2019.03.007.
95. Döbler A, Belnap BH, Pollmann H, Farin E, Raspe H, Mittag O. Telephone-delivered lifestyle support with action planning and motivational interviewing techniques to improve rehabilitation outcomes. *Rehabil Psychol*. 2018;63:170-181. doi:10.1037/rep0000224.
96. Eakin EG, Reeves MM, Winkler E, et al. Six-month outcomes from living well with diabetes: a randomized trial of a telephone-delivered weight loss and physical activity intervention to improve glycemic control. *Ann Behav Med*. 2013;46:193-203. doi:10.1007/s12160-013-9498-2.
97. Eakin EG, Winkler EA, Dunstan DW, et al. Living well with diabetes: 24-month outcomes from a randomized trial of telephone-delivered weight loss and physical activity intervention to improve glycemic control. *Diabetes Care*. 2014;37:2177-2185. doi:10.2337/dc13-2427.
98. Egede LE, Williams JS, Voronca DC, Knapp RG, Fernandes JK. Randomized controlled trial of technology-assisted case management in low income adults with type 2 diabetes. *Diabetes Technol Ther*. 2017;19:476-482. doi:10.1089/dia.2017.0006.
99. Egede LE, Walker RJ, Payne EH, Knapp RG, Acierno R, Frueh BC. Effect of psychotherapy for depression via home telehealth on glycemic control in adults with type 2 diabetes: subgroup analysis of a randomized clinical trial. *J Telemed Telecare*. 2018;24:596-602. doi:10.1177/1357633X17730419.
100. Estey AL, Tan MH, Mann K. Follow-up intervention: its effect on compliance behavior to a diabetes regimen. *Diabetes Educ*. 1990;16:291-295. doi:10.1177/014572179001600408.
101. Faridi Z, Liberti L, Shuval K, Northrup V, Ali A, Katz DL. Evaluating the impact of mobile telephone technology on type 2 diabetic patients' self-management: the NICHE pilot study. *J Eval Clin Pract*. 2008;14:465-469. doi:10.1111/j.1365-2753.2007.00881.x.
102. Farsaei S, Sabzghabaee A, Zargarzadeh A. Effect of pharmacist-led patient education on glycemic control of type 2 diabetes: a randomized controlled trial. *J Res Med Sci*. 2011;16:43-49.
103. Fernandes BSM, Reis IA, Torres HdC. Evaluation of the telephone intervention in the promotion of diabetes self-care: a randomized clinical trial. *Rev Lat Am Enfermagem*. 2016;24:e2719. doi:10.1590/1518-8345.0632.2719
104. Fortmann AL, Gallo LC, Garcia MI, et al. Dulce digital: an mHealth SMS-based intervention improves glycemic control in Hispanics with type 2 diabetes. *Diabetes Care*. 2017;40:1349-1355. doi:10.2337/dc17-0230.
105. Fottrell E, Ahmed N, Morrison J, et al. Community groups or mobile phone messaging to prevent and control type 2 diabetes and intermediate hyperglycaemia in Bangladesh (DMagic): a cluster-randomised controlled trial. *Lancet Diabetes Endocrinol*. 2019;7:200-212. doi:10.1016/S2213-8587(19)30001-4.
106. Fountoulakis S, Papanastasiou L, Gryparis A, Markou A, Piaditis G. Impact and duration effect of telemonitoring on HbA1c, BMI and cost in insulin-treated diabetes mellitus patients with inadequate glycemic control: a randomized controlled study. *Hormones*. 2015;14:632-643. doi:10.14310/horm.2002.1603.
107. Franc S, Hanaire H, Benhamou PY, et al. DIABEO system combining a mobile app software with and without telemonitoring versus standard care: a randomized controlled trial in diabetes patients poorly controlled with a basal-bolus insulin regimen. *Diabetes Technol Ther*. 2020;22:904-911. doi:10.1089/dia.2020.0021.
108. Franciosi M, Lucisano G, Pellegrini F, et al. ROSES: role of self-monitoring of blood glucose and intensive education in patients with type 2 diabetes not receiving insulin. A pilot randomized clinical trial. *Diabet Med*. 2011;28:789-796. doi:10.1111/j.1464-5491.2011.03268.x.
109. Frosch DL, Uy V, Ochoa S, Mangione CM. Evaluation of a behavior support intervention for patients with poorly controlled diabetes. *Arch Intern Med*. 2011;171:2011-2017. doi:10.1001/archinternmed.2011.497.
110. García AA, Brown SA, Horner SD, Zuñiga J, Arheart KL. Home-based diabetes symptom self-management education for Mexican Americans with type 2 diabetes. *Health Educ Res*. 2014;30:484-496. doi:10.1093/her/cyv018.
111. Garg R, Hurwitz S, Rein R, Schuman B, Underwood P, Bhandari S. Effect of follow-up by a hospital diabetes care team on diabetes control at one year after discharge from

the hospital. *Diabetes Res Clin Pract*. 2017;133:78-84. doi:10.1016/j.diabres.2017.08.014.
112. Gagliardino J, Arrechea V, Assad D, et al. Type 2 diabetes patients educated by other patients perform at least as well as patients trained by professionals. *Diabetes Metab Res Rev*. 2013;29:152-160. doi:10.1002/dmrr.
113. Wasif Gillani S. Determining effective diabetic care; a multicentre—longitudinal Interventional Study. *Curr Pharm Des*. 2016;22:6469-6476. doi:10.2174/1381612822666160813235704.
114. Gimbel RW, Rennert LM, Crawford P, et al. Enhancing patient activation and self-management activities in patients with type 2 diabetes using the US Department of Defense mobile health care environment: feasibility study. *J Med Internet Res*. 2020;22:e17968. doi:10.2196/17968.
115. Glasgow RE, Nutting PA, Toobert DJ, et al. Effects of a brief computer-assisted diabetes self-management intervention on dietary, biological and quality-of-life outcomes. *Chronic Illn*. 2006;2:27-38. doi:10.1179/174592006X93851.
116. Glasgow RE, Strycker LA, King DK, Toobert DJ, Rahm AK, Jex M. Robustness of a computer-assisted diabetes self-management intervention across patient characteristics, healthcare settings, and intervention staff. *Am J Manag Care*. 2006;12:137-145.
117. Glasgow R, Toobert D. Brief, computer-assisted diabetes dietary self-management counseling: effects on behavior, physiologic outcomes, and quality of life. *Med Care*. 2000;38:1062-1073.
118. Glasgow RE, Toobert DJ, Hampson SE, Strycker LA. Implementation, generalization and long-term results of the "choosing well" diabetes self-management intervention. *Patient Educ Couns*. 2002;48:115-122. doi:10.1016/S0738-3991(02)00025-3.
119. Glasgow R, Nutting P, King D, et al. Randomized effectiveness trial of a computer-assisted intervention to improve diabetes care. *Diabetes Care*. 2005;28:33-39.
120. Goodarzi M, Ebrahimzadeh I, Rabi A, Saedipoor B, Jafarabadi MA. Impact of distance education via mobile phone text messaging on knowledge, attitude, practice and self efficacy of patients with type 2 diabetes mellitus in Iran. *J Diabetes Metab Disord*. 2012;11:10. doi:10.1186/2251-6581-11-10.
121. Goodarzi F, Zahed S, Esfahani A, Nourian M, Zamani-Alavijeh F. The effects of mobile text messages on raising knowledge of men with type 2 diabetes. *Electron Physician*. 2018;10:7243-7248.
122. Graziano JA, Gross CR. A randomized controlled trial of an automated telephone intervention to improve glycemic control in type 2 diabetes. *Adv Nurs Sci*. 2009;32:42-57. doi:10.1097/ANS.0b013e3181b117a9.
123. Griffin SJ, Simmons RK, Prevost AT, et al. Multiple behaviour change intervention and outcomes in recently diagnosed type 2 diabetes: the ADDITION-Plus randomised controlled trial. *Diabetologia*. 2014;57:1308-1319. doi:10.1007/s00125-014-3236-6.
124. Gupta U, Gupta Y, Jose D, et al. Effectiveness of a video-based lifestyle education program compared to usual care in improving HbA1c and other metabolic parameters in individuals with type 2 diabetes: an open-label parallel arm randomized control trial (RCT). *Diabetes Ther*. 2020;11:667-679. doi:10.1007/s13300-020-00769-2.
125. Haider R, Hyun K, Cheung NW, Redfern J, Thiagalingam A, Chow CK. Effect of lifestyle focused text messaging on risk factor modification in patients with diabetes and coronary heart disease: a sub-analysis of the TEXT ME study. *Diabetes Res Clin Pract*. 2019;153:184-190. doi:10.1016/j.diabres.2019.04.030.
126. Hansen C, Perrild H, Koefoed B, Zander M. Video consultations as add-on to standard care among patients with type 2 diabetes not responding to standard regimens: a randomized controlled trial. *Eur J Endocrinol*. 2017;176:727-736.
127. Hare JL, Hordern MD, Leano R, Stanton T, Prins JB, Marwick TH. Application of an exercise intervention on the evolution of diastolic dysfunction in patients with diabetes mellitus efficacy and effectiveness. *Circ Hear Fail*. 2011;4:441-449. doi:10.1161/CIRCHEARTFAILURE.110.959312.
128. Hee-Sung K. Impact of web-based nurse's education on glycosylated haemoglobin in type 2 diabetic patients. *J Clin Nurs*. 2007;16;1361-1366. doi:10.1111/j.1365-2702.2005.01506.x.
129. Heisler M, Choi H, Mase R, Long J, Reeves PJ. Effectiveness of technologically enhanced peer support in improving glycemic management among predominantly African American, low-income adults with diabetes. *Diabetes Educ*. 2019;45:260-271. doi:10.1177/0145721719844547.
130. Hidrus A, Kueh YC, Norsaádah B, et al. Effects of brain breaks videos on the motives for the physical activity of Malaysians with type-2 diabetes mellitus. *Int J Environ Res Public Health*. 2020;17:2507. doi:10.3390/ijerph17072507.
131. Hokanson JM, Anderson RL, Hennrikus DJ, Lando HA, Kendall DM. Integrated tobacco cessation counseling in a diabetes self-management training program: a randomized trial of diabetes and reduction of tobacco. *Diabetes Educ*. 2006;32:562-570. doi:10.1177/0145721706289914.
132. Holbrook A, Thabane L, Keshavjee K, et al. Individualized electronic decision support and reminders to improve diabetes care in the community: COMPETE II randomized trial. *CMAJ*. 2009;181:37-44. doi:10.1503/cmaj.081272.
133. Holmen H, Torbjørnsen A, Wahl AK, et al. A mobile health intervention for self-management and lifestyle change for persons with type 2 diabetes, part 2: one-year results from the Norwegian randomized controlled trial RENEWING HEALTH. *JMIR Mhealth Uhealth*. 2014;2:e57. doi:10.2196/mhealth.3882.
134. Hordern MD, Coombes JS, Cooney LM, Jeffriess L, Prins JB, Marwick TH. Effects of exercise intervention on myocardial function in type 2 diabetes. *Heart*. 2009;95:1343-1349. doi:10.1136/hrt.2009.165571.
135. Huang Z, Tan E, Lum E, Sloot P, Boehm BO, Car J. A smartphone app to improve medication adherence in patients with type 2 diabetes in Asia: feasibility randomized controlled trial. *JMIR Mhealth Uhealth*. 2019;7:e14914. doi:10.2196/14914.
136. Huizinga MM, Gebretsadik T, Garcia Ulen C, et al. Preventing glycaemic relapse in recently controlled type 2 diabetes patients: a randomised controlled trial. *Diabetologia*. 2010;53:832-839. doi:10.1007/s00125-010-1658-3.
137. Hunt CW, Sanderson BK, Ellison KJ. Support for diabetes using technology: a pilot study to improve self-management. *Medsurg Nurs*. 2014;23:231-237.
138. Iljaž R, Brodnik A, Zrimec T, Cukjati I. E-healthcare for diabetes mellitus type 2 patients—a randomised controlled trial

in Slovenia. *Zdr Varst*. 2017;56:150-157. doi:10.1515/sjph-2017-0020.
139. Islam SMS, Peiffer R, Chow CK, et al. Cost-effectiveness of a mobile-phone text messaging intervention on type 2 diabetes—a randomized-controlled trial. *Heal Policy Technol*. 2020;9:79-85. doi:10.1016/j.hlpt.2019.12.003.
140. Jahangard-Rafsanjani Z, Sarayani A, Nosrati M, et al. Effect of a community pharmacist–delivered diabetes support program for patients receiving specialty medical care: a randomized controlled trial. *Diabetes Educ*. 2015;41:127-135. doi:10.1177/0145721714559132.
141. Jain V, Joshi R, Idiculla J, Xavier D. Community health worker interventions in type 2 diabetes mellitus patients: assessing the feasibility and effectiveness in Rural Central India. *J Cardiovasc Dis Res*. 2018;9:127-133. doi:10.5530/jcdr.2018.3.29.
142. Jarab AS, Alqudah SG, Mukattash TL, Shattat G, Al-Qirim T. Randomized controlled trial of clinical pharmacy management of patients with type 2 diabetes in an outpatient diabetes clinic in Jordan. *J Manag Care Pharm*. 2012;18:516-526.
143. Jennings CA, Vandelanotte C, Caperchione CM, Mummery WK. Effectiveness of a web-based physical activity intervention for adults with type 2 diabetes—a randomised controlled trial. *Prev Med*. 2014;60:33-40. doi:10.1016/j.ypmed.2013.12.011.
144. Jeong JY, Jeon JH, Bae KH, et al. Smart care based on telemonitoring and telemedicine for type 2 diabetes care: multicenter randomized controlled trial. *Telemed J E Health*. 2018;24:604-613. doi:10.1089/tmj.2017.0203.
145. Jiwani R, Wang J, Berndt A, et al. Changes in patient-reported outcome measures with a technology-supported behavioral lifestyle intervention among patients with type 2 diabetes: pilot randomized controlled clinical trial. *JMIR Diabetes*. 2020;5:e19268. doi:10.2196/19268.
146. Kardas P, Lewandowski K, Bromuri S. Type 2 diabetes patients benefit from the COMODITY12 mHealth system: results of a randomised trial. *J Med Syst*. 2016;40:259. doi:10.1007/s10916-016-0619-x.
147. Kassavou A, Mirzaei V, Brimicombe J, et al. A highly tailored text and voice messaging intervention to improve medication adherence in patients with either or both hypertension and type 2 diabetes in a UK primary care setting: feasibility randomized controlled trial of clinical effectiveness. *J Med Internet Res*. 2020;22:e16629. doi:10.2196/16629.
148. Kempf K, Altpeter B, Berger J, et al. Efficacy of the telemedical lifestyle intervention program TeLiPro in advanced stages of type 2 diabetes: a randomized controlled trial. *Diabetes Care*. 2017;40:863-871. doi:10.2337/dc17-0303.
149. Keogh KM, Smith SM, White P, et al. Psychological family intervention for poorly controlled type 2 diabetes. *Am J Manag Care*. 2011;17:105-113.
150. Kim SH, Utz S. Effectiveness of a social media-based, health literacy-sensitive diabetes self-management intervention: a randomized controlled trial. *J Nurs Scholarsh*. 2019;51:661-669. doi:10.1111/jnu.12521.
151. Kim HS. A randomized controlled trial of a nurse short-message service by cellular phone for people with diabetes. *Int J Nurs Stud*. 2007;44:687-692. doi:10.1016/j.ijnurstu.2006.01.011.
152. Kim HS, Jeong HS. A nurse short message service by cellular phone in type-2 diabetic patients for six months. *J Clin Nurs*. 2007;16:1082-1087. doi:10.1111/j.1365-2702.2007.01698.x.
153. Kim HS, Song MS. Technological intervention for obese patients with type 2 diabetes. *Appl Nurs Res*. 2008;21:84-89. doi:10.1016/j.apnr.2007.01.007.
154. Kim SI, Kim HS. Effectiveness of mobile and Internet intervention in patients with obese type 2 diabetes. *Int J Med Inform*. 2008;77:399-404. doi:10.1016/j.ijmedinf.2007.07.006.
155. Kim HS, Oh JA. Adherence to diabetes control recommendations: impact of nurse telephone calls. *J Adv Nurs*. 2003;44:256-261. doi:10.1046/j.1365-2648.2003.02800.x.
156. Kim HS, Oh JA, Lee HO. Effects of nurse-coordinated intervention on patients with type 2 diabetes in Korea. *J Nurs Care Qual*. 2005;20:154-160. doi:10.1097/00001786-200504000-00011.
157. Kim CJ, Kang DH. Utility of a web-based intervention for individuals with type 2 diabetes: the impact on physical activity levels and glycemic control. *Comput Informatics Nurs*. 2006;24:337-345. doi:10.1097/00024665-200611000-00008.
158. Kim MT, Han HR, Song HJ, et al. A community-based, culturally tailored behavioral intervention for Korean Americans with type 2 diabetes. *Diabetes Educ*. 2009;35:986-994. doi:10.1177/0145721709345774.
159. Kim CS, Park SY, Kang JG, et al. Insulin dose titration system in diabetes patients using a short messaging service automatically produced by a knowledge matrix. *Diabetes Technol Ther*. 2010;12:663-669. doi:10.1089/dia.2010.0031.
160. Kim KM, Park KS, Lee HJ, et al. Efficacy of a new medical information system, ubiquitous healthcare service with voice inception technique in elderly diabetic patients. *Sci Rep*. 2015;5:18214. doi:10.1038/srep18214.
161. Kim HS, Sun C, Yang SJ, et al. Randomized, open-label, parallel group study to evaluate the effect of Internet-based glucose management system on subjects with diabetes in China. *Telemed J E Health*. 2016;22:666-674. doi:10.1089/tmj.2015.0170.
162. King DK, Estabrooks PA, Strycker LA, Toobert DJ, Bull SS, Glasgow RE. Outcomes of a multifaceted physical activity regimen as part of a diabetes self-management intervention. *Ann Behav Med*. 2006;31:128-137. doi:10.1207/s15324796abm3102_4.
163. Kirkman MS, Weinberger M, Landsman PB, et al. A telephone-delivered intervention for patients with NIDDM: effect on coronary risk factors. *Diabetes Care*. 1994;17:840-846. doi:10.2337/diacare.17.8.840.
164. Kleinman NJ, Shah A, Shah S, Phatak S, Viswanathan V. Improved medication adherence and frequency of blood glucose self-testing using an m-health platform versus usual care in a multisite randomized clinical trial among people with type 2 diabetes in India. *Telemed J E Health*. 2017;23:733-740. doi:10.1089/tmj.2016.0265.
165. Krein SL, Klamerus ML, Vijan S, et al. Case management for patients with poorly controlled diabetes: a randomized trial. *Am J Med*. 2004;116:732-739. doi:10.1016/j.amjmed.2003.11.028.
166. Ku EJ, Park JI, Jeon HJ, Oh T, Choi HJ. Clinical efficacy and plausibility of a smartphone-based integrated online real-time diabetes care system via glucose and diet data management: a pilot study. *Intern Med J*. 2020;50:1524-1532. doi:10.1111/imj.14738.

167. Kusnanto Widyanata KAJ, Suprajitno, Arifin H. DM-calendar app as a diabetes self-management education on adult type 2 diabetes mellitus: a randomized controlled trial. *J Diabetes Metab Disord*. 2019;18:557-563. doi:10.1007/s40200-019-00468-1.
168. Kwon HS, Cho JH, Kim HS, et al. Establishment of blood glucose monitoring system using the Internet. *Diabetes Care*. 2004;27:478-483. doi:10.2337/diacare.27.2.478.
169. Lauffenburger JC, Ghazinouri R, Jan S, et al. Impact of a novel pharmacist-delivered behavioral intervention for patients with poorly-controlled diabetes: the ENhancing outcomes through Goal Assessment and Generating Engagement in Diabetes Mellitus (ENGAGE-DM) pragmatic randomized trial. *PLoS One*. 2019;14:e0214754. doi:10.1371/journal.pone.0214754.
170. Lazo-Porras M, Bernabe-Ortiz A, Taype-Rondan A, et al. Foot thermometry with mHeath-based supplementation to prevent diabetic foot ulcers: a randomized controlled trial. *Wellcome Open Res*. 2020;5:23. doi:10.12688/wellcomeopenres.15531.2.
171. Lee JY, Wong CP, Tan CSS, Nasir NH, Lee SWH. Telemonitoring in fasting individuals with type 2 diabetes mellitus during Ramadan: a prospective, randomised controlled study. *Sci Rep*. 2017;7:10119. doi:10.1038/s41598-017-10564-y.
172. Lee DY, Yoo SH, Min KP, Park CY. Effect of voluntary participation on mobile health care in diabetes management: randomized controlled open-label trial. *JMIR Mhealth Uhealth*. 2020;8:e19153. doi:10.2196/19153.
173. Lee JY, Chan CKY, Chua SS, et al. Telemonitoring and team-based management of glycemic control on people with type 2 diabetes: a cluster-randomized controlled trial. *J Gen Intern Med*. 2019;35:87-94. doi:10.1007/s11606-019-05316-9.
174. Li F, Yao P, Hsue C, Xu J, Lou Q. Impact of "Conversation Maps" on diabetes distress and self-efficacy of Chinese adult patients with type 2 diabetes: a pilot study. *Patient Prefer Adherence*. 2016;10:901-908. doi:10.2147/PPA.S95449.
175. Liebreich T, Plotnikoff RC, Courneya KS, Boulé N. Diabetes NetPLAY: a physical activity website and linked email counselling randomized intervention for individuals with type 2 diabetes. *Int J Behav Nutr Phys Act*. 2009;6:18. doi:10.1186/1479-5868-6-18.
176. Lim S, Kang SM, Shin H, et al. Improved glycemic control without hypoglycemia in elderly diabetic patients using the ubiquitous healthcare service, a new medical information system. *Diabetes Care*. 2011;34:308-313. doi:10.2337/dc10-1447.
177. Lim S, Kang SM, Kim KM, et al. Multifactorial intervention in diabetes care using real-time monitoring and tailored feedback in type 2 diabetes. *Acta Diabetol*. 2016;53:189-198. doi:10.1007/s00592-015-0754-8.
178. Lorig K, Ritter PL, Laurent DD, et al. Online diabetes self-management program: a randomized study. *Diabetes Care*. 2010;33:1275-1281. doi:10.2337/dc09-2153.
179. Lujan J, Ostwald SK, Ortiz M. Promotora diabetes intervention for Mexican Americans. *Diabetes Educ*. 2007;33:660-670. doi:10.1177/0145721707304080.
180. Luley C, Blaik A, Reschke K, Klose S, Westphal S. Weight loss in obese patients with type 2 diabetes: effects of telemonitoring plus a diet combination—the Active Body Control (ABC) Program. *Diabetes Res Clin Pract*. 2011;91:286-292. doi:10.1016/j.diabres.2010.11.020.
181. Lutes LD, Cummings DM, Littlewood K, Dinatale E, Hambidge B. A community health worker–delivered intervention in African American women with type 2 diabetes: a 12-month randomized trial. *Obesity*. 2017;25:1329-1335. doi:10.1002/oby.21883.
182. Lynch EB, Liebman R, Ventrelle J, Avery EF, Richardson DJ. A self-management intervention for African Americans with comorbid diabetes and hypertension: a pilot randomized controlled trial. *Prev Chronic Dis*. 2014;11:E90. doi:10.5888/pcd11.130349.
183. MacPhail M, Mullan B, Sharpe L, MacCann C, Todd J. Using the health action process approach to predict and improve health outcomes in individuals with type 2 diabetes mellitus. *Diabetes Metab Syndr Obes Targets Ther*. 2014;7:469-479. doi:10.2147/DMSO.S68428.
184. Marios T, Dalton S, Smart NA. The effect of tele-monitoring on exercise training adherence, functional capacity, quality of life and glycemic control in patients with type II diabetes. *J Sport Sci Med*. 2012;11:51-56.
185. Maslakpak MH, Razmara S, Niazkhani Z. Effects of face-to-face and telephone-based family-oriented education on self-care behavior and patient outcomes in type 2 diabetes: a randomized controlled trial. *J Diabetes Res*. 2017;2017:8404328. doi:10.1155/2017/8404328.
186. Mayberry LS, Berg CA, Greevy RA, et al. Mixed-methods randomized evaluation of FAMS: a mobile phone-delivered intervention to improve family/friend involvement in adults' type 2 diabetes self-care. *Ann Behav Med*. 2021;55:165-178. doi:10.1093/abm/kaaa041.
187. McEwen MM, Pasvogel A, Murdaugh C, Hepworth J. Effects of a family-based diabetes intervention on behavioral and biological outcomes for Mexican American adults. *Diabetes Educ*. 2017;43:272-285. doi:10.1177/0145721717706031.
188. McKay HG, King D, Eakin EG, Seeley JR, Glasgow RE. The Diabetes Network Internet-based physical activity intervention. *Diabetes Care*. 2001;24:1328-1334.
189. McKay HG, Glasgow RE, Feil EG, Boles SM, Barrera MJ. Internet-based diabetes self-management and support: initial outcomes from the Diabetes Network project. *Rehabil Psychol*. 2002;47:31-48. doi:10.1037/0090-5550.47.1.31.
190. McKee MD, Fletcher J, Sigal I, Giftos J, Schechter C, Walker EA. A collaborative approach to control hypertension in diabetes: outcomes of a pilot intervention. *J Prim Care Community Health*. 2011;2:148-152. doi:10.1177/2150131911401028.
191. McMahon GT, Fonda SJ, Gomes HE, Alexis G, Conlin PR. A randomized comparison of online- and telephone-based care management with Internet training alone in adult patients with poorly controlled type 2 diabetes. *Diabetes Technol Ther*. 2012;14:1060-1067. doi:10.1089/dia.2012.0137.
192. Mease A. Telemedicine improved diabetic management. *Mil Med*. 2000;165:579-584. doi:10.1093/milmed/165.8.579.
193. Mons U, Raum E, Krämer HU, et al. Effectiveness of a supportive telephone counseling intervention in type 2 diabetes patients: randomized controlled study. *PLoS One*. 2013;8:e77954. doi:10.1371/journal.pone.0077954.
194. Moriyama M, Nakano M, Kuroe Y, Nin K, Niitani M, Nakaya T. Efficacy of a self-management education

program for people with type 2 diabetes: results of a 12 month trial. *Japan J Nurs Sci*. 2009;6:51-63. doi:10.1111/j.1742-7924.2009.00120.x.

195. Mwangi N, Bascaran C, Ng'ang'a M, et al. Feasibility of a cluster randomized controlled trial on the effectiveness of peer–led health education interventions to increase uptake of retinal examination for diabetic retinopathy in Kirinyaga, Kenya: a pilot trial. *Pilot Feasibility Stud*. 2020;6:102. doi:10.1186/s40814-020-00644-8.
196. Namjoo Nasab M, Ghavam A, Yazdanpanah A, Jahangir F, Shokrpour N. Effects of self-management education through telephone follow-up in diabetic patients. *Health Care Manag (Frederick)*. 2017;36:273-281. doi:10.1097/HCM.0000000000000172.
197. Nesari M, Zakerimoghadam M, Rajab A, Bassampour S, Faghihzadeh S. Effect of telephone follow-up on adherence to a diabetes therapeutic regimen. *Japan J Nurs Sci*. 2010;7:121-128. doi:10.1111/j.1742-7924.2010.00146.x.
198. Nicolucci A, Cercone S, Chiriatti A, et al. A randomized trial on home telemonitoring for the management of metabolic and cardiovascular risk in patients with type 2 diabetes. *Diabetes Technol Ther*. 2015;17:563-570. doi:10.1089/dia.2014.0355.
199. Niswender K, Piletic M, Andersen H, Conradsen Hiort L, Hollander P. Weight change upon once-daily initiation of insulin detemir with or without dietary intervention in overweight or obese insulin-naïve individuals with type 2 diabetes: results from the DIET trial. *Diabetes Obes Metab*. 2014;16:186-192. doi:10.1111/dom.12218.
200. O'Neil PM, Miller-Kovach K, Tuerk PW, et al. Randomized controlled trial of a nationally available weight control program tailored for adults with type 2 diabetes. *Obesity*. 2016;24:2269-2277. doi:10.1002/oby.21616.
201. Odegard P, Christensen D. MAP study: RCT of a medication adherence program for patients with type 2 diabetes. *J Am Pharm Assoc (2003)*. 2012;52:753-762.
202. Odnoletkova I, Goderis G, Nobels F, et al. Optimizing diabetes control in people with Type 2 diabetes through nurse-led telecoaching. *Diabet Med*. 2016;33:777-785. doi:10.1111/dme.13092.
203. Oh JA, Kim HS, Yoon KH, Choi ES. A telephone-delivered intervention to improve glycemic control in type 2 diabetic patients. *Yonsei Med J*. 2003;44:1-8.
204. Orsama AL, Lähteenmäki J, Harno K, et al. Active assistance technology reduces glycosylated hemoglobin and weight in individuals with type 2 diabetes: results of a theory-based randomized trial. *Diabetes Technol Ther*. 2013;15:662-669. doi:10.1089/dia.2013.0056.
205. Owolabi EO, Goon D, Ter Ajayi AI. Efficacy, acceptability and feasibility of daily text-messaging in promoting glycaemic control and other clinical outcomes in a low-resource setting of South Africa: a randomised controlled trial. *PLoS One*. 2019;14:e0224791. doi:10.1371/journal.pone.0224791.
206. Parsons SN, Luzio SD, Harvey JN, et al. Effect of structured self-monitoring of blood glucose, with and without additional TeleCare support, on overall glycaemic control in non-insulin treated Type 2 diabetes: the SMBG Study, a 12-month randomized controlled trial. *Diabet Med*. 2019;36:578-590. doi:10.1111/dme.13899.
207. Patja K, Absetz P, Auvinen A, et al. Health coaching by telephony to support self-care in chronic diseases: clinical outcomes from The TERVA randomized controlled trial. *BMC Health Serv Res*. 2012;12:147. doi:10.1186/1472-6963-12-147.
208. Peasah SK, Granitz K, Vu M, Jacob B. Effectiveness of a student pharmacist-led telephone follow-up intervention to improve hemoglobin A_{1C} in diabetic patients. *J Pharm Pract*. 2020;33:832-837. doi:10.1177/0897190019857409.
209. Peimani M, Rambod C, Omidvar M, et al. Effectiveness of short message service-based intervention (SMS) on self-care in type 2 diabetes: a feasibility study. *Prim Care Diabetes*. 2016;10:251-258. doi:10.1016/j.pcd.2015.11.001.
210. Piette J, Richardson C, Himle J, et al. A randomized trial of telephone counseling plus walking for depressed diabetes patients. *Med Care*. 2011;49:641-648. doi:10.1038/jid.2014.371.
211. Plotnikoff RC, Karunamuni N, Courneya KS, Sigal RJ, Johnson JA, Johnson ST. The Alberta diabetes and physical activity trial (ADAPT): a randomized trial evaluating theory-based interventions to increase physical activity in adults with type 2 diabetes. *Ann Behav Med*. 2013;45:45-56. doi:10.1007/s12160-012-9405-2.
212. Presley C, Agne A, Shelton T, Oster R, Cherrington A. Mobile-enhanced peer support for African Americans with type 2 diabetes: a randomized controlled trial. *J Gen Intern Med*. 2020;35:2889-2896. doi:10.1007/s11606-020-06011-w.
213. Quinn CC, Swasey KK, Crabbe JCF, et al. The impact of a mobile diabetes health intervention on diabetes distress and depression among adults: secondary analysis of a cluster randomized controlled trial. *JMIR Mhealth Uhealth*. 2017;5:e183. doi:10.2196/mhealth.8910.
214. Quinn CC, Shardell MD, Terrin ML, Barr EA, Ballew SH, Gruber-Baldini AL. Cluster-randomized trial of a mobile phone personalized behavioral intervention for blood glucose control. *Diabetes Care*. 2011;34:1934-1942. doi:10.2337/dc11-0366.
215. Raj JP, Mathews B. Effect of behavioral intervention on medication adherence among elderly with select noncommunicable diseases (ENDORSE): pilot randomized controlled trial. *Geriatr Gerontol Int*. 2020;20:1079-1084. doi:10.1111/ggi.14032.
216. Ralston JD, Hirsch IB, Hoath J, Mullen M, Cheadle A, Goldberg HI. Web-based collaborative care for type 2 diabetes a pilot randomized trial. *Diabetes Care*. 2009;32:234-239. doi:10.2337/dc08-1220.
217. Ramadas A, Chan CKY, Oldenburg B, Hussein Z, Quek KF. Randomised-controlled trial of a web-based dietary intervention for patients with type 2 diabetes: changes in health cognitions and glycemic control. *BMC Public Health*. 2018;18:716. doi:10.1186/s12889-018-5640-1.
218. Rasmussen OW, Lauszus FF, Loekke M. Telemedicine compared with standard care in type 2 diabetes mellitus: a randomized trial in an outpatient clinic. *J Telemed Telecare*. 2016;22:363-368. doi:10.1177/1357633X15608984.
219. Rodríguez-Idígoras MI, Sepúlveda-Muñoz J, Sánchez-Garrido-Escudero R, et al. Telemedicine influence on the follow-up of type 2 diabetes patients. *Diabetes Technol Ther*. 2009;11:431-437. doi:10.1089/dia.2008.0114.

220. Ruggiero L, Riley BB, Hernandez R, et al. Medical assistant coaching to support diabetes self-care among low-income racial/ethnic minority populations: randomized controlled trial. *West J Nurs Res*. 2014;36:1052-1073. doi:10.1177/0193945914522862.
221. Sacco WP, Malone JI, Morrison AD, Friedman A, Wells K. Effect of a brief, regular telephone intervention by paraprofessionals for type 2 diabetes. *J Behav Med*. 2009;32:349-359. doi:10.1007/s10865-009-9209-4.
222. Sacco WP, Bykowski CA, Mayhew LL, White KE. Educational attainment moderates the effect of a brief diabetes self-care intervention. *Diabetes Res Clin Pract*. 2012;95:62-67. doi:10.1016/j.diabres.2011.08.027.
223. Samuel-Hodge CD, Keyserling TC, Park S, Johnston LF, Gizlice Z, Bangdiwala SI. A randomized trial of a church-based diabetes self-management program for African Americans with type 2 diabetes. *Diabetes Educ*. 2009;35:439-454. doi:10.1177/0145721709333270.
224. Sarayani A, Mashayekhi M, Nosrati M, et al. Efficacy of a telephone-based intervention among patients with type-2 diabetes; a randomized controlled trial in pharmacy practice. *Int J Clin Pharm*. 2018;40:345-353. doi:10.1007/s11096-018-0593-0.
225. Saslow LR, Moskowitz JT, Mason AE, et al. Intervention enhancement strategies among adults with type 2 diabetes in a very low-carbohydrate web-based program: evaluating the impact with a randomized trial. *JMIR Diabetes*. 2020;5:e15835. doi:10.2196/15835.
226. Sazlina SG, Browning CJ, Yasin S. Effectiveness of personalized feedback alone or combined with peer support to improve physical activity in sedentary older Malays with type 2 diabetes: a randomized controlled trial. *Front Public Heal*. 2015;3:178. doi:10.3389/fpubh.2015.00178.
227. Schillinger D, Handley M, Wang MS, Hammer H. Effects of self-management support on structure, process, and outcomes among vulnerable patients with diabetes: a three-arm practical clinical trial. *Diabetes Care*. 2009;32:559-566. doi:10.2337/dc08-0787.
228. Shahid M, Mahar SA, Shaikh S, Shaikh ZUD. Mobile phone intervention to improve diabetes care in rural areas of Pakistan: a randomized controlled trial. *J Coll Physicians Surg Pak*. 2015;25:166-171. doi:03.2015/JCPSP.166171.
229. Shahsavari A, Bakhshandeh Bavarsad M. Is telenursing an effective method to control BMI and HbA1c in illiterate patients aged 50 years and older with type 2 diabetes? a randomized controlled clinical trial. *J Caring Sci*. 2020;9:73-79. doi:10.34172/jcs.2020.011.
230. Shetty AS, Chamukuttan S, Nanditha A, Raj RKC, Ramachandran A. Reinforcement of adherence to prescription recommendations in Asian Indian diabetes patients using short message service (SMS)—a pilot study. *J Assoc Physicians India*. 2011;59:711-714.
231. Shreck E, Gonzalez JS, Cohen HW, Walker EA. Risk perception and self-management in urban, diverse adults with type 2 diabetes: the improving diabetes outcomes study. *Int J Behav Med*. 2014;21:88-98. doi:10.1007/s12529-013-9291-4.
232. Sigurdardottir AK, Benediktsson R, Jonsdottir H. Instruments to tailor care of people with type 2 diabetes. *J Adv Nurs*. 2009;65:2118-2130. doi:10.1111/j.1365-2648.2009.05040.x.
233. Skelly AH, Carlson J, Leeman J, Soward A, Burns D. Controlled trial of nursing interventions to improve health outcomes of older African American women with type 2 diabetes. *Nurs Res*. 2009;58:410-418.
234. Sone H, Katagiri A, Ishibashi S, et al. Effects of lifestyle modifications on patients with type 2 diabetes: the Japan Diabetes Complications Study (JDCS) study design, baseline analysis and three year-interim report. *Horm Metab Res*. 2002;34:509-515. doi:10.1055/s-2002-34791.
235. Sone H, Tanaka S, Iimuro S, et al. Long-term lifestyle intervention lowers the incidence of stroke in Japanese patients with type 2 diabetes: a nationwide multicentre randomised controlled trial (the Japan Diabetes Complications Study). *Diabetologia*. 2010;53:419-428. doi:10.1007/s00125-009-1622-2.
236. Song MS, Kim HS. Intensive management program to improve glycosylated hemoglobin levels and adherence to diet in patients with type 2 diabetes. *Appl Nurs Res*. 2009;22:42-47. doi:10.1016/j.apnr.2007.05.004.
237. Spencer MS, Kieffer EC, Sinco B, et al. Outcomes at 18 months from a community health worker and peer leader diabetes self-management program for Latino adults. *Diabetes Care*. 2018;41:1414-1422. doi:10.2337/dc17-0978.
238. Steventon A, Bardsley M, Doll H, Tuckey E, Newman SP. Effect of telehealth on glycaemic control: analysis of patients with type 2 diabetes in the Whole Systems Demonstrator cluster randomised trial. *BMC Health Serv Res*. 2014;14:334. doi:10.1186/1472-6963-14-334.
239. Sun C, Sun L, Xi S, et al. Mobile phone–based telemedicine practice in older Chinese patients with type 2 diabetes mellitus: randomized controlled trial. *JMIR Mhealth Uhealth*. 2019;7:e10664. doi:10.2196/10664.
240. Sunil Kumar D, Prakash B, Subhash Chandra BJ, et al. Technological innovations to improve health outcome in type 2 diabetes mellitus: a randomized controlled study. *Clin Epidemiol Glob Heal*. 2021;9:53-56. doi:10.1016/j.cegh.2020.06.011.
241. Takenga C, Berndt RD, Musongya O, et al. An ICT-based diabetes management system tested for health care delivery in the African context. *Int J Telemed Appl*. 2014;2014:437307. doi:10.1155/2014/437307.
242. Tamban C, Isip-Tan IT, Jimeno C. Use of short message services (SMS) for the management of type 2 diabetes mellitus: a randomized controlled trial. *J ASEAN Fed Endocr Soc*. 2013;28:143-149. doi:10.15605/jafes.028.02.08.
243. Tan CCL, Cheng KKF, Hwang SW, Zhang N, Holydard E, Wang W. Effect of a diabetes self-efficacy enhancing program on older adults with type 2 diabetes: a randomized controlled trial. *Clin Nurs Res*. 2020;29:293-303. doi:10.1177/1054773818792480.
244. Tang PC, Overhage JM, Chan AS, et al. Online disease management of diabetes: engaging and motivating patients online with enhanced resources-diabetes (EMPOWER-D), a randomized controlled trial. *J Am Med Informatics Assoc*. 2013;20:526-534. doi:10.1136/amiajnl-2012-001263.
245. Teston EF, Arruda GO, de Sales CA, Serafim D, Marcon SS. Nursing appointment and cardiometabolic control of diabetics: a randomized clinical trial. *Rev Bras Enferm*. 2017;70:468-474. doi:10.1590/0034-7167-2016-0352.
246. Thom DH, Ghorob A, Hessler D, DeVore D, Chen E, Bodenheimer TA. Impact of peer health coaching on

glycemic control in low-income patients with diabetes: a randomized controlled trial. *Ann Fam Med*. 2013;11:137-144. doi:10.1370/afm.1443.

247. Torbjørnsen A, Jenum AK, Småstuen MC, et al. A low-intensity mobile health intervention with and without health counseling for persons with type 2 diabetes, part 1: baseline and short-term results from a randomized controlled trial in the Norwegian part of RENEWING HEALTH. *JMIR Mhealth Uhealth*. 2014;2:e52. doi:10.2196/mhealth.3535.
248. Tu KS, McDaniel G, Templeton Gay J. Diabetes self-care knowledge, behaviors, and metabolic control of older adults—the effect of a posteducational follow-up program. *Diabetes Educ*. 1993;19:25-30. doi:10.1177/014572179301900105.
249. Van Dyck D, De Greef K, Deforche B, et al. The relationship between changes in steps/day and health outcomes after a pedometer-based physical activity intervention with telephone support in type 2 diabetes patients. *Health Educ Res*. 2013;28:539-545. doi:10.1093/her/cyt038.
250. Van Dyck D, De Greef K, Deforche B, et al. Mediators of physical activity change in a behavioral modification program for type 2 diabetes patients. *Int J Behav Nutr Phys Act*. 2011;8:105. doi:10.1186/1479-5868-8-105.
251. Van Vugt M, De Wit M, Sieverink F, et al. Uptake and effects of the e-vita personal health record with self-management support and coaching, for type 2 diabetes patients treated in primary care. *J Diabetes Res*. 2016;2016:5027356. doi:10.1155/2016/5027356.
252. Varney JE, Weiland TJ, Inder WJ, Jelinek GA. Effect of hospital-based telephone coaching on glycaemic control and adherence to management guidelines in type 2 diabetes, a randomised controlled trial. *Intern Med J*. 2014;44:890-897. doi:10.1111/imj.12515.
253. Vaughan EM, Hyman DJ, Naik AD, Samson SL, Razjouyan J, Foreyt JP. A Telehealth-supported, Integrated care with CHWs, and MEdication-access (TIME) program for diabetes improves HbA1c: a randomized clinical trial. *J Gen Intern Med*. 2021;36:455-463. doi:10.1007/s11606-020-06017-4.
254. Vervloet M, van Dijk L, de Bakker DH, et al. Short- and long-term effects of real-time medication monitoring with short message service (SMS) reminders for missed doses on the refill adherence of people with type 2 diabetes: evidence from a randomized controlled trial. *Diabet Med*. 2014;31:821-828. doi:10.1111/dme.12439.
255. Vinitha R, Nanditha A, Snehalatha C, et al. Effectiveness of mobile phone text messaging in improving glycaemic control among persons with newly detected type 2 diabetes. *Diabetes Res Clin Pract*. 2019;158:107919. doi:10.1016/j.diabres.2019.107919.
256. Von Storch K, Graaf E, Wunderlich M, Rietz C, Polidori MC, Woopen C. Telemedicine-assisted self-management program for type 2 diabetes patients. *Diabetes Technol Ther*. 2019;21:514-521. doi:10.1089/dia.2019.0056.
257. Wakefield BJ, Holman JE, Ray A, et al. Effectiveness of home telehealth in comorbid diabetes and hypertension: a randomized, controlled trial. *Telemed J E Health*. 2011;17:254-261. doi:10.1089/tmj.2010.0176.
258. Wakefield BJ, Holman JE, Ray A, et al. Outcomes of a home telehealth intervention for patients with diabetes and hypertension. *Telemed J E Health*. 2012;18:575-579. doi:10.1089/tmj.2011.0237.
259. Wakefield BJ, Koopman RJ, Keplinger LE, et al. Effect of home telemonitoring on glycemic and blood pressure control in primary care clinic patients with diabetes. *Telemed J E Health*. 2014;20:199-205. doi:10.1089/tmj.2013.0151.
260. Waki K, Fujita H, Uchimura Y, et al. DialBetics: a novel smartphone-based self-management support system for type 2 diabetes patients. *J Diabetes Sci Technol*. 2014;8:209-215. doi:10.1177/1932296814526495.
261. Walker EA, Shmukler C, Ullman R, Blanco E, Scollan-Koliopoulus M, Cohen HW. Results of a successful telephonic intervention to improve diabetes control in urban adults: a randomized trial. *Diabetes Care*. 2011;34:2-7. doi:10.2337/dc10-1005.
262. Wang X, Liu D, Du M, Hao R, Zheng H, Yan C. The role of text messaging intervention in Inner Mongolia among patients with type 2 diabetes mellitus: a randomized controlled trial. *BMC Med Inform Decis Mak*. 2020;20:90. doi:10.1186/s12911-020-01129-7.
263. Wang Y, Li M, Zhao X, et al. Effects of continuous care for patients with type 2 diabetes using mobile health application: a randomised controlled trial. *Int J Health Plann Manage*. 2019;34:1025-1035. doi:10.1002/hpm.2872.
264. Wang G, Zhang Z, Feng Y, et al. Telemedicine in the management of type 2 diabetes mellitus. *Am J Med Sci*. 2017;353:1-5.
265. Warren R, Carlisle K, Mihala G, Scuffham PA. Effects of telemonitoring on glycaemic control and healthcare costs in type 2 diabetes: a randomised controlled trial. *J Telemed Telecare*. 2018;24:586-595. doi:10.1177/1357633X17723943.
266. Weinberger M, Kirkman MS, Saa GP, et al. A nurse-coordinated intervention for primary care patients with non-insulin-dependent diabetes mellitus: impact on glycemic control and health-related quality of life. *J Gen Intern Med*. 1995;10:59-66. doi:10.1007/BF02600227.
267. Whittemore R, Melkus G, Sullivan A, Grey M. A nurse-coaching intervention for women with type 2 diabetes. *Diabetes Educ*. 2004;30:795-804. doi:10.1177/014572170403000515.
268. Wichit N, Mnatzaganian G, Courtney M, Schulz P, Johnson M. Randomized controlled trial of a family-oriented self-management program to improve self-efficacy, glycemic control and quality of life among Thai individuals with type 2 diabetes. *Diabetes Res Clin Pract*. 2017;123:37-48. doi:10.1016/j.diabres.2016.11.013.
269. Wild SH, Hanley J, Lewis SC, et al. Supported telemonitoring and glycemic control in people with type 2 diabetes: the telescot diabetes pragmatic multicenter randomized controlled trial. *PLoS Med*. 2016;13:e1002098. doi:10.1371/journal.pmed.1002098.
270. Williams ED, Bird D, Forbes AW, et al. Randomised controlled trial of an automated, interactive telephone intervention (TLC Diabetes) to improve type 2 diabetes management: baseline findings and six-month outcomes. *BMC Public Health*. 2012;12:602. doi:10.1186/1471-2458-12-602.
271. Williams M, Cairns S, Simmons D, Rush E. Face-to-face versus telephone delivery of the green prescription for Māori and New Zealand Europeans with type-2 diabetes mellitus: influence on participation and health outcomes. *N Z Med J*. 2017;130:71-79.
272. Wolever RQ, Dreusicke M, Fikkan J, et al. Integrative health coaching for patients with type 2 diabetes: a

randomized clinical trial. *Diabetes Educ*. 2010;36:629-639. doi:10.1177/0145721710371523.
273. Wolf A, Conaway M, Crowther J, et al. Translating lifestyle intervention to practice in obese patients with type 2 diabetes. *Diabetes Care*. 2004;27:1570-1576.
274. Wu CJJ, Sung HC, Chang AM, Atherton J, Kostner K, McPhail SM. Cardiac-diabetes self-management program for Australians and Taiwanese: a randomized blocked design study. *Nurs Heal Sci*. 2017;19:307-315. doi:10.1111/nhs.12346.
275. Yang Y, Lee EY, Kim HS, Lee SH, Yoon KH, Cho JH. Effect of a mobile phone-based glucose-monitoring and feedback system for type 2 diabetes management in multiple primary care clinic settings: cluster randomized controlled trial. *JMIR Mhealth Uhealth*. 2020;8:e16266. doi:10.2196/16266.
276. Yasmin F, Yasmin F, Nahar N, et al. The influence of mobile phone-based health reminders on patient adherence to medications and healthy lifestyle recommendations for effective management of diabetes type 2: a randomized control trial in Dhaka, Bangladesh. *BMC Health Serv Res*. 2020;20:520. doi:10.1186/s12913-020-05387-z.
277. Yoo HJ, Park MS, Kim TN, et al. A Ubiquitous Chronic Disease Care system using cellular phones and the Internet. *Diabet Med*. 2009;26:628-635. doi:10.1111/j.1464-5491.2009.02732.x.
278. Yoon KH, Kim HS. A short message service by cellular phone in type 2 diabetic patients for 12 months. *Diabetes Res Clin Pract*. 2008;79:256-261. doi:10.1016/j.diabres.2007.09.007.
279. Young R, Taylor J, Friede T, et al. Pro-active call center treatment support (PACCTS) to improve glucose control in type 2 diabetes: a randomized controlled trial. *Diabetes Care*. 2005;28:278-282.
280. Yu Y, Yan Q, Li H, et al. Effects of mobile phone application combined with or without self-monitoring of blood glucose on glycemic control in patients with diabetes: a randomized controlled trial. *J Diabetes Investig*. 2019;10:1365-1371. doi:10.1111/jdi.13031.
281. Zamanzadeh V, Zirak M, Hemmati Maslakpak M, Parizad N. Distance education and diabetes empowerment: a single-blind randomized control trial. *Diabetes Metab Syndr Clin Res Rev*. 2017;11:S247-S251. doi:10.1016/j.dsx.2016.12.039.
282. Zhou P, Xu L, Liu X, Huang J, Xu W, Chen W. Web-based telemedicine for management of type 2 diabetes through glucose uploads: a randomized controlled trial. *Int J Clin Exp Pathol*. 2014;7:8848-8854.
283. Wu C, Wu Z, Yang L, et al. Evaluation of the clinical outcomes of telehealth for managing diabetes: a PRISMA-compliant meta-analysis. *Medicine (Baltimore)*. 2018;97:e12962. doi:10.1097/MD.0000000000012962.
284. Tchero H, Kangambega P, Briatte C, Brunet-Houdard S, Retali GR, Rusch E. Clinical effectiveness of telemedicine in diabetes mellitus: a meta-analysis of 42 randomized controlled trials. *Telemed J E Health*. 2019;25:569-583. doi:10.1089/tmj.2018.0128.
285. Ekeland AG, Bowes A, Flottorp S. Methodologies for assessing telemedicine: a systematic review of reviews. *Int J Med Inform*. 2012;81:1-11. doi:10.1016/j.ijmedinf.2011.10.009.
286. Soriano JB, García-Río F, Vázquez-Espinosa E, et al. A multicentre, randomized controlled trial of telehealth for the management of COPD. *Respir Med*. 2018;144:74-81. doi:10.1016/j.rmed.2018.10.008.
287. Shojania KG, Ranji SR, McDonald KM, et al. Effects of quality improvement strategies for type 2 diabetes on glycemic control: a meta-regression analysis. *JAMA*. 2006;296:427-440. doi:10.2337/diaclin.25.4.155.