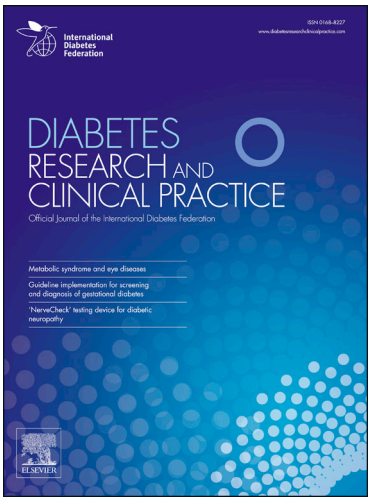

Mobile Phone Text Messaging in Improving Glycaemic Control for Patients with Type 2 Diabetes Mellitus: A Systematic Review and Meta-Analysis

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Mobile Phone Text Messaging in Improving Glycaemic Control for Patients with Type 2 Diabetes Mellitus: A Systematic Review and Meta-Analysis[1]

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[1] This review was presented as a poster in the Australasian Diabetes Congress, held from 22nd to 24th of August 2018, in Adelaide, Australia.

Background: Mobile health is the use of mobile technology in developing healthcare, with the aim of reminding and motivating patients to adopt a healthy lifestyle. We conducted a systematic review assessing the effectiveness of text-messaging interventions on HbA1c in patients with Type 2 diabetes mellitus (T2DM).

Methods: Two authors independently searched MEDLINE, Embase, CINAHL, Cochrane Register of Randomized Control Trials and PsychInfo. The review included randomized control trials with at least 4 weeks follow up, evaluating the effect of text messaging on HbA1c, in patients with T2DM. Trials involving participants with Type 1 diabetes mellitus, pre-diabetes or gestational diabetes, or other forms of telemedicine were excluded. Studies employing bi-directional messaging were excluded.

Results: 208 papers were identified as meeting inclusion criteria and their abstracts reviewed. Of these, we examined the full text article of forty-four studies. Eleven randomized controlled trials were included in the final review, with a total of 1710 participants. One study focused on medication adherence only, while the remaining had educational and motivational messages. Five studies showed a significant improvement in HbA1c with the intervention. The remaining studies demonstrated a trend to improvement in HbA1c. Our meta-analysis on 9 of the 11 studies found an overall reduction in HbA1c of 0.38% (-0.53;-0.23, p-value <0.001).

Conclusion: Lifestyle-focused text messaging is a low cost initiative aimed at motivating patients with T2DM to adhere to a healthy lifestyle. We demonstrate that lifestyle focused text messaging is effective, with a significant improvement in HbA1c in the meta-analysis.

Introduction

Type 2 diabetes mellitus (T2DM) is a growing epidemic in Australia and worldwide. According to the World Health Organisation (WHO), the number of people with diabetes in 2014 was 422 million, and the global prevalence was 8.5% (1). With the high burden of disease generated by diabetes, there is an immense need to develop simple, low cost approaches to encourage patients with diabetes to lead a healthy lifestyle. Effective diabetes management with oral mediation, insulin administration, and regular contact with health care providers is associated with improved glycaemic control. It is well established that even small improvements in glycaemic control are associated with reduction in potentially debilitating long-term micro and macro vascular complications.

Mobile health is the use of mobile and wireless technology in facilitating healthcare, which has the potential to provide low cost initiatives on a large scale. Mobile phone text messages can remind and motivate patients to adopt a healthy lifestyle, in turn supporting self-management of their disease. The TEXTME randomized control trial (RCT) involving 710 participants at Westmead Hospital demonstrated that a 6 month text messaging program improved LDL cholesterol (LDL-c), blood pressure, body mass index (BMI), physical activity and encouraged smoking cessation in patients with cardiovascular disease. (2) These findings are consistent with other studies on text messaging, which have demonstrated favourable outcomes in promoting short-term weight loss and smoking cessation. (3)(4) A systematic review of 111 eligible RCTs evaluated the effectiveness of telemedicine on glycated haemoglobin in diabetes and found that telemedicine achieved significant reductions in HbA1c during all 3 follow up periods (<3 months, 4-12 months and >12 months). (5)

A number of systematic reviews have provided evidence for the effectiveness of mobile phone based interventions for management of chronic disease. (6)(7)(8). However, there are few up to date meta-analyses done on text messaging interventions in a diabetes cohort. Our systematic review examines unidirectional text messaging, with a focus on lifestyle management, in improving glycaemic control in patients with Type 2 diabetes mellitus. Our secondary outcomes include assessing the acceptability of these interventions by participants

enrolled in the trials, as well as reduction in cardiovascular risk factors. We have also conducted a meta-analysis to synthesize data from all published trials to date.

Methods

This review was written and detailed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) statement and the Cochrane Collaboration reporting items for systematic reviews and meta-analyses. (9) The review was registered in the International Prospective Register of Systematic Reviews (PROSPERO) Registry CRD42018099541.

Literature Search

An electronic database search was conducted of Medline, Embase, CINAHL, PsychInfo and the Cochrane Central Register of Controlled Trials. The search was conducted using Medical Subject Headings and keywords (see appendix for Medline search strategy used). There was no time period restriction applied to the search. Only studies written in English and involving adult participants were included. The keywords used included the (a) disease process (type II/2 diabetes mellitus) and the (b) intervention (text messaging, texting, SMS, short message service). We used the Boolean operator of and/or to combine terms.

References in selected articles were also examined manually to find other relevant studies. The electronic databases were last searched on the 10th of August 2018.

Study Eligibility

Trials were included based on the following criteria: (a) the trial enrolled adult patients (≥18 years of age) with type 2 diabetes mellitus, (b) studies published in English, where (c) the patients received a text message intervention designed to improve diabetes related outcomes and (d) the trial reported quantitative measures of text messaging on HbA1c and e) the design was a randomized control trial with at least 4 weeks follow up. We excluded studies if (a) the primary intervention was not limited to text messaging and included other forms of telemedicine such as email, (b) involved patients with gestational diabetes (GDM), pre-

diabetes, or type I diabetes mellitus and (c) were bidirectional in nature, providing feedback about parameters to the participants. We defined bidirectional studies as those that involved a response from the research team, and included any advice given regarding adjustment of insulin doses or changing of medications.

Data Extraction and Assessment of Data Quality

Two individuals (R.H and L.S) independently screened all identified titles and abstracts from the literature search using a predefined protocol. Full texts of screened articles were reviewed for inclusion criteria. Disagreements were resolved through discussion or in consultation with a third independent reviewer (N.W.C).

We used the 'Cochrane Handbook for Systematic Reviews of Intervention' guidelines for trials with multiple intervention arms. (9) A bibliographical database was created using EndNote X7, which was used to store and manage the references.

Data was extracted from each study, detailing the study design, population characteristics, sample size, age and country, as well as the intervention, comparator and the outcome of interest (HbA1c, acceptability of the intervention and cardiovascular risk factors). Data extraction was primarily performed by the first author and crosschecked by the second author.

We assessed the risk of bias in accordance with the Cochrane Handbook for Systematic reviews of Interventions, and reported on the following elements: random sequence generation, randomization sequence concealment, masking, completeness of outcome data, selective outcome reporting, and other sources of bias. (9)

Statistical Analysis

We used the program Comprehensive Meta-Analysis (version 3.3.070, Biostat) for statistical analysis and meta-analysis. We used the difference in means to report the effectiveness of the intervention on HbA1c and the effect size was weighted as per the study sample size. From each study, we extracted the mean, sample size and standard deviation of HbA1c.

Using CMA, we transformed this information into mean difference (with 95% confidence interval) and pooled the data using a random effects model. In one study, medians and interquartile ranges were reported. In this case, we did not include the study in our meta-analysis. In another study, individual data was not available and the study was excluded from the meta-analysis.

Risk of publication bias

Heterogeneity was quantified by the I^2 statistic, where $I^2 > 50\%$ was considered evidence of substantial heterogeneity. Publication bias was assessed using a funnel plot and presence of asymmetry tested with Begg and Egger tests. If publication bias exists, the funnel plot is asymmetric, with Egger test $P < .05$. We used the trim-and-fill method by Duval and Tweedie to impute the missing studies. (10) Studies with smaller sizes, which are concentrated near the bottom, have a higher chance for publication if they include larger effects than average and are more likely to be significant.

Results

A total of 308 records were identified through the combined databases. 188 records were screened following removal of duplicates. 26 full text articles were assessed for eligibility and 11 studies were included in the systematic review (see figure 1). In articles where complete information was not provided, we emailed authors in an attempt to include all available data in the meta-analysis. Mean HbA1c and sample sizes were available for inclusion in 9 out of 11 studies. The remaining 2 studies did not report mean HbA1c or were not contactable via email. Figure 1 details the data collection process.

Study Characteristics

A total of 1710 participants were included in the studies analysed. The median sample size was 129 participants. The mean age of participants in the study was 52.2±3.6 years. The median length of the intervention was 6 months. The majority of participants were women in 6 out of 11 studies, with the remaining studies having a majority of male participants. The

exception was one study, which did not detail the exact numbers of male and female participants. Two of the studies were conducted in the United States, while the remaining studies were conducted in Asia, Europe, United Arab Emirates and New Zealand. All studies compared the text messaging intervention to usual care, which generally involved contact with an endocrinologist and/or diabetes educator.

One study targeted medication adherence and provided medication reminders only, while the remaining ten studies delivered lifestyle-focused text messages, with an emphasis on diet, exercise and cardiovascular risk factor modification. Three out of eleven studies reported on acceptability and user satisfaction with the text messaging intervention.

Text Message Characteristics

The text messaging intervention characteristics varied between studies (table 1). Five studies sent one or more messages per day during the period of the intervention. Two studies had a pre-determined and set time for sending messages on a daily basis, while the others sent messages at random times of the day or did not list this information in their article.

Tamban et al focused their messages on topics pertaining to diet and exercise, and sent three messages per week to participants. Similarly, Goodarzi et al delivered 4 messages per week and focussed on exercise, diet, diabetes medication adherence and importance of self-monitoring of blood glucose levels. The recommendations covered the four areas of knowledge, attitude, practice and self-efficacy. In contrast, the study by Argay et al, which focused primarily on medical adherence, was not able to show a reduction in HbA1c. All studies that were able to show a significant reduction in HbA1c targeted diet, exercise, importance of monitoring blood sugar levels and medication adherence. Behaviours targeted by each text messaging intervention are outlined in table 4.

Characteristics of effective interventions

The five interventions that demonstrated significant reductions in HbA1c were heterogeneous in their designs. Of these, 4 of the trials sent 3-4 messages per week, with the content of the

messages focussing primarily on diet, exercise, self-monitoring of blood sugar levels (BSLs) and cardiovascular risk factor reduction. The remaining intervention sent monthly text messages and micro-letter only, but focus remained on diet, exercise and self-monitoring of BSLs. The effective interventions were all of similar duration (3-6 months).

Our review also suggests that lifestyle focused text messaging that is tailored to the individual is more effective than standardised messages. Peimani et al found that an intervention involving tailored messages, wherein the participants had a choice of topics they received information on, led to a greater reduction in HbA1c compared to both the non-tailored and control group (-0.356% standard difference in means, compared to -0.210% standard difference in means between intervention and control group). (15) Dobson et al also implemented a tailored intervention, whereby participants were able to choose the modules of messages they received.

Intervention Efficacy on Diabetes Related Outcomes

Of the 11 studies included in our systematic review, 5 studies demonstrated significant improvements in HbA1c after the intervention was implemented. Similar to our qualitative analysis, the meta-analysis conducted after pooling results from 9 studies showed that the mean difference in HbA1c was -0.38% (-0.53; -0.23, p-value <0.001), with the overall analysis favouring the text messaging intervention (see figure 2).

Publication Bias

We found that the studies had minimal heterogeneity (I^2 = 9.13%) across the clinical trials. Publication bias was assessed by funnel plot asymmetry (figure 3), with all studies falling inside the funnel, and thus demonstrating minimal publication bias.

Assessment of risk bias

Due to the nature of the text messaging intervention, participant blinding was not feasible in any of the trials. All eleven studies described random sequence generation, which resulted in low risk of bias. Overall, 5 out of 11 studies were considered high quality evidence. Allocation

concealment was not described in 5 of the included studies, with three studies considered high risk due to absence of allocation concealment. The individual study bias assessment is detailed in the appendix.

Text Message Acceptability

Only three studies reported on the acceptability of the text messaging intervention. In the trial of Arora et al, 100% of participants responded that they would recommend it to family members and 97% in the trial conducted by Dobson et al. In all three studies, participants responded that the text-messaging program increased their knowledge about diabetes and the messages functioned as valuable reminders to encourage adoption of a healthy lifestyle. There were no negative comments noted in the articles about the texting intervention, suggesting that the intervention was considered acceptable and feasible to the participants of the trials.

Cardiovascular risk factor reduction

4 of the 11 studies demonstrated an improvement in cardiovascular risk factors levels. Goodarzi et al demonstrated a reduction in total cholesterol levels as a result of the intervention. Similarly, Peimani et al also demonstrated a reduction in BMI in the text-messaging group, while Ronghua et al observed a reduction LDL-c. Shetty et al demonstrated a reduction in total cholesterol as a result of the intervention. Insufficient cardiovascular risk factor data was collected in these studies for a meta-analysis to be performed on these outcomes.

Discussion

We found eleven randomized control trials that evaluated the effect of unidirectional text messaging interventions on glycaemic control in participants with T2DM. We focused primarily on improvement in HbA1c, but examined acceptability of the intervention and cardiovascular risk factor reduction as secondary outcomes. We found that text-messaging interventions had a favourable effect on HbA1c in patients with type 2 diabetes mellitus, with significant reductions in HbA1c by 0.38% when nine of the eleven studies were pooled

together in meta-analysis. Additionally, the intervention was considered acceptable to the majority of participants and resulted in reduction of some cardiovascular risk factor levels in 4 of the 11 studies.

Given the simplicity of the intervention and low cost of implementation, our systematic review suggests that lifestyle focused text messaging has significant potential to improve glycaemic control in patients with diabetes. It is well known that improved glycaemic control results in reduction in micro and macro vascular diabetes complications, translating to lower morbidity and mortality in these patients. However, this remains an ongoing challenge, with many patients being insufficiently motivated to adopt a healthy lifestyle. As demonstrated by our review, assisting individuals with motivational and educational reminders can potentially overcome this barrier, encouraging participant self-empowerment to implement meaningful lifestyle changes.

Our finding of an overall reduction in HbA1c of 0.38% represents a significant improvement in diabetes management. A report from the UKPDS found that every 1% reduction in HbA1c was associated with significant reductions of 21% in diabetes-related deaths, 14% in myocardial infarction and 37% in micro vascular complications. (11) While the effects of various anti-diabetes medication on HbA1c reduction are well known, our review indicates that lifestyle focussed text messaging may achieve reductions in HbA1c, and act as an adjunct to standard care for patients with T2DM. Our review also suggests that a tailored approach to text messaging may be more beneficial, as demonstrated in the trials by Peimani et al and Dobson et al. However, the other trials did not have a tailored approach to text messaging and there is paucity of literature examining the beneficial effects of this method, with our review highlighting the need for more robust trials examining this in further detail.

The most common cause of death in patients with diabetes is cardiovascular mortality, and one study showed that risk of death from coronary artery disease was almost three fold higher in individuals with diabetes. (12) Mortality after the first myocardial infarction is higher in both men and women with diabetes, compared to those without diabetes. (13) In the UK

prospective diabetes study, 49% of deaths within 10 years of diagnosis were due to cardiovascular disease. In addition, atherosclerosis is more frequent and more extensive and has an earlier onset among people with diabetes mellitus than in people without the condition. (14) As a result, control of cardiovascular risk factors has the potential to significantly improve morbidity and mortality in patients with diabetes. Our systematic review also suggested that the intervention had an effect on other risk factors such as BMI and LDL-c levels. In the trial by Peimani et al, there was a reduction in BMI and fasting blood glucose levels, while Ronghua, Shetty and Goodarzi et al, demonstrated a reduction in cholesterol levels. (15)(16)(17)(18) Larger, more robust trials are needed to examine the improvement in cardiovascular risk factor levels as a result of a text-messaging intervention in greater detail. .

Our review does have a number of limitations. We included only trials that employed a unidirectional messaging intervention, which may have limited the number of studies analysed. However, the rationale behind this criterion was that unidirectional messages have the potential to be implemented on a large scale. Bidirectional messaging on the other hand, requires considerable cost, resources and time to be invested by research assistants and clinicians. Given real time responses, feedback and engagement between the participant and the clinician, it can be argued that bidirectional messaging is no different to individual clinician guidance and does not allow for the true impact of telemedicine to be assessed, resulting in a limited application to a real-world setting. Unidirectional messaging has the potential to be employed as a public health intervention, without requiring large amounts of clinical information and funding. By disseminating information to a large target audience, text messaging is a low cost approach to improving glycaemic management and cardiovascular risk factor control.

In our review, we did not include individuals with type 1 diabetes, GDM or pre-diabetes. While this was done in order to target the largest population of patients with diabetes (those with T2DM), further reviews could potentially target these population groups only.
However, even in these subgroups, there is evidence that lifestyle focused text messaging is advantageous in improving lifestyle. A feasibility study conducted by Bin Abbas et al in 2014

in 200 adolescents with Type I diabetes mellitus (T1DM) that received daily diabetes related text messages displayed increased adherence to diabetes therapy and improved clinical outcomes. (19) Similarly, an acceptability study conducted by Johnson et al in 19 women diagnosed with GDM found that daily text messages for 4 weeks was found to be acceptable, with overall satisfaction with the program, and improved dietary habits as a result of the intervention. (20)

Our meta-analysis was unable to include data from 2 of the 11 studies that met the inclusion criteria due to lack of availability of individual data. Additionally, due to the short duration of the trials included in the analysis, the long-term effects of text messaging on HbA1c could not be examined. While we were able to demonstrate a favourable effect in the short term, it is uncertain if this effect translates to long-term benefits on HbA1c and sustained lifestyle changes, or if these are present only for the duration of the intervention.

Conclusion

Our systematic review of 11 randomised controlled trials demonstrated the favourable impact of lifestyle-focused text messaging on HbA1c in patients with T2DM. Four of the 11 included studies demonstrated that text messaging also improved secondary outcomes such as total fasting cholesterol, LDL-c and BMI.. 3 of the 11 studies reported that the vast majority of participants would recommend the program to others. Our meta-analysis pooled results from 9 of 11 studies and found that there was a mean reduction in HbA1c of 0.38%, suggesting that low cost text messaging, when delivered in addition to usual care, has the potential to generate significant improvements in glycaemic control.

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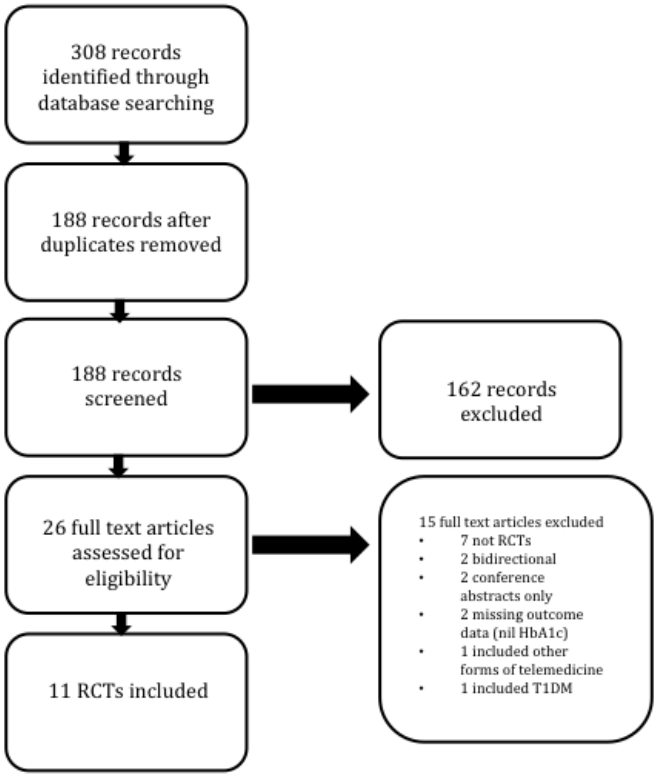
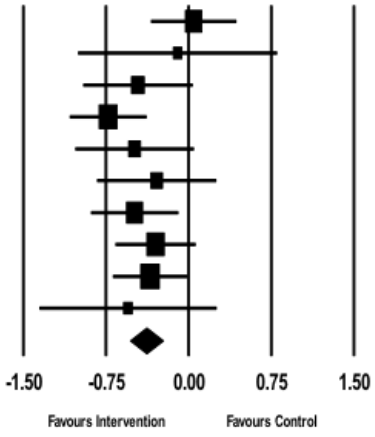


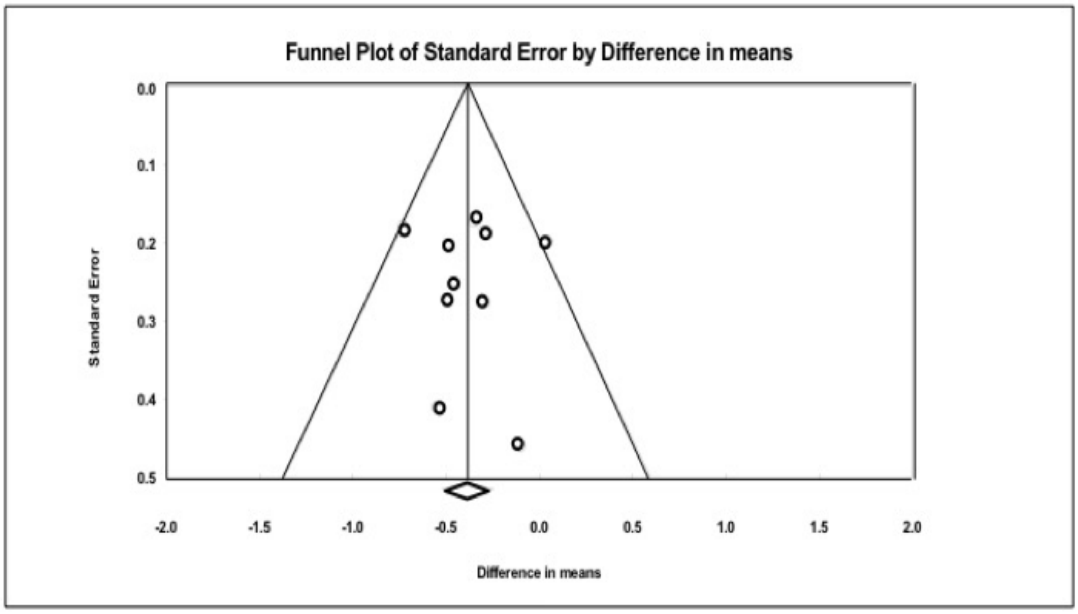
Study name	Difference in means	Standard error	Variance	Lower limit	Upper limit	p-Value
Argay	0.045	0.198	0.039	-0.342	0.433	0.818
Dobson	-0.100	0.461	0.213	-1.004	0.804	0.828
Goodrazi	-0.460	0.254	0.064	-0.957	0.037	0.070
Islam	-0.730	0.178	0.032	-1.079	-0.381	0.000
Peimani (tailored)	-0.490	0.275	0.076	-1.030	0.050	0.075
Peimani (non-tailored)	-0.290	0.276	0.076	-0.831	0.251	0.294
Ronghua	-0.490	0.203	0.041	-0.887	-0.093	0.016
Shetty	-0.300	0.186	0.035	-0.664	0.064	0.106
Tamban	-0.350	0.173	0.030	-0.688	-0.012	0.043
Zolfaghari	-0.550	0.411	0.169	-1.355	0.255	0.180
	-0.383	0.076	0.006	-0.531	-0.234	0.000

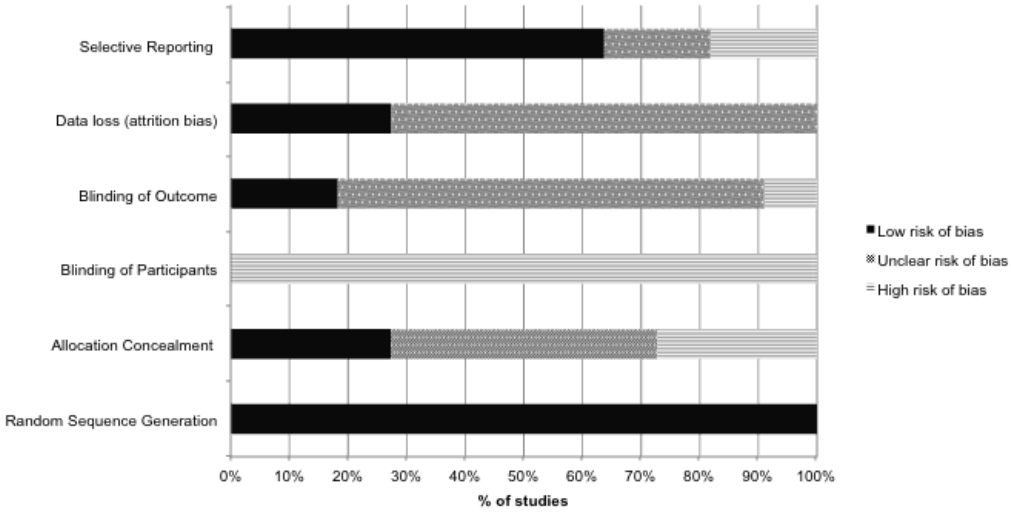
Statistics for each study

Difference in means and 95% CI



Meta Analysis





Study Name	Year	Country	Number of participants	Duration of intervention	Intervention	Mean Age	Females	Behav

Argay	2015	Hungary	131	12 months	Medication reminders - 3x per day vs. usual care	59 years	61 (46.6%)	Medica
Arora	2014	USA	128	6 months	2 daily text messages for 6 months vs. usual care	50.7 years	82 (64%)	Educat l; medi healthy challer
Capozza	2015	USA	93	6 months	1-7 diabetes related text messages per day vs. usual care	53.3 years	36 (60%) in intervention arm, 22 (63%) in control arm	Medica glucos (includ coachi glucos monito educat l
Dobson	2018	New Zealand	366	9 months	Individually tailored text messages sent for 3, 6 or 9 months vs. usual care	47 years	177 (48%)	Motiva insulin lifestyl tailore smokir
Goodrazi	2012	Iran	81	3 months	4 messages weekly vs usual care	53.85 years	34 (79.1%) in intervention arm, 29 (76.3%) in control group	Knowle practic efficac
Islam	2015	Bangladesh	236	6 months	90 messages over 6 months vs. usual care	48.1 years	54.20%	Educat l
Peimani	2016	Bahrain, UAE	150	3 months	Tailored SMS group vs. non tailored SMS group vs. usual care Tailored - 75% messages tailored to top 2 barriers reported in survey/scale Non tailored - random messages regardless of barriers	52.5 years	46% were female	Diet, e medica and fre monito glucos

Ronghua	2018	China	129	12 months	SMS +micro-letter vs. routine care plus 3 monthly phone calls	57.34 years	Control 6 (11.76), Intervention 9 (15.52)	Messa cardiov factors compli freque glucos reducir consur signific mass i regular and oth topics.
Shetty	2011	India	215	12 months	SMS once in 3 days vs. usual care	50.5 years	-	Genera ons/ ph medica
Tamban	2013	Philippines	104	6 months	SMS 3x per week vs usual care	49.5 years	71% in intervention group, 75% in control group	Monda diet Wedne about e Friday consec adherir manag
Zolfaghari	2012	Iran	77	12 weeks	Daily SMS vs telephone call	52.4 years	20 in SMS (52.6%), 21 in control (53.8%)	Educat l

Table I: Study and SMS messaging Characteristics

Study	Random Sequence Generation	Allocation concealment	Blinding participants / personnel*	Blinding of outcome assessment	Incomplete outcome data (Data loss %)	S r
Argay	+	?	-	?	- (9/140 lost to FU, 6%)	+
Arora	+	?	-	?	+	-
Capozza	+	+	-	?	+	-
Dobson	+	-	-	+	- (2%)	+
Goodrazi	+	+	-	?	- (19/100 lost to follow up, 19%)	+
Islam	+	?	-	?	- (36/236 lost to follow up, 15%)	+
Peimani	+	-	-	-	+	+
Ronghua	+	?	-	?	- (20/129 dropped out, 16%)	+
Shetty	+	?	-	?	- (71/215, 33%)	?
Tamban	+	+	-	+	- (22/104, 21%)	+
Zolfaghari	+	-	-	?	- (2/79, 3%)	?

Table II: Study quality assessment (as per Cochrane guidelines) ('+' represents low risk of bias, '–' represents high risk of bias, '?' represents unclear risk of bias)

Author	HbA1c outcomes	Self management outcomes	Satisf

Argay	No statistically significant difference in HbA1c between the two groups. However in the SMS group, the trend was towards improvement.	Not reported	Not re
Arora	Nil statistically significant improvement in HbA1c (p-value 0.23), but trend towards improvement in primary outcome of HbA1. HbA1c decreased 1.05% in intervention group compared with 0.60% in control (D 0.45; 95% CI –0.27 to 1.17).	Outcomes measured included: changes in medication adherence, self-efficacy, performance of self-care tasks, quality of life, diabetes-specific knowledge, ED utilization, and patient satisfaction. Medication adherence improved from 4.5 to 5.4 in the TExT-MED group compared with a net decrease of –0.1 in the controls (D1.1; 95% CI 0.1 to 2.1). Similar trends toward greater improvement in the treatment group were observed in all secondary outcomes.	High s enjoye recom Majori way to strong the pr 53.2% messa 36.2%
Capozza	No statistically significant difference at 90 and 180 days (p >0.05). However, HbA1c decreased from baseline in both groups	Not reported	45% o mid po recom improv and ho report
Dobson	Statistically significant reduction in HbA1c for all patients, but not in the T2DM subset.	Of 21 secondary outcomes, only four showed statistically significant improvements in favour of the intervention group at nine months. Significant improvements were seen for foot care behaviour, overall diabetes support, overall health status and perceptions of illness identity.	High le were f partici 164 (9 progra diabet
Goodrazi	The results showed that exp. group compared with cont. group improved significantly in HbA1C (p = 0.024),	Improvements in LDL (p = 0.019), cholesterol (p = 0.002), BUN (p ≤ 0.001), micro albumin (p ≤ 0.001), knowledge (p ≤ 0.001), practice (p ≤ 0.001) and self efficacy (p ≤ 0.001). BMI improvements also noted	Not re
Islam	HbA1c mean difference from baseline to after 6 months was -0.85 (95% CI -1.05, -0.64) in the SMS group and -0.18 (-0.41, 0.04) in the control group. Difference between means was -0.66 (-0.97, -0.35; P < 0.0001).	Increased self reported adherence to medications over time Mean medication adherence score decreased significantly in both the SMS and the control groups, indicating greater self-reported adherence to medication over time. No significant difference between the groups.	Not re

Peimani	After 12 weeks, HbA1c levels did not demonstrate statistically significant change (both intervention groups however did show decrease in HbA1c from baseline)	Significant decline was observed in FBS and mean BMI in both intervention groups (p 0.003 tailored, p0.026 non tailored). Mean SCI-R scores significantly increased and mean DSCB and DMSES scores significantly decreased in both tailored and non-tailored SMS groups. In the control group, mean SCI-R scores decreased and mean DSCB and DMSES scores significantly increased ($P < 0.001$). Both tailored and non-tailored experienced significant decline in mean BMI (mean BMI of control group increased marginally).	Not re
Ronghua	There were statistically significant decreases in HbA1c in intervention arm (p = 0.034)	Statistically significant postprandial plasma glucose (p = .001), postprandial insulin (p = .005), total cholesterol (p = .038) and low-density lipoprotein (p < .001). In control group - systolic BP decreased significantly	Not re
Shetty	No significant difference in mean HbA1c between groups.	Adherence to treatment prescriptions, including physical activity, diet modifications, and medication Serum triglyceride decreased significantly in both groups. (p<0.03)	Not re
Tamban	After 3 months, significant difference is observed in mean HbA1c (SMS= 7.13 + 0.99, control= 7.53 + 0.91, p=0.034).	At 6 months, significant difference was seen in mean number of meals/day (SMS=2.61 + 0.63, control= 2.29 + 0.72, p= 0.018), mean number of minutes/exercise (SMS= 37.40 + 14.87, control=31.44 + 10.82, p= 0.021) and mean HbA1c (SMS=6.99 + 0.86, control= 7.34 + 0.90, p= 0.0452).	Not re
Zolfaghari	Significant change in HbA1c for the SMS group (p = 0.000), with a mean change of −1.01 (8.97% pre-test to 7.96% three months). No significant difference between the interventions of SMS and phone (p = 0.186).	Not reported	Not re

Table III: Primary and Secondary Outcomes Reported in Individual Trials

Table 4: Behaviours targeted as a result of the intervention, identified by the Associated of American Diabetes Education.

Self management behaviours targeted	Number of studies
Healthy eating	10
Physical activity	10
Blood glucose monitoring	10
Medication adherence	8
Problem solving	0
Cardiovascular risk factor reduction	6
Healthy coping	2