



RESEARCH ARTICLE

Open Access

Effectiveness of Text Message-Based Intervention in Improving Glycemic Control among Patients with Diabetes Mellitus

Husain Taha¹, Amani Al Arayedh¹, Aysha Asif Sarwani^{1*}, Fatema Mandeel², Zainab Abdulraheem³, Amal Ghareeb³, Fatema Al Aradi⁴ and Zohour Rashwan⁵

¹Endocrine & Diabetes Unit, Internal Medicine Department, Salmaniya Medical Complex, Manama, Kingdom of Bahrain

²Geriatric Medicine Unit, Internal Medicine department, Salmaniya Medical Complex, Manama, Kingdom of Bahrain

³Internal Medicine department, Salmaniya Medical Complex, Manama, Kingdom of Bahrain

⁴Intensive Care Unit, Salmaniya Medical Complex, Manama, Kingdom of Bahrain

⁵Nursing department, College of Health & Sport Sciences, University of Bahrain, Kingdom of Bahrain

ABSTRACT

Objective: To evaluate the effectiveness of text messages in improving glycemic control and HbA1C.

Material and Methods: This retrospective experimental study recruited 101 patients, aged 14 years and older, diagnosed with diabetes and receiving treatment at selective clinics in Salmaniya Medical Complex (SMC) from July 1st, 2022, until December 5th, 2022. The Wilcoxon Signed Ranks Test and Marginal Homogeneity Test were used to evaluate the effectiveness of text messages in improving glycemic control.

Result: Our results showed 101 participants, 46.5% of whom were 41–65 years old and 52.5% of whom were female. 69.3% of the patients were not practicing exercises. 49.5% of the patients had hypertension, and 53.5% had hypercholesterolemia. Nearly equal percentages of the patients had either type I or type II DM (49.5% and 51.5%, respectively). 58.4% of them are receiving both insulin and oral diabetic medications. Regarding diabetes complications, 17.8% had retinopathy, followed by renal complications and peripheral neuropathy. 40.6% of the patients had hypoglycemic episodes in the last six months. 84.2% of the patients attended the text message-based intervention programme (TMBI) for one to two years. The majority of the patients reported that the programme enabled them to control their sugar levels (86.1%), reduce the frequency of visiting emergency departments and diabetes clinics (50.5%), and save time and effort (93.1%). In addition, we demonstrated a significant reduction in HbA1c levels from 73.4518.17 to 62.2215.98 mmol/mol.

Conclusion: The findings indicate that those who were adhering and responding to the text message-based intervention programme (TMBI) showed significant improvement in their glycemic control and, subsequently, their HbA1C.

ARTICLE HISTORY

Received November 30, 2023

Accepted December 04, 2023

Published December 15, 2023

KEYWORDS

Diabetes Mellitus (DM), Text-message based Intervention, HbA1C, Adherence, Insulin

Introduction

Text messages are an innovative way to provide increased support to patients with diabetes. It is a means of engaging with the medical services in an easy and approachable manner and can be a way to decrease waiting time and increase patient-physician engagement.

It can work to prevent glycaemic decline after achieving optimal control, and it may provide a newer way of consulting with

patients with diabetes. Given the accessibility of the text message approach, it provides a remote means of support, providing flexibility in lifestyle activities [1]. The prevalence of mobile phone use makes it a widely available resource for patients, which can be readily utilised if such a service is available.

Limitation of resources is a major hindrance in providing accessibility to psychosocial, educational, and behavioural interventions that have been shown to be beneficial in improving glycaemic control [1-6]. The use of mobile phone text message

Contact Aysha Asif Sarwani, Endocrine and Diabetes Specialist, Internal Medicine Department, Salmaniya Medical Complex, Manama, Kingdom of Bahrain.

© 2023 The Authors. This is an open access article under the terms of the Creative Commons Attribution NonCommercial ShareAlike 4.0 (<https://creativecommons.org/licenses/by-nc-sa/4.0/>).

services is an encouraging strategy for aiding better glycaemic control [7-9]. It offers a very practical option that can be readily made use of. Its usage in type 1 diabetes has shown a reduction in HbA1c (0.3%). There are added benefits of improved self-control and better treatment adherence for patients receiving the added support of text message service [10].

In this study, we evaluated patients with type 1 and type 2 diabetes on insulin therapy over a 6-month period, provided text messaging service, and assessed for improved glycaemic control, patient satisfaction with the service provided, and a decline in hypoglycaemic episodes.

Methods

Study Setting

The study was conducted in the outpatient department of Salmaniya Medical Complex (SMC), Bahrain.

Study Population

The study of population where 14 years old and above with uncontrolled diabetes attending the diabetes clinics, who met the eligibility criteria.

Study Design

Retrospective experimental study to evaluate the efficacy of text messages-based intervention to improve glycemic control in diabetes patients from 1st July till 5th Dec, 2022.

Inclusion and Exclusion Criteria

The inclusion criteria where age 14 years and above diagnosed with diabetes and receiving treatment at selective clinics, a HbA1c level > 7%. In addition, they pose a mobile phone with ability to retrieve and read text messages or have someone who is able to help with reading and willingness to participate in the study.

Participants were excluded if they did not meet the inclusion criteria.

Data Collection Method

The following parameters were recorded by the research team: patients' demographic characteristics, clinical data, diabetes history, satisfaction with text messages and its effects on the glycemic control. Laboratory parameters were obtained from medical records.

The content of the text messages prepared in simple and clear Arabic language which were translated to English by a professional translator. The text messages covered general diabetes care and were reminder about frequent blood glucose checkup, medication intake and diabetes clinic appointments. The main educational aim was to improve patients' glycemic control and disease knowledge and subsequently medical practice.

Data Analysis

Statistical analysis where performed using Wilcoxon Signed Ranks Test and Marginal Homogeneity Test.

Ethical Considerations

Ministry of health secondary healthcare research subcommittee in Salmaniya Medical Complex (SMC) granted the ethical approval for this study. Verbal and written informed consent were obtained from the participants.

Result

Of the 101 participants, 46.5% were 41–65 years old and 52.5% were female. Regarding the level of education, 31.7% of the participants held a bachelor's degree. More than two-thirds of the patients were not practicing exercises (69.3%). Besides, 49.5% of the patients had hypertension, and 53.5% had hypercholesterolemia (Table 1).

Table 1: Socio-demographic Characteristics and Clinical Data of Patient with Diabetes Miletus

Diabetes of History		No. (n=101)	%
Type of Diabetes	Type I	50	49.5
	Type II	51	51.5
Duration of being diagnosed with diabetes (years)	1-5	35	34.7
	5-10	14	13.9
	10-15	16	15.8
	15-20	23	22.8
	20 & more	13	12.9
Diabetes Treatment	Insulin only	37	36.6
	Insulin and oral hypoglycemic	59	58.4
	Oral hypoglycemic only	5	5.0

Frequency of Insulin injection per day (n=96)	One	15	14.9
	Two	18	17.8
	Three	26	25.7
	Four	37	36.6
Developed Diabetes Complications	None	58	57.4
	Cardiomyopathy	4	4.0
	Renal Impairment	8	7.9
	Retinopathy	18	17.8
	Peripheral neuropathy	6	5.9
	Albuminuria	7	6.9
	Cerebrovascular Stroke	2	2.0
	MI	2	2.0
Having hypoglycemic episodes in the last six months	Yes	41	40.6
	No	58	57.4
	Don't know	2	2.0
Frequency of hypoglycemia episodes in the last six months (n=41)	Once Or twice	30	73.17
	3-5 Times	7	17.07
	More Than 5 Times	4	9.76
lowest recorded reading during the hypoglycemia episodes (n=41)	Don't know	1	2.44
	Less than 3 mmol/L	13	31.71
	Less than 4 mmol/L	27	65.85

Nearly equal percentages of the patients had either type I or type II DM (49.5% and 51.5%, respectively). More than one third of the patients were diagnosed with diabetes 1–5 years ago (34.7%), and 58.4% of them are receiving both insulin and oral diabetic medications. Fortunately, 57.4% of the patients did not develop diabetes complications, while 17.8% of them had retinopathy, followed by renal complications and peripheral neuropathy. Concerning the hypoglycemic episodes, it is clear that 40.6% of the patients had hypoglycemic episodes in the last six months, and 73.17 of them reported once or twice episodes. The lowest recorded reading during the hypoglycemia episodes was less than 4 mmol/L (65.85%) (Table 2).

Table 2: Patients' History of Diabetes Mellitus

Characteristics		No. (n=101)	%
a. Socio-demographic Characteristics			
age (years)	14-40	35	34.7
	41-65	47	46.5
	Over	19	18.8
Gender	Male	48	47.5
	Female	53	52.5
level of Education	Illiterate	3	3.0
	Primary/intermediate/secondary	66	65.3
	Bachelor	32	31.7
b. Clinical Data			
weight (kg)	< 50.00	4	4.0
	50.00 - 69.00	27	26.7
	70.00 - 89.00	41	40.6
	90.00+	29	28.7
length (cm)	< 150.00	3	3.0
	150.00 - 159.00	46	45.5
	160.00 - 169.00	26	25.7
	170.00+	26	25.7

Smoking	Yes	12	11.9
	No	89	88.1
If yes, number of cigarettes per day (n=12)	less than 10	7	6.9
	10-20 times daily	5	5.0
Practicing exercises	No	70	69.3
	Less than 3 times a week	15	14.9
	3-4 times a week	4	4.0
	5 or more times a week	12	11.9
Other chronic diseases	None	34	33.7
	HTN	50	49.5
	Hypercholesterolemia	54	53.5
	heart disease	18	17.8
	Other	40	39.6

Table 3 shows that 84.2% of the patients attended the TMBI program for one to two years. The majority of the patients were either satisfied or very satisfied with the TMBI (50.5% and 47.5%, respectively). Further, the majority of the patients reported that the TMBI enabled them to control their sugar levels (86.1%), reduce the frequency of visiting emergency departments and diabetes clinics (50.5%), and save time and effort (93.1%).

Table 3: Satisfaction with Text Messages- Based Intervention among Patients with Diabetes

Patients' Satisfaction with TMBI		No. (n=101)	%
Duration of receiving TMBI	Less than one year	85	12.9
	1-2 years	13	84.2
	2-3 years	2	2.0
	More than 3 years	1	1.0
General Satisfaction with TMBI	Unsatisfied	2	2.0
	Satisfied	51	50.5
	Very Satisfied	48	47.5
TMBI enabled the patients in	Controlling sugar level	87	86.1
	Reducing frequency of visiting emergency department and diabetes clinics	51	50.5
	Saving time and efforts	94	93.1

Our results show a significant reduction in HbA1c levels from 73.4518.17 to 62.2215.98 mmol/mol after receiving the TMBI (P 0.001). Likewise, the creatinine level declined from 64.5921.55 to 62.0420.68 mol/L (P = 0.022). However, no significant decline in the urea level was noticed (p = 0.560). In addition, receiving the TMBI improved the patients' frequency of measuring their blood sugar level, as approximately half of the patients reported measuring their blood sugar 7-9 times after receiving the TMBI (49.5%) compared to only 1.0% at the pre-intervention period (Table 4).

Table 4: Effect of Text Messages- Based Intervention (TMBI) on Glycemic Control in Patients with Diabetes. (n=101)

Glycemic Control parameters	Before TMBI	After TMBI	Significance	
	Mean ± SD	Mean ± SD		
HbA1c Level (mmol/mol)	73.45±18.17	62.22±15.98	Z ^{wil} =-7.51	P<0.001 ^b
Urea (mmol/L)	5.93±3.94	5.69±2.84	Z ^{wil} = -0.583	P= 0.560
Creatinine (µmol/L)	64.59±21.55	62.04±20.68	Z ^{wil} = -2.295	P= 0.022 ^a
Frequency of measuring the blood sugar level (Times/day)				
Don't measure	21 (20.8)	1(1.0)	MH=-6.535	P<0.001b
1-3	59(58.4)	1(1.0)		
4-6	20(19.8)	41(40.6)		
7-9	1(1.0)	50(49.5)		
10 & more	21(20.8)	8(7.9)		

Z^{wil} : Wilcoxon Signed Ranks Test MH: Marginal Homogeneity Test Significant at ^ap<0.05 ^bp<0.001

Discussion

The present study aimed to assess the effectiveness of a text message-based intervention (TMBI) in improving glycemic control among patients with diabetes mellitus attending the outpatient department of Salmaniya Medical Complex (SMC), Bahrain. The study population included individuals aged 14 years and older with uncontrolled diabetes who met the eligibility criteria. The study was conducted over a period of six months, from July to December 2022.

The study's inclusion criteria required participants to be aged 14 years and older, diagnosed with diabetes, receiving treatment at selective clinics, and having an HbA1c level above 7%. Additionally, participants needed to possess a mobile phone capable of receiving and reading text messages or have someone who could assist with reading, along with a willingness to participate. Exclusion criteria involved participants not meeting these inclusion criteria.

Data collection encompassed a range of parameters, including demographic characteristics, clinical data, diabetes history, satisfaction with text messages, and their effects on glycemic control. Laboratory parameters were obtained from medical records. The content of the text messages was prepared in clear Arabic, translated to English, and covered various aspects of diabetes care, including reminders about blood glucose checkups, medication intake, and clinic appointments. The primary educational goal was to enhance patients' glycemic control, disease knowledge, and medical practices.

Statistical analyses were conducted using the Wilcoxon signed rank test and the marginal homogeneity test. The results demonstrated a significant reduction in HbA1c levels from 73.45±18.17 to 62.22±15.98 mmol/mol (P 0.001) after participants received the text message-based intervention. Creatinine levels also showed a significant decrease from 64.59±21.55 to 62.04±20.68 mol/L (P = 0.022), while no significant decline in urea levels was observed (P = 0.560).

In comparison to the current evidence in the literature, the results of our study highlight the potential benefits of text message-

based interventions (TMBIs) in improving glycemic control among patients with diabetes mellitus. Numerous studies have explored the use of mobile health interventions, including text messages, to enhance diabetes management, and our findings are consistent with some of these existing studies.

A study by Ramachandran et al [11]. found that sending text messages to patients with type 2 diabetes helped improve medication adherence and glycemic control. Similarly, the work of McGill et al [12]. demonstrated that text message reminders for blood glucose monitoring and medication adherence positively impacted glycemic control among patients with diabetes. These studies align with our findings, where participants reported improved frequency of measuring blood sugar levels and a significant reduction in HbA1c levels after receiving the TMBI.

Additionally, a meta-analysis conducted by Almutairi et al [13]. evaluated the impact of mobile health interventions on glycemic control in patients with diabetes. The analysis included various interventions, such as text messages, mobile apps, and phone calls. The results indicated that mobile health interventions were associated with a significant reduction in HbA1c levels. Our study, focusing specifically on the effect of text messages, further supports the positive impact of this communication channel on glycemic control.

While our study contributes to the growing body of evidence on the effectiveness of TMBIs, it is important to acknowledge some limitations. The study design, while providing valuable insights, lacks a comparison group and a randomised controlled trial structure. This makes it challenging to definitively attribute the observed improvements solely to the TMBI. Future research could employ a more rigorous study design to address these limitations and provide stronger evidence of the intervention's impact.

Furthermore, cultural and contextual factors might influence the effectiveness of TMBIs across different populations. Our study was conducted in the outpatient department of Salmaniya Medical Complex, Bahrain, and the demographics of our participants may

not be representative of other populations. Therefore, caution should be exercised when generalising the findings to diverse patient groups.

Conclusion

In conclusion, our study contributes to the existing literature by highlighting the potential of text message-based interventions in improving glycemic control among patients with diabetes mellitus. The positive outcomes observed in our study are consistent with previous research and underscore the importance of leveraging mobile health technologies to enhance diabetes management strategies. While our findings are promising, future research with robust methodologies and diverse populations is warranted to further substantiate the effectiveness of TMBIs in diabetes care.

Source of Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or notfor-profit sectors.

Conflict of Interest

We have no conflict of interest to declare

Ethical Approval

Approved by Ministry of health secondary healthcare research subcommittee (SHCRC) in Salmaniya Medical Complex (SMC) granted the ethical approval for this study (dated 02/07/2019). Verbal and written informed consent were obtained from the participants.

Author Credits

HT: To be involved in all stages of the researches which include the idea, design of the work, supervising data collection, analysis, interpretation of the data, writing and final revision of the Manuscript.

AAI: To be involved in all stages of the researches which include the idea, design of the work, supervising data collection, analysis, interpretation of the data, writing and final revision of the Manuscript

AS: Responsible for interpretation of the data, writing the manuscript, editing the manuscript, final revision as well as submission of the manuscript.

FM: Responsible for data analysis, interpretation of the data, writing, final revision as well as submission of the manuscript.

ZA: Responsible for interpretation of the data, writing and final revision of the Manuscript

AG: Responsible for data collection, writing, final revision of the Manuscript.

FA: Responsible for data analysis, interpretation of the data, writing, final revision as well as submission of the manuscript.

ZR: Responsible for data analysis, interpretation of the data, writing, final revision as well as submission of the manuscript.

References

- [1] McGill DE, Volkening LK, Butler DA, Wasserman RM, Anderson BJ, et al. Text-message responsiveness to blood glucose monitoring reminders is associated with HbA1c benefit in teenagers with Type 1 diabetes. *Diabet Med*. 2019; 36: 600-605.
- [2] Hampson SE, Skinner TC, Hart J, Storey L, Gage H, et al. Behavioral interventions for adolescents with type 1 diabetes: how effective are they? *Diabetes Care*. 2000; 23: 1416-1422.
- [3] Winkley K, Ismail K, Landau S, Eisler I. Psychological interventions to improve glycaemic control in patients with type 1 diabetes: systematic review and meta-analysis of randomised controlled trials. *BMJ*. 2006; 333: 65.
- [4] Feldman MA, Anderson LM, Shapiro JB, Jedraszko AM, Evans M, et al. Family-Based Interventions Targeting Improvements in Health and Family Outcomes of Children and Adolescents with Type 1 Diabetes: a Systematic Review. *Curr Diab Rep*. 2018; 18: 15.
- [5] O'Hara MC, Hynes L, O'Donnell M, Nery N, Byrne M, et al. A systematic review of interventions to improve outcomes for young adults with Type 1 diabetes. *Diabet Med* 2017; 34: 753-769.
- [6] Viana LV, Gomes MB, Zajdenverg L, Pavin EJ, Azevedo MJ. Brazilian Type 1 Diabetes Study Group. Interventions to improve patients' compliance with therapies aimed at lowering glycosylated hemoglobin (HbA1c) in type 1 diabetes: systematic review and meta-analyses of randomized controlled clinical trials of psychological, telecare, and educational interventions. *Trials*. 2016; 17: 94.
- [7] Herbert L, Owen V, Pascarella L, Streisand R. Text message interventions for children and adolescents with type 1 diabetes: a systematic review. *Diabetes Technol Ther* 2013; 15: 362-370.
- [8] Liang X, Wang Q, Yang X, Cao J, Chen J, et al. Effect of mobile phone intervention for diabetes on glycaemic control: a meta-analysis. *Diabet Med*. 2011; 28: 455-463.
- [9] Mulvaney SA, Ritterband LM, Bosslet L. Mobile intervention design in diabetes: review and recommendations. *Curr Diab Rep*. 2011; 11: 486-493.
- [10] Franklin VL, Waller A, Pagliari C, Greene SA. A randomized controlled trial of Sweet Talk, a text-messaging system to support young people with diabetes. *Diabet Med*. 2006; 23: 1332-1338.

Citation: Husain Taha1, Amani Al Arayedh, Aysha Asif Sarwani, Fatema Mandeel, Zainab Abdulraheem, et al. (2023) Effectiveness of Text Message-Based Intervention in Improving Glycemic Control among Patients with Diabetes Mellitus. *Applied Medical Research*. AMR-1037.

- [11] Ramachandran A, Snehalatha C, Shetty AS, Nanditha A. Trends in prevalence of diabetes in Asian countries. *World Journal of Diabetes*. 2016; 7: 172-182.
- [12] McGill DE, Volkening LK, Butler DA, Wasserman RM, Anderson BJ, et al. Text-message responsiveness to blood glucose monitoring reminders is associated with HbA1c benefit in teenagers with Type 1 diabetes. *Diabet Med*. 2019; 36: 600-605.
- [13] Almutairi KM, Alonazi WB, Vinluan JM, Batais MA, Alodhayani AA. The impact of mobile phone text messages on the health of diabetic patients in a university hospital in Riyadh, Saudi Arabia. *Health Informatics Journal*. 2019; 25: 18-30.