Original Articles

Text messaging improves diabetes-related knowledge of patients in India: A quasi-experimental study

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ABSTRACT

Background. Diabetes-related health education promotes patient efficacy for diabetes self-management. However, sub-optimal knowledge of diabetes in people with diabetes is recognized as a challenge in overcrowded public health facilities in India. We aimed to determine the effect of health education through mobile phone text messages (short messaging service [SMS]) on diabetes-related knowledge of patients with diabetes.

Methods. From February 2016 to February 2017, we recruited adult patients with diabetes for this quasi-experimental study done in the outpatient setting of a major tertiary care government hospital in Delhi, India. Participants in the intervention group received a text message on diabetes self-care practices every alternate day for 90 days. We evaluated the patients' knowledge of diabetes using the Spoken Knowledge in Low Literacy in Diabetes (SKILL-D) questionnaire and a self-designed diabetes knowledge questionnaire.

Results. We enrolled 190 men and 160 women, of whom 52 (13.7%) were lost to follow-up. At baseline, mean diabetes knowledge scores were higher in the intervention group compared to the control group. After the intervention period of 3 months, the diabetes knowledge scores for SKILL-D and the patient diabetes knowledge questionnaire showed a statistically significant increase in the intervention group (mean difference 0.7 and 0.5, respectively; $p<0.001$, but there was no increase in the control group).

Conclusion. The use of mobile phone technology for diabetes-related health education through mobile text-message (SMS) technology is an effective method for health promotion.

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INTRODUCTION

Diabetes, a chronic metabolic disorder characterized by the phenotype of hyperglycaemia afflicts over 69 million people in India, the second highest absolute burden globally.[1] Effective diabetes management requires patient adherence to recommended self-care practices that include a healthy diet, regular exercise, foot-care and adherence to medications.[2] Good self-care practices by patients with diabetes are essential for preventing or delaying debilitating diabetes-related complications that cause high morbidity and mortality.[3,4]

It is well established that diabetes-related health education facilitates patient's knowledge of diabetes and promotes their efficacy in the self-management of diabetes.[5–7] Nevertheless, most public (government) hospital-based studies in India have reported sub-optimal knowledge of diabetes among patients with diabetes.[8–10] Furthermore, sub-optimal glycaemic control levels were observed in the majority of patients attending diabetes clinics in India.[11–13] The Indian Diabetes Control Programme requires incorporation of strategies towards improving the knowledge of people with diabetes. However, conventional approaches which rely solely on improving the quality of the patient–provider communication despite their proven efficacy may lack adequate effectiveness and scale-up potential in the usually overcrowded and often resource-limited public healthcare settings.

The utilization of text-messaging interventions through short messaging service (SMS), which is a universally available mobile phone technology, to provide health education to patients with diabetes is an effective and credible, low-cost intervention. The joint global initiative by the WHO and the International Telecommunication Union known as diabetes 'Be He@lthy Be mobile' was found highly useful in aiding diabetes self-management through text message-based interventions in Senegal.[14] To the best of our knowledge, hardly any studies have evaluated the efficacy of text-messaging interventions in enhancing diabetes-related knowledge in Indian patients with diabetes especially in the overcrowded health settings of public healthcare facilities. We conducted this study to determine the effect of health education through mobile phone text messages (SMS) on diabetes-related knowledge of people with diabetes.

METHODS

Design and participants

We conducted a quasi-experimental study at a major tertiary care centre in Delhi, India, from February 2016 to February 2017 among adults with diabetes mellitus (DM) up to 65 years of age

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who were: (i) undergoing treatment for at least 1 year; (ii) owned a mobile phone; (iii) willing to receive SMS messages for at least 3 months; and (iv) could operate a mobile phone to read SMS messages in either Hindi (in Devanagari script) or English languages. We excluded patients with advanced cardiovascular disease, history of cardiovascular accident, renal failure requiring dialysis, cancer, patients on psychotropic drugs, dementia and blindness.

We recruited participants from the endocrinology outpatient department (OPD) constituting the intervention group, and from the diabetes OPD constituting the control group. Both the OPDs had a similar level of standard of care, a similar patient load and a similar clinician profile comprising consultants, resident doctors and interns. The diabetes-related health education was imparted only by the treating clinician while patients were provided one-time dietary counselling from a nurse-cum-dietician before initiation of treatment and in the event of referral.

We assessed the change in the diabetes-related knowledge of the study participants post-intervention with the following instruments: (i) a 10-item questionnaire adapted from the previously validated Spoken Knowledge in Low Literacy in Diabetes (SKILL-D) questionnaire by Rothman *et al.*,[15] and (ii) an 8-item self-designed knowledge of diabetes questionnaire for further assessment of patients' diabetes-related knowledge.

The primary outcome of the study was the change in the SKILL-D questionnaire score, and the secondary outcome was a change in the knowledge of diabetes questionnaire score.

Outcome measurement

We scored of the questionnaires by awarding one point for every correct response and zero points for incorrect or do not know type responses. The knowledge score range for the SKILL-D questionnaire was 0–10, and the knowledge of diabetes questionnaire was 0–9.

The sample size for this study was calculated as part of a larger study to ascertain the change in medication adherence of patients with diabetes after the text messaging intervention. This sample size is adequate at 5% significance level and 90% power to detect a 0.75 increase in the mean (SD) knowledge score from the baseline SKILL-D score of 3.0 (2.1). This was estimated in a pilot conducted among 25 patients with diabetes at a secondary care hospital in Delhi.

Ethics

All the participants provided written informed consent. Ethical clearance was obtained from the Institutional Ethics Committee and the trial was registered (CTRI/2017/05/008642).

Methodology

We recruited participants by consecutive sampling from each of the five clinic rooms by turn in which the Diabetes and Endocrine OPD clinics were conducted. We collected data through face-to-face interviews with the patients using an interview schedule and the diabetes knowledge questionnaires. We used patient medical records for validating clinical parameters such as type of anti-diabetic drug therapy and presence of comorbid conditions. We ascertained the socioeconomic status of the participants using the modified Kuppuswamy scale updated for income criteria.[16]

Questionnaire development and pretesting

The SKILL-D questionnaire has been previously validated in patients with diabetes with poor literacy.[15] The preliminary patient knowledge questionnaire was self-designed in English after an exhaustive literature search of the subject, especially with regards to the Indian context. Face validity of the questions was established by a team of experts including an endocrinologist and two public health experts.

Linguistic validation was achieved through a back-and-forth translation process from English into the local language (Hindi). The translation process included (i) a forward translation of the respective questionnaires into Hindi by a native linguistic expert translator; (ii) the back-translation process to English was done by another native language expert; and (iii) the back-translation process was continued until the back-translated version matched with the original English version of the instrument. We pretested the study instruments in a different OPD setting during which the questionnaire items were read out aloud to assess patient understanding and make suitable modifications.

Reliability

The Cronbach alpha of the SKILL-D, knowledge of diabetes and the diabetes foot-care knowledge questionnaire were 0.74 and 0.65, respectively.

Intervention

We delivered health education to the participants of the intervention group through mobile phone text messages (SMS). We sent a total of 45 SMS text messages, one message every alternate day for 90 days. The text messages provided diabetes-related knowledge on disease control, self-care practices, medication adherence and risk of diabetes-related complications and their prevention. We sent the text messages using a smartphone. The intervention was strictly unidirectional and did not respond to any attempt at patient-initiated telephonic communication during the intervention period.

Attrition

A participant who was absent more than 30 days after the end of the intervention and could not be contacted on the telephone after three attempts was considered as lost to follow-up.

Statistical analyses

Data were analysed using IBM SPSS version 17. Categorical data were expressed in proportions (frequency and percentage) and quantitative data as mean and standard deviation. Differences in baseline characteristics between the groups were tested with the chi-square test and the Student *t*-test. The normality of the data was assessed using the Shapiro–Wilk test. Paired observations were tested using the paired *t*-test for normal data and the Wilcoxon signed-rank test for non-normal data. Paired categorical outcomes were tested using McNemar test. Due to the multiple comparisons involved in comparing individual items of the knowledge questionnaires, the Bonferroni correction was applied (0.05/10) and $p<0.005$ was considered statistically significant.

A modified intention-to-treat analysis was used. Patients who were lost to follow-up were excluded from the analysis due to the absence of any intermediate follow-up in the intervention period, which precluded imputation of the missing outcome variables.

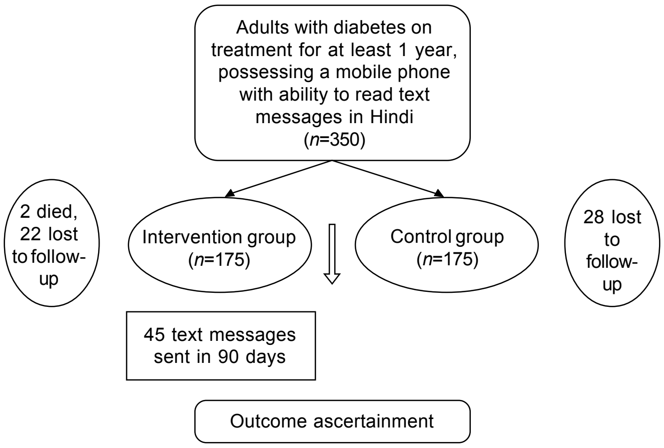

FIG 1. Flowchart for the quasi-experimental study

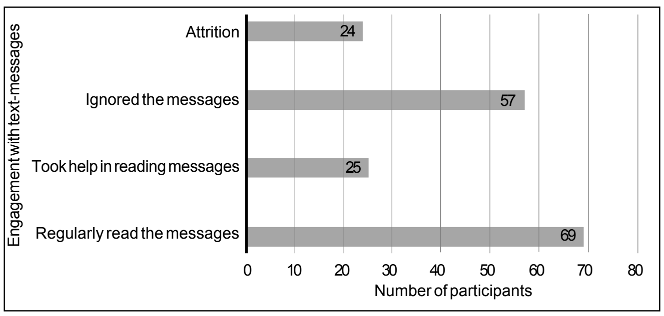

FIG 2. Utilization of text messages (short messaging service) in the intervention group (n=175)

RESULTS

We recruited 350 adults with diabetes comprising 190 men and 160 women for the study, of which 52 (14.8%) participants were lost to follow-up (Fig. 1). Furthermore, 57 (32.5%) participants reported having ignored the messages (Fig. 2). The baseline sociodemographic and clinical characteristics of the patients are reported in Table I. A total of 211 (60.2%) participants were educated up to middle school only, and 259 (74%) belonged to the lower socioeconomic classes. Participants in the intervention and control groups had comparable baseline characteristics related to age, sex, occupation, socioeconomic status and duration of diabetes. However, a significantly higher proportion of participants in the intervention group lived in nuclear families, had higher educational status and were insulin users.

At baseline, mean diabetes knowledge scores were higher in the intervention group compared to the control group. After the intervention period of 3 months, the diabetes knowledge scores for SKILL-D and the preliminary patient knowledge of diabetes questionnaire showed a statistically significant increase in the intervention group (mean difference 0.7 and 0.5, respectively; p<0.001 but there was no increase in the control group [Tables II–IV]). Furthermore, post-intervention, the mean knowledge scores in the intervention group were significantly higher compared to the control group (p<0.001). A two-way mixed ANOVA also showed a statistically significant interaction between the text-message intervention and time (pre- and post-intervention) on the mean diabetes knowledge score of the patient, F (1296)=33.8, p<0.001, partial χ^2=0.1.

The awareness of at least two complications from long-standing diabetes, recognition and management of hypo-glycaemia and the need for ophthalmic screening were found to

TABLE I. Characteristics of participants at baseline (n=350)

Characteristics	Intervention group (n=175)	Control group (n=175)	Total
Mean (SD) age (years)	48.8 (10.5)	50.1 (9.5)	49.5 (10.1)
Sex			
Men	96 (54.8)	94 (53.7)	190 (54)
Women	79 (45.1)	81 (46.2)	160 (46)
Marital status			
Currently married	147 (84)	163 (93.1)	310 (88.6)*
Family type			
Joint	129 (73.7)	147 (84)	276 (78.8)*
Nuclear	44 (25.1)	28 (16)	72 (21.2)
Educational status			
Primary school	50 (28.6)	59 (33.7)	109 (31.1)
Middle school	43 (24.6)	59 (33.7)	102 (29.1)
High school and above	82 (46.8)	57 (32.5)	139 (39.8)*
Occupation			
Clerical/shop owner	27 (15.4)	19 (10.9)	46 (13.2)
Skilled	20 (11.4)	22 (12.6)	42 (12)
Semi-skilled/unskilled	18 (10.2)	19 (10.8)	37 (10.5)
Unemployed	104 (59.4)	112 (64)	216 (61.7)
Socioeconomic class			
Upper middle	42 (24)	40 (22.9)	82 (23.4)
Lower middle	97 (55.4)	93 (53.1)	190 (54.2)
Upper lower	31 (17.7)	38 (21.7)	69 (19.7)
Duration of diabetes (years)	7.7 (6.9)	6.9 (6.5)	7.3 (6.7)
Treatment			
Oral hypoglycaemic agents	106 (60.5)	136 (77.7)	242 (69.2)*
Insulin	69 (39.5)	39 (22.3)	108 (30.8)

Values in parentheses are percentages unless otherwise stated *p<0.05

TABLE II. Change in knowledge of diabetes assessed with the SKILL-D questionnaire in participants post-intervention (*n*=298)

Item	Intervention group (*n*=151)		Control group (*n*=147)	
	Correct responses *n* (%)			
	Baseline	Endline	Baseline	Endline
Symptoms of diabetes	149 (98.6)	150 (99.3)	146 (99.3)	146 (99.3)
Controlled fasting glucose level	80 (53)	91 (60.2)	69 (44.9)	69 (44.9)
Controlled HbA1c level	11 (7.3)	15 (9.9)	7 (4.7)	6 (4)
Complications of diabetes	64 (42.4)	82 (56.3)*	52 (35.3)	57 (38.7)
Eye check-up reason	17 (11.2)	26 (17.2)	8 (5.4)	11 (7.4)
Low blood sugar signs and symptoms	89 (59)	96 (63.5)	59 (40.1)	65 (44.2)
Patient management of low blood sugar	78 (51.6)	87 (57.6)	58 (39.4)	63 (42.8)
How often should patient inspect feet	6 (3.9)	14 (9.2)	4 (2.7)	4 (2.7)
Importance of foot examination in diabetes	22 (14.6)	45 (30)*	9 (6.1)	12 (8.1)
Duration of exercise required in diabetes	16 (10.6)	31 (20.5)*	18 (12.2)	18 (12.2)
Mean (SD) total score (0–10)	3.5 (2)	4.2 (2.3)	2.9 (1.9)	2.8 (1.9)

* $p<0.05$

TABLE III. Change in knowledge of diabetes assessed with the preliminary diabetes knowledge questionnaire in participants post-intervention (*n*=298)

Item	Intervention group (*n*=151)		Control group (*n*=147)	
	Correct responses *n* (%)			
	Baseline	Endline	Baseline	Endline
What happens to blood sugar level in diabetes?	144 (95.3)	145 (96)	135 (91.8)	137 (93.1)
Risk factors of diabetes				
(a) Family history	49 (32.5)	54 (35.8)	33 (22.4)	38 (25.8)
(b) Obesity	24 (16)	30 (19.9)	15 (10.2)	15 (10.2)
(c) Sedentary lifestyle	23 (15.2)	35 (23.2)	18 (12.2)	18 (12.2)
Blood sugar in control	127 (84)	129 (85.4)	117 (79.6)	116 (78.9)
Diabetes treatment duration	142 (94)	143 (94.7)	141 (95.9)	143 (97.2)
Fruits suitable in diabetes	85 (56.3)	97 (64.2)*	76 (51.7)	79 (53.7)
Importance of HbA1c	32 (21.2)	64 (42.4)*	15 (10.2)	24 (16.3)
Controlled blood pressure in diabetes	30 (19.9)	32 (21.2)	10 (6.8)	14 (9.5)
Continue diabetes treatment in case of mild illness	140 (92.7)	140 (92.7)	138 (93.8)	139 (94.5)
Mean (SD) total score (0–10)	5.1 (1.9)	5.6 (2)*	4.6 (1.4)	4.6 (1.3)

* $p<0.05$

TABLE IV. Effect of text-messaging intervention on diabetes knowledge scores stratified by age, sex and education status

Variable	SKILL-D questionnaire			Diabetes knowledge questionnaire		
	Baseline	Endline	p value	Baseline	Endline	p value
Age (years)						
<50	3.5 (2.0)	4.2 (2.4)	<0.001	5.1 (1.8)	5.6 (2.0)	<0.001
≥50	3.5 (2.1)	4.2 (2.3)	0.001	5.1 (2.0)	5.6 (2.0)	0.002
Sex						
Men	3.6 (2.1)	4.3 (2.3)	<0.001	5.3 (1.8)	5.8 (1.8)	<0.001
Women	3.3 (2.0)	4.0 (2.4)	<0.001	4.9 (1.9)	5.3 (2.0)	0.001
Education status						
Below high school	2.9 (1.8)	3.5 (2.1)	<0.001	4.6 (1.8)	5.1 (2.0)	<0.001
High school or higher	4.1 (2.1)	4.8 (2.4)	0.001	5.7 (1.8)	6.0 (1.7)	<0.001

be significantly increased in the intervention group (Table II). The understanding of the importance of HbA1c test also improved (Table III). The knowledge of foot-care in diabetes which was very low at baseline, showed a significant increase post-intervention in the intervention group (Table II). Furthermore, a significant improvement in patient knowledge of diabetes was found across age, sex and educational status (Table IV).

In the intervention group, the HbA1c improved from 8.5 (2.2) (baseline) to 8.2 (1.9) (post-intervention). In the control group, the HbA1c changed from 8.3 (1.8) (baseline) to 8.2 (1.8) (post-intervention).

DISCUSSION

Our study shows that diabetes-related health education delivered through text messages can enhance patient knowledge of diabetes relating to various aspects such as correct self-care management, the risk of complications and glycaemic control targets. Previous studies have highlighted the acceptability of text messaging as a medium for effective health promotion against non-communicable diseases in the general population.[17,18] However, to the best of our knowledge, this is one of the first studies in India where SMS has been used to improve diabetes care in a predominantly low socioeconomic diabetes population availing treatment from a resource-constrained clinic setting.

The text-messaging intervention was effective in enhancing diabetes-related knowledge in patients with a low educational status, which was a major challenge even in an Indian diabetic counselling-based intervention.[19] In our study, nearly one-sixth (14.2%) of the participants who were technologically or educationally semi-literate were able to benefit from the intervention through assistance from family or friends. This implies that SMS can be used to improve knowledge of diabetes among friends and family members that can promote diabetes awareness in the community and enlist family support for helping patients cope with diabetes. Certain aspects such as awareness of hypoglycaemic symptoms and their early management within the family can reduce their incidence and resulting hospitalization and healthcare expenses. These findings are similar to other diabetes health-education counselling interventions which reported an improvement in diabetes knowledge in patients across all literacy levels, but were unable to close the initial learning gap between patients of low and high literacy.[6,7]

The diabetes knowledge score in the control group did not show any improvement after the intervention period of 3 months. This suggests that the existing diabetes education strategies at the study site relying on patient–provider communication were mostly ineffective due to the heavy patient load, which reduced health education opportunities for patients.

Our study observed only a modest improvement in glycaemic control, probably due to the short period of follow-up. Moreover, the improvement in knowledge about diabetes could potentially enhance their efficacy towards recommended self-care practices such as foot-care without actually improving their metabolic outcomes.[20]

Limitations

The first limitation of our study was the baseline imbalance between the intervention and control groups due to which there was a significant difference in the baseline characteristics of the intervention and control groups. The participants of the intervention group were more likely to be better educated and insulin users which reflected in their significantly higher baseline diabetes knowledge scores in comparison to the control group. This situation was perhaps due to bad luck in a quasi-experimental design occurring from patient management issues that could not be anticipated. These limitations could have been avoided by using a randomized controlled trial design and selecting participants from the same OPD setting. However, we opted for a quasi-experimental design since there were concerns regarding contamination in our study settings as the patients were prone to discuss the text messages with other patients during the long waiting periods at the OPD, which could have potentially increased the diabetes knowledge of participants in the control group. Moreover, ensuring that cases and controls visited the clinic on separate days was not feasible as the patients often came to the special clinics as per their convenience and not as per their scheduled appointment. Finally, selectively offering the text-message service to some of the patients within the same OPD setting and not the others could have resulted in patient dissatisfaction.

Second, our study used a mobile phone for text messaging which is unlike real-world settings in which automated text message systems operate for broadcasting to large populations. In our study, the participants were aware that the text messages were being sent by a healthcare provider which may have a different degree of patient acceptability and efficacy compared to real-world automated text messaging.

Third, our study used a unidirectional mode of text messaging that precluded the possibility of tailored messaging and patient interaction—this limited the utilization of the complete potential of mobile phone technology towards attaining the study objective.

Fourth, a sizeable proportion of participants reported having ignored the messages, which often occurred since they did not regularly check their SMS inbox. It is advisable then for healthcare providers to provide a reminder to patients to read their messages at the time of appointments, especially during the periods when the intervention is active.

Conclusion

An average patient with diabetes usually spends no more than a few hours in the healthcare setting for the entire year. However, their health outcomes are primarily determined by adherence to self-care practices during the rest of the time at their home and work away from their healthcare settings signifying the importance of maintaining continuity of care and motivation in patients with diabetes for which a few healthcare resources are usually allocated. Harnessing mobile phone technology by implementing low-cost, text messaging interventions can bridge this gap, especially in resource-constrained and underserved areas. Our study findings indicate such technology is equitable as it is beneficial even among patients with low literacy. In the Indian context, which has the second highest total mobile phone connections in the world but with a relatively lower smartphone and mobile internet access,[21,22] SMS technology is the most viable medium for the transmission of health education with timely reinforcement and optimum frequency. Future studies in the developing world should ascertain the long-term effectiveness of text-messaging interventions in improving diabetes care and behavioural change through more complex interventions involving higher frequency of text-messaging, bi-directional mode of communication and tailoring of messages with patient-centred approaches.

Conflicts of interest. None declared

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