ORIGINAL ARTICLE

mDiabetes initiative using text messages to improve lifestyle and health-seeking behaviour in India

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ABSTRACT

Background Data on the use of mobile technology in public health are sparse. Text messaging is cost-effective in disseminating information to large communities. The Ministry of Health and Family Welfare, Government of India, initiated and executed this mDiabetes programme.

Objectives The main objective of this commissioned study was to test the feasibility of using mobile technology to reach a large number of people to improve their lifestyle and health-seeking behaviour. Participants' interest, acceptability and scope for improvement were assessed.

Methods This mDiabetes observational study was done in India between 2016 and 2017. Text messages inviting registrations were sent to 130 million people in the country, mostly to the working class. Respondents (n=107 548) were registered by dialling a given phone number (missed phone call) or through a website. Based on the response, participants were grouped into six categories: persons with diabetes, pregnant/lactating women, high-risk individuals, healthcare professionals, elderly and normal population. They received 90 messages on healthy living during the 6 months. The impact of intervention was assessed at the third and sixth months by feedback messages. Telephonic interviews were conducted at 1 year in a subpopulation (n=855).

Results The registered respondents, 31 725, were grouped into six categories. 21.4% had diabetes and 5.3% had multiple risk factors. 15.6% responded to feedback messages. Among them, 57.2% followed a healthy diet, 72.3% practised advice on physical activity, 51.9% screened for diabetes and 67.3% checked their glycaemic status. The telephonic interviews showed that the programme was feasible and acceptable. The participants suggested use of interactive voice response system for registration and motivation.

Discussion and conclusion The study demonstrated the feasibility and acceptability of mHealth in a large population to disseminate knowledge regarding diabetes and healthy lifestyle, and to improve health-seeking behaviour. It helped to identify the limitations and scope for future improvements.

INTRODUCTION

The burden due to non-communicable diseases (NCDs) and injuries as a whole has overtaken that of communicable diseases in every state of India.[1] Among the NCDs, diabetes is one of the disease conditions that reached an epidemic proportion in India. In 2015 there were 69.2 million people with diabetes in the country.[2]

Several clinical trials, including the Indian Diabetes Prevention Programme, have shown that intensive lifestyle modification (LSM) in people with impaired glucose tolerance (IGT) can reduce progression to diabetes up to 58%.[3–8] Such programmes are, however, labour-intensive, costly and have not been widely implemented, even in high-income countries.

In order to implement a prevention or awareness programme, we need a tool which is cost-effective, is not human resource-intensive and is accessible to all individuals in the country. Mobile phones provide such an opportunity. Mobile phone has become an important tool for day-to-day activities, such as for communication and business transactions. In

India its use has become widespread even in rural areas. Therefore, text messaging can be used to disseminate information to large communities. Mobile phone messaging (text messaging or short message service (SMS)) is the method for delivery of educational advice and motivation to achieve LSM.[8–14] There is a paucity of data on the use of mobile technology in public health.

In 2009, Ramachandran *et al* used text messages through mobile phones to educate and motivate persons with IGT who were enrolled in a 2-year randomised controlled prevention trial.[8] A relative risk reduction of 36% in the incidence of diabetes in 2 years was seen among the participants who received frequent text messages, in comparison with people who received standard lifestyle advice. A similar intervention done by Arogya World in the country had shown significant behaviour changes ($F(1, 1238)=30.181$, $p<0.001$) among registered individuals.[14]

Under the mDiabetes programme, tailored short mobile text messages were sent that encourage lifestyle changes to prevent or manage diabetes. The Ministry of Health and Family Welfare (MoHFW), Government of India (GOI), has implemented the mDiabetes programme. The technical support was provided by the Ministry of Electronics and Information Technology, academic and research institutions. The WHO and the India Diabetes Research Foundation (IDRF), Chennai, are part of the technical group. The mDiabetes programme was launched in June 2016. The main objective of the programme was to examine the feasibility (ease and convenience) of effectively reaching a large number of people through mobile technology, to improve healthcare-seeking behaviour and to promote early diagnosis of diabetes and treatment and lifestyle adherence.

In this commissioned study, we have examined the process and outcomes of the mDiabetes intervention 1 year after its implementation and assessed possible areas of modification and scale-up. It is expected that the outcome of the mDiabetes programme will open up avenues for implementation of similar large-scale interventions to prevent and control lifestyle disorders.

METHODS

The mDiabetes programme was conceptualised by the MoHFW (GOI) and WHO Country Office for India, in consultation with various stakeholders. A technical advisory committee was constituted to finalise the algorithm, and text messages were drafted by the IDRF and were further revised by MoHFW (GOI). The evaluation study was a prospective observational cohort study done between June 2016 and September 2017 involving various categories of population who were registered in the programme.

Registration and categorisation

Text messages providing key information and inviting registration were sent to the participants by MyGov and National Informatics Centre departments of GOI. The participants could self-register either by making missed phone call on a given number or using mDiabetes website interface. The initial categorisation questions were sent by text messages to the participants registered by missed phone call. For those who registered through website, responses were sought from the participants during the registration itself. The questions sent are shown in figure 1. Participants were subsequently categorised as persons with diabetes, pregnant/lactating women, persons with high risk of diabetes (having two or more risk factors: body mass index $\geq 23\,kg/m^2$, family history of diabetes, history of hypertension and sedentary lifestyle), healthcare professionals, elderly and normal population.

Text messages

The text messages on healthy diet, lifestyle behaviours such as tobacco and alcohol use, physical activity, adherence to medication and basics of diabetes/gestational diabetes were sent in English or Hindi as per participants' preference. Each participant received 90 text messages in a span of 6 months on alternate days (online supplementary table 1 shows the sample text messages). Each text message costed less than 0.03 rupees.

Impact of text messages on behavioural changes at the third and sixth months

Behavioural changes related to diet, physical activity and medication adherence were obtained by response to text messages at the end of the third or sixth month (online supplementary table 2). Health-seeking behaviour such as screening for diabetes/gestational diabetes was also assessed. During the programme participants had to respond to eight text messages on their behavioural changes. For each response the participant had to pay 3.00 rupees.

Telephonic interview with the participants at the end of the first year of the programme

To obtain feedback on the programme, a subsample of the selected participants were chosen and individual telephonic interviews were conducted. Subsamples were chosen to represent persons according to type of registration, geographical zone, category of persons and the responses at third or sixth month (figure 2). For each of the above factor we chose 45 participants, and the total sample size was 855. Participants in each category were selected after the mobile numbers were sorted based on the date of registration. Random numbers from each category were chosen from the four zones (figure 2). Participants who were unable to recall receiving

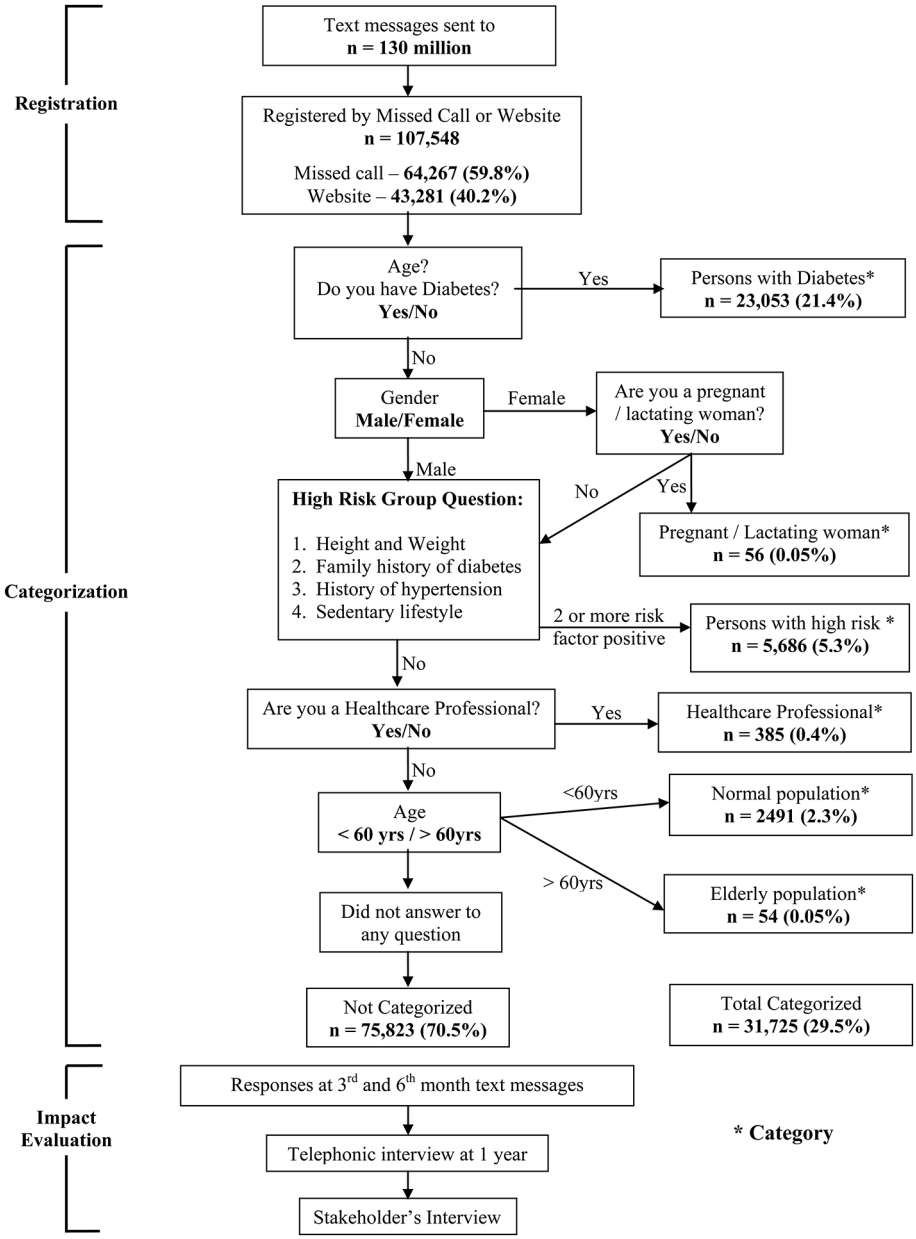


Figure 1 Methods of registration, categorisation and impact evaluation of the mDiabetes programme, n (%).

the messages or unwilling for the interview were excluded. The selected participants were telephonically interviewed by a trained research assistant using a structured questionnaire after obtaining oral consent. The interview was conducted in English or Hindi at a convenient time to the participants. The questionnaire was tested and validated in our previous study.[8] Participants were given sufficient time to answer all the questions. All the details given by the participants were noted down and the conversation was voice-recorded.

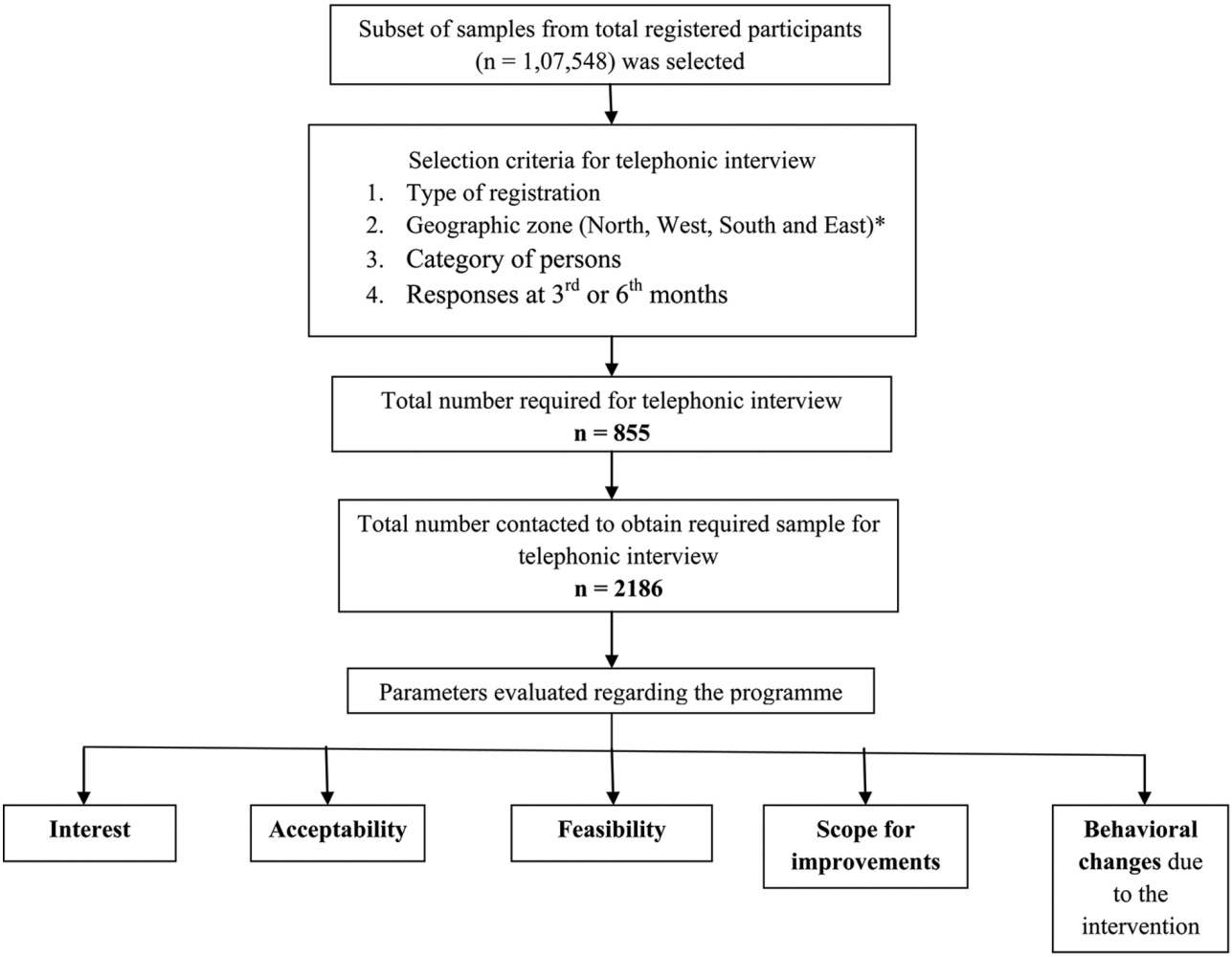
The parameters evaluated include participants' interest and acceptability of the programme, feasibility, scope for improvement and the behavioural changes that occurred following the intervention (figure 2).

Statistical analysis

The results of the qualitative and quantitative parts of the study were expressed in number and percentage. No further analysis was required in this descriptive study.

RESULTS

In the programme text messages were sent to 130 million mobile phone numbers using a database from the national registry of individuals. A total of 107 548 responded to the text messages and were registered in the programme. Of the participants, 43 281 (40.2%) registered by website, while 64 267 (59.8%) registered by missed phone call. The details of registration are shown in figure 1.



* *Zones - States:*

North zone: Jammu and Kashmir, Himachal Pradesh, Punjab, Uttarakhand, Uttar Pradesh, Haryana, Chandigarh and Delhi.

West zone: Rajasthan, Gujarat, Goa, Maharashtra, Madhya Pradesh, Dadra and Nagar Haveli and Daman and Diu.

South Zone: Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, Pondicherry, Lakshadweep and Andaman and Nicobar Islands.

East zone: Chhattisgarh, Bihar, Orissa, Jharkhand, West Bengal, Assam, Sikkim, Nagaland, Meghalaya, Manipur, Mizoram, Tripura and Arunachal Pradesh.

Figure 2 Impact evaluation of the programme at 1 year. Selection of participants for telephonic interview and parameters assessed.

The percentages of people who responded from the North, West, East and South zones were 32.7%, 32.7%, 23.4% and 11.2%, respectively. Figure 1 also shows the categorisation of the registered participants. A large number (n=75 825, 70.5%) could not be categorised since they did not respond to all the initial questions on categorisation. Among the categorised persons, the largest proportion had diabetes (n=23 053, 21.4%). A higher proportion were men (86.2%) and 24.3% were in the age group of 40–50 years. Two or more risk factors were present among 5.3% (n=5686) of the participants.

Among the registered participants, 31 725 persons were categorised into six different categories. The inbuilt programmatic evaluation questions through text message were responded to by 4954 (15.6%) participants (2022 responded after the third month, 2354 responded after the sixth month and 578 responded both of the times). The proportions responding to questions on diet, physical activity and health-seeking

Table 1 Lifestyle and health-seeking behaviour at third-month and/or sixth-month follow-up

Components of behaviour	Responders (n)	Followed advice, n (%)
Diet habits	1989	1138 (57.2)
Physical activity	1129	816 (72.3)
Screening for diabetes	1709	888 (51.9)
Checked glycaemic control	969	652 (67.3)

behaviour were n=1989 (6.3%), 1129 (3.6%) and 2678 (8.4%), respectively. Among them 1138 (57.2%) followed a healthy dietary advice, 816 (72.3%) practised physical activity, 888 (51.9%) did screening for diabetes and 652 (67.3%) checked their glycaemic status (table 1).

Outcome evaluation at the end of the first year by telephonic interview

In a subsample of participants (n=855), an evaluation was done at the end of 1 year to assess interest and acceptability of the intervention, feasibility, scope for improvement and the behavioural changes that occurred due to the intervention. According to the type of responses obtained at the various stages (n=19) of the study, we arbitrarily chose 45 participants from each stage (figure 2). To select a total of 855 participants, 2186 had to be contacted. Among 2186 telephonic calls, 20% were not aware of the programme, 8% had not registered and 33% were not reachable.

Interest in the programme

All the interviewed participants were interested in this programme. Among them 623 (72.9%) wanted to know about diabetes and 144 (16.8%) wanted details of healthy lifestyle. The text messages were shared with parents, relatives and friends by 549 (64.2%) participants, and 646 (75.6%) understood and tried to follow a healthy lifestyle behaviour (figure 3A).

Acceptability

The text messages sent for registration were acceptable to 832 (97.3%) and prompted them to participate. Among them 689 (80.5%) agreed to participate to improve their knowledge about diabetes and healthy lifestyle. The contents of the messages were understood and appreciated by 715 (83.5%), while 490 (57.2%) were satisfied with the frequency of the messages. Another 141 (16.5%) preferred increased frequency of the messages (figure 3B). Since the evaluation was done 1 year after completion of the initial phase, the

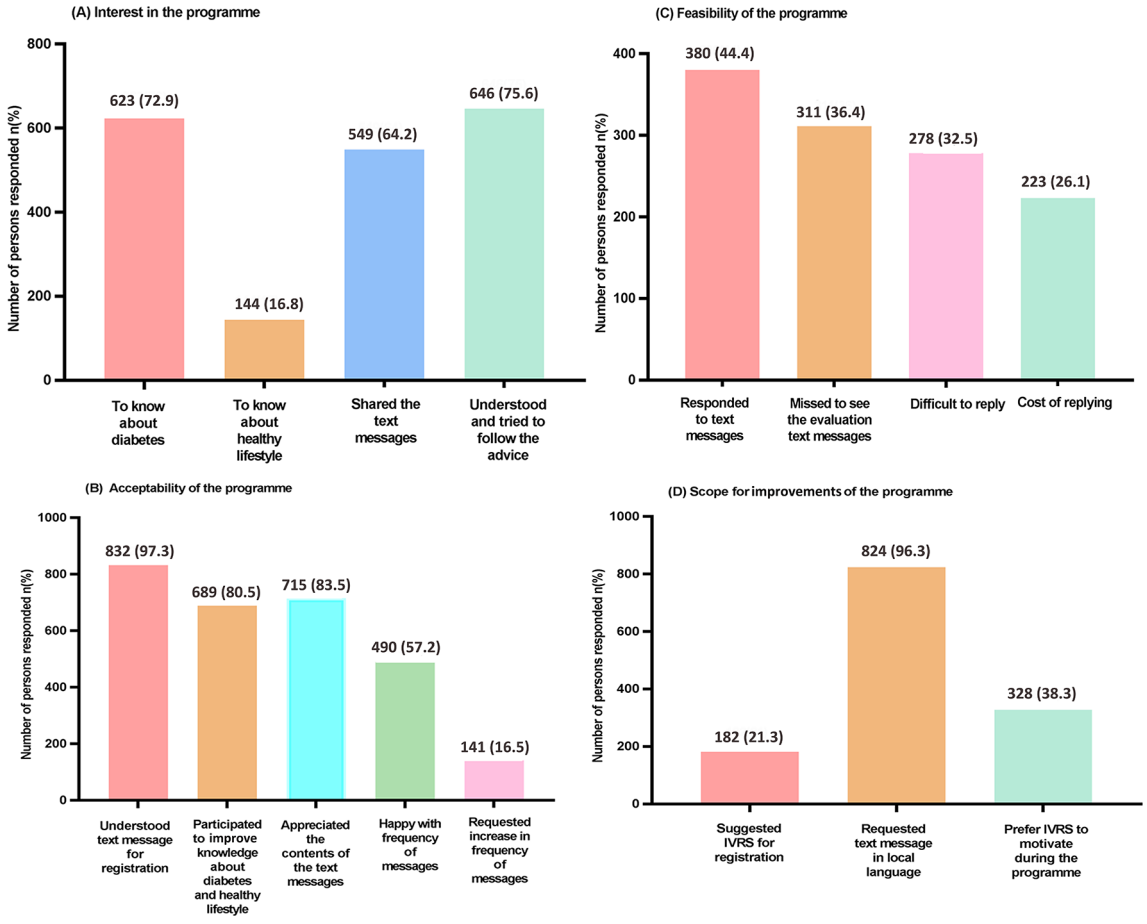


Figure 3 Parameters evaluated by telephonic interview of participants at 1-year follow-up, n (%). IVRS, interactive voice response system.

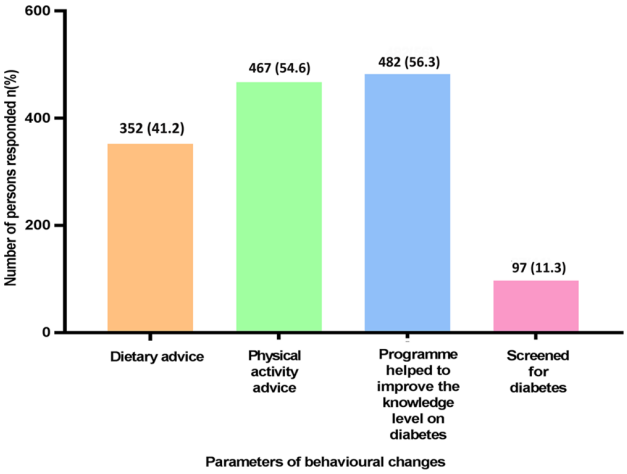


Figure 4 Impact evaluation at 1 year (n=855). Responses to questions on behavioural changes, n (%). Participants who followed healthy lifestyle practice and had health-seeking behaviour.

participants could not remember the time and count of text messages they received.

Feasibility of the programme

The mode of registration was found to be easy and feasible by 727 (85.0%). However, 278 (32.5%) reported that the text messages at the third and sixth months were difficult to understand and reply to, 311 (36.4%) missed to see the evaluation text messages and 223 (26.1%) did not respond since they had to pay to reply. Those who responded to text messages did not have any difficulty in replying (figure 3C).

Scope for improvement of the programme

Using an interactive voice response system (IVRS) for registration was suggested by 182 (21.3%), 328 (38.3%) preferred to use IVRS to motivate or remind them during the programme, and 824 (96.3%) felt receiving text messages in their local language would help them understand better (figure 3D).

Behavioural changes due to intervention

Responses were obtained for behavioural changes from 855 participants; among them nearly 352 (41.2%) followed a healthy dietary advice and 467 (54.6%) practised physical activity. This programme helped to improve knowledge level regarding diabetes in 482 (56.3%) and prompted 97 (11.3%) to screen for diabetes (figure 4).

DISCUSSION

The results of the evaluation suggested that mHealth intervention was principally acceptable to the participants. Large communities can be approached with valuable information on healthy lifestyle at a low cost in a short period of time.

Type 2 diabetes (T2D) is one of the major public health problems. India has a large population affected by T2D, yet awareness among the public regarding disease prevention, components of healthy lifestyle, need for early diagnosis and disease management requires improvement.[2 15 16] Studies from different parts of the world, including India, have shown that T2D is a preventable disorder.[3–8 17] Healthy lifestyle practices prevent the disease in 30%–50% of persons with high risk of developing diabetes. Initiation of appropriate therapy from an early stage can considerably reduce the development of the vascular complications and ensuing morbidity and mortality.[17]

Simple, cost-effective and innovative strategies of communication have to be evaluated and implemented at the national level. The mDiabetes programme was implemented in order to generate awareness and to sensitise the general population on healthy lifestyle factors, and to identify people with the disease or its risk factors. mHealth using mobile text messages for communication has proven to be a suitable and cost-effective mode for dissemination of knowledge and for gathering information on a large scale with minimal requirement of trained manpower.

In India, a randomised controlled diabetes prevention trial by Ramachandran *et al*[8] used text messages to motivate persons with IGT to follow LSM. Pfammatter *et al*[14] also used mHealth procedure to motivate the participants to follow a healthy lifestyle. In both the studies participants were also contacted through personal reviews or through telephonic interview. In the mDiabetes programme, participants were contacted only through text messages except during the final feedback assessment, which was done in a subset of selected participants through telephonic interviews.

A few earlier initiatives using mHealth were successfully documented in India; therefore, this programme was taken up by the MoHFW (GOI) with support from the WHO Country Office for India and other stakeholders. Inbuilt evaluation text messages were designed in the programme to encourage participation, to get feedback from the registered participants, to categorise the individuals for sending contextualised messages, to assess the level of knowledge acquired and to assess changes in lifestyle. Evaluations were made at the third and sixth months after the messages were sent to the registered participants, and the impact was assessed at the end of 1 year by telephonic interviews.

Although the promotional text messages were sent to 130 million persons, response for registration was obtained from a fraction (107 548). Since the promotional messages were sent only once, it is possible that many would not have noticed it and also many would not have responded because of apprehensions about the registration process.

Out of the 107 548 registered, 75 823 (70.5%) could not be categorised since they did not respond to the initial categorisation questions. The SMS were sent in only two languages. Hence there is a possibility

that many participants would not have understood the categorisation messages and therefore did not respond. Introduction of interactive methods such as IVRS could enhance the impact and outcome of the initiative.

A higher percentage of persons with diabetes have responded to both the third-month and sixth-month questions on physical activity, diet and regular monitoring of blood glucose as compared with other categories. This showed that persons with diabetes were more interested in this programme than those from other categories. The responses were further verified during the telephonic interview.

The text messages on the principles of healthy lifestyle and health-seeking behaviour prompted more than 50% of the participants to follow the advice on dietary habits and physical activity and motivated 52% of the participants to screen for diabetes. Among the people with diabetes, 67.3% checked their glycaemic control.

During the telephonic interviews, the participants gave suggestions to improve the acceptability and replicability of the programme. Since the evaluation was done after a year of completion of the programme, most of the participants were not able to recollect the frequency of text messages and the time when they were delivered. The participants were interested in joining the programme and imbibe new knowledge regarding diabetes. More than 60% of the participants tried to follow the advice mentioned in the text messages and shared them with their parents, friends and relatives. The reasons for the low response could be due to the time gap between the delivery of the programme and the interview, missing the messages, difficulty in replying, as well as the cost to reply. Based on the lack of responses from participants at the third-month and sixth-month evaluation questions, it might be considered that those participants did not complete the programme. Other reasons behind low response rates could have been difficulty in understanding the questions and not repeatedly reminding them to respond to the questions.

Comparatively better response rate among participants with diabetes could be partly due to their better knowledge about the risk factors and about the disease management.

Lack of comprehensive publicity strategies, implementation only in two languages, including too many different categories, levying of user charges while replying to text messages and using text messages as a sole method for receiving the feedback could be limitations during the initial phase of the programme. Reporting or recall bias during telephonic interview was another limitation of the programme.

Repeated and brief promotional messages may improve participation. Sending messages in local languages and provision for an initial interaction via voice messages also may have improved the participation and the rate of response at the third and sixth months. The reply message from participants can be free without any user charges.

Existing resources at the Centre of Health Informatics and National Informatics Centre (GOI) were used to host the programme, which did not require extra resources. The text messages were sent to participants using SMS gateway at 0.03 rupees/SMS. The user paid 3.00 rupees/SMS for responding to the evaluation questions.

Overall, the results from the evaluation study suggested that the programme was acceptable to the public. The use of text messages through mobile phones was a feasible approach to reach a large population. The text messages were sent through predefined algorithm-based platform, and it does not require regular engagement of the professional staff. The feedback from the participants has helped to identify limitations in the design of the programme. The study shows that lifestyle changes can be promoted at the population level through mHealth interventions. However, some improvements in the programme can enhance the reach among population. Text messages can be supplemented with different interactive methods such as IVRS or outbound call to encourage proper responses. Filling the gaps and implementation of improved strategies can help to scale up and improve the performance of mDiabetes interventions in India. The mHealth intervention has potential to become an efficient strategy in public health.

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Contributors Conceived and designed the experiments: AmR, CS, SK, PJ, FT, RK. Trained the technical team to deliver the programme: SK, PJ. Performed the experiments: SK, PJ, FT, RK. Analysed the data: AmR, CS, SK. Wrote the first draft of the manuscript: AmR, CS, SK. Contributed to discussion, reviewed/edited the manuscript: AN, ArR, PJ, FT, RK. Agreed with the manuscript's results and conclusions: all authors.

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