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Interventional study to improve diabetic guidelines adherence using mobile health (m-Health) technology in Lahore, Pakistan

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ABSTRACT

Objective To check if mobile health (m-Health) short message service (SMS) can improve the knowledge and practice of the American Diabetic Association preventive care guidelines (ADA guidelines) recommendations among physicians.

Methodology Quasi-experimental pre–post study design with a control group.

Participants The participants of the study were 62 medical officers/medical postgraduate trainees from two hospitals in Lahore, Pakistan. Pretested questionnaire was used to collect baseline information about physicians' knowledge and adherence according to the ADA guidelines. All the respondents attended 1-day workshop about the guidelines. The intervention group received regular reminders by SMS about the ADA guidelines for the next 5 months. Postintervention knowledge and practice scores of 13 variables were checked again using the same questionnaire. Statistical analysis included χ^2 and McNemar's tests for categorical variables and t-test for continuous variables. Pearson's correlation analysis was done to check correlation between knowledge and practice scores in the intervention group. P values of <0.05 were considered statistically significant.

Results The total number of participating physicians was 62. Fifty-three (85.5%) respondents completed the study. Composite scores within the intervention group showed statistically significant improvement in knowledge (p<0.001) and practice (p<0.001) postintervention. The overall composite scores preintervention and postintervention also showed statistically significant difference of improvement in knowledge (p=0.002) and practice (p=0.001) between non-intervention and intervention groups. Adherence to individual 13 ADA preventive care guidelines level was noted to be suboptimal at baseline. Statistically significant improvement in the intervention group was seen in the following individual variables: review of symptoms of hypoglycaemia and hyperglycaemia, eye examination, neurological examination, lipid examination, referral to ophthalmologist, and counselling about non-smoking.

Conclusion m-Health technology can be a useful educational tool to help with improving knowledge and practice of diabetic guidelines. Future multicentre trials will help to scale this intervention for wider use in resource-limited countries.

Strengths and limitations of this study

- ► This was a pioneer interventional mobile health technology study done in Pakistan.
- ► There is good response rate from the respondents and use of validated tool.
- ► Small study sample size does not permit generalisation, but this was an exploratory study.
- ► The study looked only at the process variables and not patient outcomes, and self reporting may overestimate the actual adherence to the guidelines due to social desirability bias.

INTRODUCTION/BACKGROUND

Diabetes mellitus (DM) is a multisystem disease requiring coordinated care among various subspecialties. Pakistan is a country with a high burden of DM with increased morbidity and mortality.[1] According to the WHO the prevalence of DM was 9.8% in 189 million Pakistani population in 2016, and it is expected to increase to 14 million by 2030.[2]

In Pakistan diabetic care is not optimal. In a study done in Karachi, Pakistan, it was noted that only 44% patients with diabetes had examination of their lower legs and only 30% had eye examination. Haemoglobin A1c levels were recorded in 44% of the patients and fasting blood sugar was checked in 50%.[3] Another study done in Mirpur, Azad Kashmir, Pakistan, in 2012–2013 checked the diabetic preventive care recommendations by physicians. The results revealed that 39% of the patients had not been properly counselled about required lifestyle changes, and that 68% had not received information on prevention of diabetic complications.[4]

Diabetic guidelines are important tools to provide structured evidence-based care of DM.[5] Diabetic guidelines have been shown to improve diabetic care, and inconsistent use of clinical guidelines by healthcare

professionals has been linked to substandard diabetic care.[6] Compliance with diabetic guidelines has been known to be affected by various factors, including workload, time constraints, knowledge and attitudes of healthcare professionals. Patient factors including patient literacy, their beliefs and financial resources also impact the adherence to diabetic guidelines. Various healthcare organisational constraints and lack of availability of national diabetic guidelines are also important determinants for guideline adherence.[7 8] There is a lack of national diabetic guidelines and standardised evidence-based care in Pakistan.[3 4] In a study done in Rawalpindi, Pakistan, only 7% of the physicians were following diabetic guidelines completely.[9]

Studies have shown that current educational methods may result in significant gaps in physician knowledge for diabetes management.[10 11] Medical professionals need to acquire and assimilate huge amounts of medical information. This requires efforts to retain a lot of information and to update it regularly as new information becomes available. Studies have shown that physician reminders can be used to improve preventive care services.[12] Translating Research into Action for Diabetes study (TRIAD) data has shown that when physicians are given regular reminders and are trained to use diabetic guidelines, diabetic care is improved.[13] The lack of regular use of diabetic guidelines may be due to gaps in diabetic education and inadequate training of physicians to use diabetic guidelines.[14 15] New strategies are being recommended for effective guideline implementation instead of just passive dissemination of guidelines.[7]

Pakistan has limited resources, but mobile phones are widely available and it has been noted that clinicians use their medical devices for a variety of purposes, including accessing clinical information.[16] Mobile phones have the benefit of widespread use, internet access and portability, which can allow mobile phone interventions integration into the daily routine of the individuals and have been used in care of chronic diseases including DM.[17] Healthcare professionals are increasingly using smartphones because they offer easy and timely access to updated medical information and better communication.[18] The mobile health (m-Health) short message service (SMS) technology also specifically has been used to improve adherence to clinical guidelines.[19 20]

The rationale of the study was therefore to use this novel m-Health technology (SMS) method to improve the knowledge and practice of the American Diabetic Association (ADA) preventive care diabetic guidelines among physicians.[21]

METHODOLOGY

Study design

The study has a quasi-experimental pre–post design with a control group.[22]

Table 1 Recommended frequency of diabetic preventive care as per the American Diabetic Association (ADA) guidelines

Variables	Recomended frequency of follow up care after the intial work up in at risk patients
Haemoglobin A1c check	Every 6 months unless change in treatment or uncontrolled blood sugar levels
Blood pressure check, smoking counselling, check for symtomatic and asymptomatic hyperglycaemia/ hypoglycaemia	Every visit
Fasting lipids, neurological examination, eye examinationand referral to ophthalmologist(if evidence of retinopathy), urine for protein, influenza vaccine administration	Annually
Pneumovax administration	All patients with diabetes ≥2 years of age, a one-time revaccination for individuals >65 years of age who have been immunised with PPSV23 vaccine >5 years ago

Table 1 shows the important preventive care variables that should be checked as recommended by the ADA guidelines.

Study population

We randomly selected two hospitals in Lahore, Pakistan, by the pick out of hat method after listing all public teaching hospitals in Lahore, Pakistan. There were four medical units in each hospital with different outpatient days as well as full-functioning wards. We randomly picked one medical unit by the pick out of hat method in each hospital for our study, and all the medical house officers/postgraduate (PG) trainees (PG trainees) in that unit were invited to participate in the study. We did not pick the groups and randomise them within one hospital due to the limited availability of required number of physicians in each unit and to prevent contamination bias. The medical officers were fresh graduates doing mandatory internship in medicine, and the PG trainees were pursing postgraduate training in medicine. All of the house officers/PG trainees in the study had formal responsibilities and duties to actively participate in the decision-making process for the appropriate care of their patients with diabetes in both hospitals. The duration of the intervention was 5 months. We used the ADA preventive care guidelines because they were simple to use and are updated regularly. These guidelines are summarised in table 1.

Intervention model
The study used a parallel assignment model.

Primary objective
The primary objective of this study was to check if m-Health educational intervention can improve ADA preventive care guidelines knowledge and practice scores among physicians.

Primary process outcome checked
The primary process outcome checked was improvement in the ADA preventive care guidelines knowledge and practice scores after 5 months of intervention.

Secondary outcomes checked
The secondary outcomes were physicians' attitude towards diabetic guidelines and patients' views about their diabetic care (the data for these are being compiled for later publications).

Inclusion criteria
The inclusion criteria were physicians who were seeing at least 10 or more patients with diabetes a month in the past 1 year, and house medical officers/PG trainees working in the medical units of the participating hospitals.

Exclusion criteria
The exclusion criteria were physicians who could not assure at least 6 months of participation in the study or who did not have a working phone, and physicians who were already following a particular diabetic guideline.

Sample size calculation
The sample size was based on the following assumptions using a statistical package program V.3 software power and precision: alpha: 0.05; power (1-beta): 80%.

Six per cent of physicians in Pakistan follow the diabetic guideline.[9] Postintervention we anticipate an increase in adherence to ADA preventive care diabetic guidelines by 30%.[23 24]

The calculated sample size was 56. Adjusting for 10% attrition rate, the calculated sample size was 62 physicians, with 31 in each of the intervention and control groups.

Figure 1 presents a flow chart of the methodology showing that 62 physicians were recruited and 53 (85.5%)

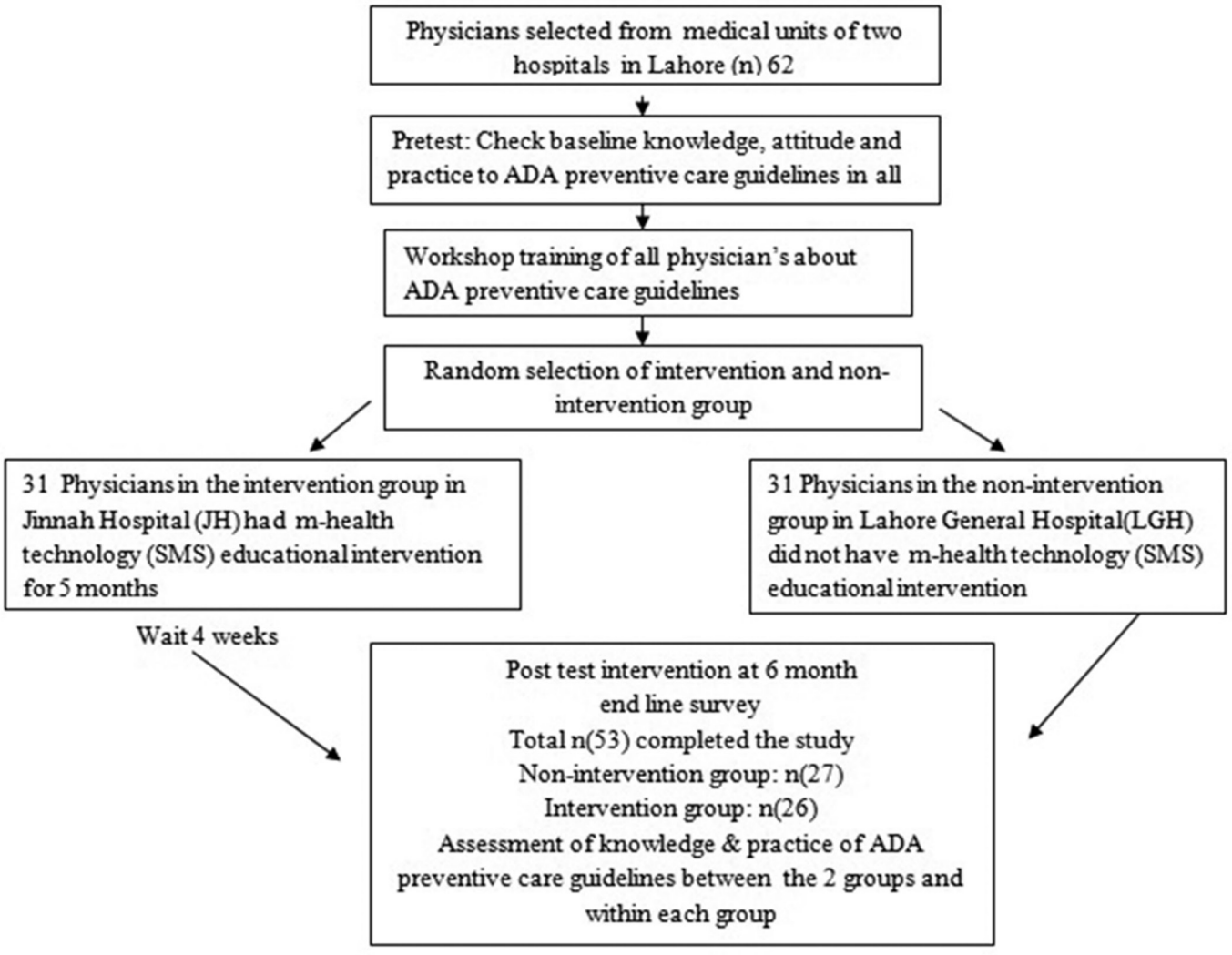

Figure 1 Flow chart of methodology. ADA, American Diabetic Association; SMS, short message service.

completed the study. In the intervention group there were five dropouts. In the non-intervention group, there were four dropouts. The m-Health intervention lasted for 5 months. The total duration of the study was 6 months.

A standardised protocol and pretested questionnaires were used with training of interviewers to prevent observer bias and improve the internal validity of the study. The two selected hospitals were of sufficient distance so that there was less chance of contamination bias.

Patient and public involvement

The intervention was done on physicians only and not on patients or the public at large. The results of the study will be disseminated by print media and through physician liaison at both hospitals.

Study tool

The physician questionnaire was a pretested questionnaire adapted from the Centers for Disease Control and Prevention (CDC) (USA).[25] The internal consistency of the questionnaire checked by the Guttman Scale was 0.78. The questionnaire was also reviewed by experts involved in diabetes care who were not involved in the study. An initial pilot study was done on a sample of seven physicians, and a final external review by two experts in the field of diabetes management and a statistician was done before collecting the data. The pilot study data were not included in the study. SMS were sent to the participants at regular intervals about three to four times a week with information about the 13 ADA preventive care variables. SMS were sent with the delivery notification system to make sure the SMS were received by the respondents.

Data analysis

Data analysis was multidimensional. Using self-reported frequency, we calculated the composite and individual scores of timely compliance to the ADA guidelines for each of the 13 preventive care guidelines. The total correct score assigned was 13 (for each of the 13 variables, 1 mark for each correct score). The responses were analysed using SPSS V.23 program. Statistical analysis included the χ^2 test, McNemar's test for categorical variables and independent sample t-test for continuous variables after checking the normality of the data using Shapiro-Wilk test of normality. Pearson's correlation analysis of knowledge and practice scores postintervention was done. Calculated p values were two-tailed, and p values less than or equal to 0.05 were considered statistically significant.

RESULTS

The total number of participating physicians was 62 at baseline. Fifty-three physicians (85.5%) completed the study. Majority were postgraduate (PG) trainees (34, 64.1%), and 33 (62.3%) were female. Majority (41, 77.3%) were in the age group 20–29 years, and majority (46, 86.8%) had no postgraduate degree and were seeing 10–20 patients daily.

In the intervention group there were 5 (16%) dropouts, including 4 house officers (80%) and 1 PG trainee (20%). Among them were four women (80%) and 1 (20%) man. None of them had any postgraduate degree. Four (80%) of them had worked <2 years and 1 (20%) had worked for 2–4 years.

There were four (13%) dropouts in the non-intervention group. All of them were female in the age group 20–29 years and had no postgraduate degree. They were demographically similar to the respondents who completed the study. All of the respondents who were lost to follow-up were due to lack of contact despite repeated efforts by phone and emails due to their relocation after finishing the training period.

DISCUSSION

Diabetic care is less than optimal as noted from studies around the world[26] as well as from Pakistan.[5 6] Medical education requires lifelong learning, and traditional continuing medical education programmes do not effectively change physician performance or patient health outcomes.[27] A study done in Pakistan showed that less than 50% of family physicians correctly answered questions about diabetes prevention and management.[28] Lack of knowledge among healthcare providers has been found to be one of the major obstacles in the management of DM.[29] A majority of physicians in our study had less than optimal knowledge and practice of diabetic care at baseline. This is similar to several other studies that have shown that healthcare providers do not follow the recommended clinical guidelines.[30 31] Our results of physicians' compliance with the preventive care guidelines at baseline are relatively less compared with other studies where complete adherence to clinical guidelines ranged from 54%[32] to 56%.[33]

Diabetes quality care improves when it is based on evidence-based guidelines.[7] Mobile phones are transforming the health field by their increased availability and accessibility. m-Health interventions have been noted to be effective in low-income and middle-income countries especially in improving patient management, data gathering and developing healthcare support systems.[34] Mobile phone educational intervention has been used to improve type 2 diabetes management in Pakistan.[35] In our study we used regular SMS reminders to provide physicians in the intervention group information on preventive care recommendations as per the ADA guidelines. We looked at 13 preventive care variables preintervention and postintervention. As noted in table 2, within the intervention group composite scores showed statistically significant improvement in knowledge (p=0.001) and in practice scores (p<0.001). Comparison between groups preintervention and postintervention also showed statistically significant difference in improvement of knowledge scores difference (p=0.002) and practice scores difference (p=0.001). This is similar to studies done elsewhere where SMS were noted to be useful in improving

Table 2 Comparison of baseline and endline composite knowledge and practice scores between and within the intervention and non-intervention groups

	Variables		Intervention group Mean±SD	Non-intervention group Mean±SD	Comparison between groups P values
Comparison within groups, p values	Knowledge	Baseline	4.92±2.33	4.70±2.25	0.920
		Endline	7.54±2.72	4.89±2.37	0.002
	P values		0.001	0.652	
	Practice	Baseline	4.04±2.62	4.15±2.43	0.451
		Endline	6.92±2.16	4.70±2.23	0.001
	P values		<0.001	0.262	

Both mean baseline and endline scores show that intervention had a big impact on knowledge and practice scores in the intervention group. The improvement in scores was less and not statistically significant in the non-intervention group. Between groups there was no difference in scores at baseline. In the non-intervention group there was non-significant improvement in the knowledge and practice scores. In postintervention within groups higher scores were noted in knowledge and practice scores, which were statistically significant.

adherence to management of childhood illness guidelines and malaria.[22 23 36] As noted in figure 2 correlation analysis showed a strong correlation between knowledge scores and practice scores postintervention with an r value of 0.843. Partial correlation adjustment for the confounder (duration of work of respondents postgraduation) still showed a correlation of 0.799 with a p value of <0.001. In the non-intervention group, there was no statistically significant improvement seen in any individual variables, as noted in table 3. Postintervention statistically significant improvement in the intervention group was seen in these individual variables, including review of signs and symptoms of hypoglycaemia and hyperglycaemia practice (p=0.030), eye examination knowledge (p=0.039) and practice (p=0.012), neurological examination knowledge (p=0.002), lipid examination knowledge (p=0.039) and practice (p=0.039), referral to ophthalmologist knowledge (p=0.001) and practice (p=0.002), and counselling about non-smoking knowledge (p=0.016), as noted in table 4. The rest of the variables did not show

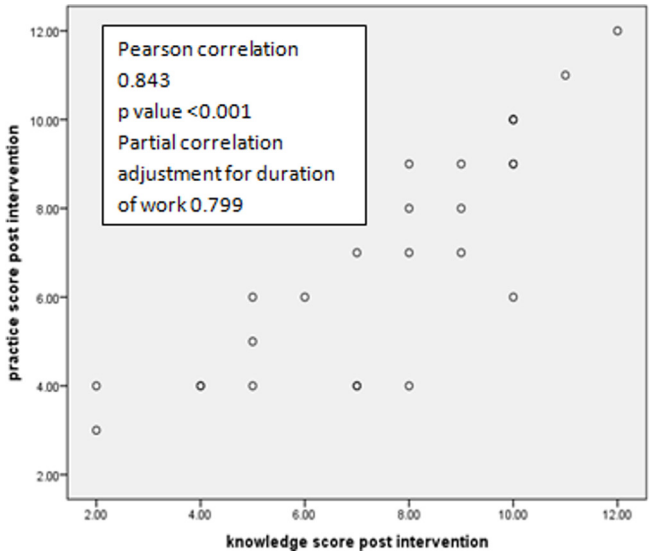

Figure 2 Correlation analysis.

statistically significant improvement postintervention. As can be seen in table 5, only duration of work of respondents since graduation from medical school was statistically significantly different between the two groups. The rest of the demographic variables were similar in both groups. At baseline except for three variables, including review of sign and symptoms, blood pressure examination, and smoking counselling, knowledge and practice of all the other variables were adhered to less than 50% in both the non-intervention and intervention groups.

Similar variability of improvement has been noted in other studies when m-Health technology (SMS) was used for different healthcare interventions. SMS educational intervention improved contraceptive use; however, using SMS for dengue education showed no statistically significant improvement in the intervention group.[37 38] Guidelines have been noted to be very important for quality improvement internationally. However their impact on clinical practices has been variable.[39] Numerous barriers have been noted that prevent the actual practice of guidelines, including lack of adequate clinical/technical skills and institutional barriers due to limited resources.[40] Lack of awareness, lack of applicability to individual patients, disagreement with the recommendations, as well as contextual constraints also affect application of guideline recommendations to individual patients.[11] Doctors who are busy with their established practices also may not necessarily be aware of the new diabetic treatment guidelines.[28] In our study the lack of adherence improvement in all variables could be because of several reasons. One of the reasons is that diabetes is a multisystem complex disease that requires comprehensive updated information for adequate management. In Pakistan we do not have a system of proper recertification of practising physicians. Simply disseminating information on the guidelines does not guarantee that the knowledge will be adequately acquired and used for clinical decision making. Proactive efforts are needed to encourage the use of guidelines.[41] It was seen in a systemic review that m-Health tools have low rates of retention unless incentives such

Table 3 Frequency of correct answers in the non-intervention (Lahore General Hospital) group preintervention and postintervention

	Variables	Adherence	Baseline scores n (%)	Endline scores n (%)	P values
1	Review of signs and symptoms of hyperglycaemia and hypoglycaemia	Knowledge	20 (74.1)	23 (88.5)	0.508
		Practice	13 (48.1)	18 (66.6)	0.302
2	Blood pressure examination	Knowledge	22 (81.5)	21 (77.8)	1.000
		Practice	20 (74.1)	21 (77.8)	1.000
3	Eye examination	Knowledge	11 (40.7)	9 (33.3)	0.727
		Practice	8 (29.6)	12 (44.4)	0.289
4	Foot examination	Knowledge	13 (48.1)	14 (51.9)	1.000
		Practice	12 (44.4)	11 (40.7)	1.000
5	Neurological examination	Knowledge	5 (18.5)	7 (25.9)	0.500
		Practice	6 (22.2)	8 (29.6)	0.687
6	Haemoglobin A1c examination	Knowledge	7 (25.9)	8 (29.6)	1.000
		Practice	8 (29.6)	10 (37.0)	0.727
7	Urine examination	Knowledge	6 (22.2)	7 (25.9)	1.000
		Practice	8 (29.6)	6 (22.2)	0.727
8	Lipid examination	Knowledge	5 (18.5)	4 (14.8)	1.000
		Practice	5 (18.5)	5 (18.5)	1.000
9	Referral to dietitian	Knowledge	9 (33.3)	7 (25.9)	0.687
		Practice	6 (22.2)	10 (37.0)	0.344
10	Referral to ophthalmologist	Knowledge	8 (29.6)	7 (25.9)	1.000
		Practice	5 (18.5)	6 (22.2)	1.000
11	Counselling about non-smoking	Knowledge	19 (70.4)	21 (77.8)	0.727
		Practice	14 (51.9)	17 (63.0)	0.549
12	Pneumovax administration	Knowledge	0	0	–
		Practice	7 (25.8)	1 (3.7)	0.070
13	Influenza vaccine administration	Knowledge	2 (7.4)	4 (14.8)	0.625
		Practice	0	0	–

As can be seen from the above data, there was no statistical improvement in any of the variables in the non-intervention group.

as feedback and monetary benefits are provided.[42] In our study a lack of incentives could have contributed to the variable improvement in the different diabetic guidelines variables. Another reason could be the lack of national diabetic guidelines in Pakistan. It has been seen that when there is active involvement and input in the guideline development and implementation from the end users of the guideline, it leads to significant changes in practice patterns.[43] Another factor that may have affected the effectiveness of using the SMS reminders is the possibility that physicians after the initial texts stopped reacting to them.[44] Our intervention with SMS also was brief and covered different variables superficially. This may have limited the expected improvement in all the variables as desired. We were hoping that SMS would have served to increase self-study, and unless this lateral learning complements the SMS intervention the full impact is usually not seen.[45] Additionally our study was done in public hospitals which cater mostly to patients who have limited financial resources, and therefore socioeconomic conditions of patients and organisational constraints also may have contributed to a lack of recommendations by the physicians of all the preventive care guidelines.[10]

Strengths and limitations of the study

The strengths include our study being one of the pioneer interventional m-Health technology studies done in Pakistan. We used pretested validated questionnaire from the CDC (USA). We had a good response rate from the respondents. Our small study sample size in two hospitals does not permit generalisation, but this was an exploratory study. Our study was not designed to check the effects of using diabetic guidelines in improving patient clinical outcomes; we looked at the process variables only. An analysis of correlation between knowledge and practice scores in the intervention group (as shown in figure 2) showed a strong correlation between knowledge scores and practice scores postintervention with an r value of

Table 4 Frequency of correct answers in the intervention (Jinnah Hospital) group preintervention and postintervention

	Variables	Adherence	Preintervention n (%)	Postintervention n (%)	P values
1	Review of signs and symptoms of hyperglycaemia and hypoglycaemia	Knowledge	17 (65.4)	22 (84.6)	0.227
		Practice	14 (53.8)	22 (84.6)	0.030
2	Blood pressure examination	Knowledge	18 (69.2)	23 (88.5)	0.063
		Practice	21 (80.2)	22 (84.6)	1.000
3	Eye examination	Knowledge	11 (42.3)	19 (73.1)	0.039
		Practice	6 (23.1)	15 (57.7)	0.012
4	Foot examination	Knowledge	9 (34.6)	12 (46.1)	0.508
		Practice	7 (26.9)	7 (26.9)	1.000
5	Neurological examination	Knowledge	4 (15.4)	16 (61.5)	0.002
		Practice	5 (19.2)	9 (34.6)	0.289
6	Haemoglobin A1c examination	Knowledge	10 (38.5)	13(50)	0.581
		Practice	4 (15.4)	11 (42.3)	0.065
7	Urine examination	Knowledge	9 (34.6)	15 (57.7)	0.109
		Practice	7 (26.9)	12 (46.2)	0.227
8	Lipid examination	Knowledge	6 (23.1)	13 (50.0)	0.039
		Practice	7 (26.9)	14 (53.8)	0.039
9	Referral to dietitian	Knowledge	4 (15.4)	3 (11.5)	1.000
		Practice	2 (11.5)	5 (19.2)	0.453
10	Referral to ophthalmologist	Knowledge	9 (34.6)	20 (76.9)	0.001
		Practice	8 (30.8)	20 (76.9)	0.002
11	Counselling about non-smoking	Knowledge	16 (61.5)	23 (88.5)	0.016
		Practice	15 (57.7)	22 (84.6)	0.065
12	Pneumovax administration	Knowledge	3 (11.5)	4 (15.4)	1.000
		Practice	3 (11.5)	7 (26.9)	0.219
13	Influenza vaccine administration	Knowledge	12 (46.2)	15 (57.7)	0.549
		Practice	6 (23.1)	14 (53.8)	0.349

The comparison of scores for correct responses preintervention and postintervention in the intervention group showed that only review of signs and symptoms (practice), eye examination (knowledge and practice), neurological examination (knowledge), lipid examination (knowledge and practice), referral to ophthalmologist (knowledge and practice), and counselling about non-smoking (knowledge) variables showed statistical improvement postintervention.

0.843. Partial adjustment for the confounder (duration of work postgraduation of respondents) between the two groups still showed a correlation of 0.799 with a p value of <0.001. There was a risk of recall bias; however, the short duration of study hopefully countered this. A standardised protocol and pretested questionnaires were used with training of interviewers to prevent observer bias and improve the internal validity of the study. The two selected hospitals were of sufficient distance so that there was less chance of contamination bias. Both the groups were similar at baseline as noted by their knowledge and practice pattern, so there was less risk of selection bias. We used the same questionnaire at preintervention and at postintervention to decrease possible testing effect bias. The sufficient length of time between preintervention and postintervention also mitigated the potential testing effect. Since self-reporting was used to check the process outcome, it may overestimate the actual adherence to the guidelines due to social desirability bias. However the responses were anonymous and the questions had no single right or wrong response to decrease the effect of this bias on the validity of our study. Due to the small mobile phone screen, we could only send concise information by SMS. The study was not designed to obtain feedback from the physicians, which could have helped us to determine physicians' views about the intervention. Our study's intervention duration was less than a year, which could limit assessment of the long-term effects from our study.

CONCLUSION

Diabetic preventive care was suboptimal at baseline in both the study groups. The m-Health (SMS) reminder intervention showed statistically significant improvement in composite knowledge and practice scores within the

Table 5 Analysis of potential confounders in both groups

Variables		Group				P values for likelihood ratio
		Non-interventional		Interventional		
		n	%	n	%	
Age in years	20–29	21	77.8	20	76.9	0.476
	30–39	6	22.2	5	19.2	
	40–49	0	0.0	1	3.8	
	50	0	0.0	0	0.0	
Gender	Female	8	29.6	12	46.2	0.214
	Male	19	70.4	14	53.8	
Postgraduate medical degree	None	23	85.2	23	88.5	0.387
	MD	1	3.7	0	0.0	
	MCPS	1	3.7	0	0.0	
	FCPS	2	7.4	2	7.7	
	MRCP	0	0.0	1	3.8	
Duration of work since graduation	<2 years	18	66.7	13	50.0	0.009
	2–4 years	9	33.3	7	26.9	
	5–7 years	0	0.0	6	23.1	
Number of patients with diabetes mellitus seen daily	<10	3	11.1	10	38.5	0.135
	10–20	15	55.6	10	38.5	
	21–30	6	22.2	4	15.4	
	31–40	3	11.1	2	7.7	

As can be seen from the above table, only duration of work of respondents since graduation from medical school was statistically significantly different between the two groups. The rest of the demographic variables were similar in both groups.

intervention group and between groups. m-Health (SMS) reminders also improved some of the individual ADA diabetes recommended preventive care variables in the intervention group.

Future implications

m-Health (SMS) technology could help in improving structured diabetic care in a resource-limited country such as Pakistan, and it can be scaled easily as it requires minimum additional resources other than a working phone. We need to develop our own local diabetic guidelines based on our contextual constraints; however, if this cannot be done due to lack of adequate resources, then local adaptation of international diabetes guidelines is a viable option. Future research should focus on long-term effectiveness of text messages interventions on objective clinical measures. Multiple stakeholders in the academia and healthcare organisations have to ensure its integration into the current medical education system.

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Competing interests None declared.

Patient consent Not required.

Ethics approval Ethical approval was obtained from the Institutional Ethical Review Committee of Health Services Academy, Islamabad. Permission was also taken from the administration of the Jinnah Hospital, Lahore, where data collection was undertaken. The administration in the Lahore General Hospital said since our study was an educational intervention, it did not require formal ethical approval.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement The data are not freely available; however, specific enquiries can be submitted to drnoreen2@gmail.com.

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