ARTICLE

The effect of short message service (SMS) reminder on adherence to standard care and glycemic control of adolescent patients with Type 1 Diabetes Mellitus

Kristine Mae D. Betansos, Ignace Claire P. Gamallo, Lorna R. Abad

BACKGROUND: Adolescence is associated with suboptimal diabetes control. Studies supporting the use of mobile technology to improve glycemic control and adherence to treatment had mixed results.

OBJECTIVE: This study aimed to evaluate the effect of SMS reminders on improving glycemic control in adolescents with Type 1 Diabetes Mellitus (T1DM).

MATERIALS AND METHODS: A randomized control study among adolescents with poorly controlled type 1 diabetes mellitus was done. Data were processed from 56 out of 64 subjects who were randomized into control (N=29) who received standard of care and SMS group (N=27), who received standard of care and a daily SMS reminder regarding diabetes self-care for 12 weeks. An adherence form was answered by all participants and glycosylated hemoglobin (HbA1c) before and after intervention was compared.

RESULTS: HbA1c did not significantly differ between SMS and control groups after 12 weeks of intervention (SMS 9.98±2.12 vs control 10.54±2.13, p value of 0.305). Post intervention, there was no significant difference between SMS and control group in terms of adherence to insulin injection (no p value), blood glucose (BG) monitoring (p value 0.106), and diabetic diet (p value 0.803). However, adherence on exercise was significantly higher among control group than SMS group (p value 0.003).

CONCLUSION: A 12-week SMS intervention reminder in adolescents with type 1 diabetes mellitus did not significantly improve glycemic control and adherence to standard of care (insulin injection, blood glucose monitoring, diet and exercise).

RECOMMENDATION: Future research could include a bigger study population and longer duration of intervention. Other forms of mobile technology could also be used as a form of reminder.

KEYWORDS: *DM Type 1, SMS reminder, adherence*

Correspondence: Clinical Trial and Research Division
Clinical Research Department
Philippine Children's Medical Center Quezon Ave., Quezon City Philippines
Phone: (02) 8588 9900 local 1308
Email: ctrd@pcmc.gov.ph

The authors affirm that this manuscript is original, has been read and approved by all contributing authors, that each author meets the established criteria for authorship, and that the content represents a truthful and accurate account of the work conducted.

Disclosure: This study was funded by the Philippine Children's Medical Center (PCMC). The institution had no role in the study's design, conduct, analysis, or interpretation of the results. The authors declare that they have no financial interests or other potential conflicts of interest that could influence the content of this work. This study was presented at the PCMC Annual Research Forum in November 2024.

INTRODUCTION

Type 1 diabetes mellitus (T1DM) is a disorder characterized by autoimmune-mediated destruction of pancreatic beta cells eventually leading to absolute insulin deficiency (1). As of 2021, more than 1.2 million children and adolescents (0-19 years old) have T1DM (2). Adolescents have difficulty following a diabetes management program that includes healthy eating, blood glucose (BG) monitoring, and insulin injections. (3). Recent estimates suggest that only 17% of youth meet American Diabetes Association glycemic control recommendations (4). Good glycemic control reduces risk for macrovascular (e.g. stroke, coronary heart disease) and microvascular complications (e.g. retinopathy, neuropathy, and nephropathy) (5). Mobile health interventions have the potential to promote lifestyle modifications and is an attractive approach in healthcare systems with limited resources. SMS reminder was deemed effective in improving adherence to a healthy diet, medication, and cessation of smoking on adult patients with cardiovascular diseases (6). Clinical significance for long-term daily type 1 diabetes mellitus management and glycemic control, however, is unclear (7). Likewise, compliance to text message reminders in adolescents with T1DM has not been assessed (8,9).

A study done in 2015 concluded that text messaging using the short messaging service (SMS) was the preferred mode of communication in adolescents with diabetes (10). A study to evaluate Sweet Talk, a text messaging support system geared to enhance self-efficacy and facilitate updates of intensive insulin therapy, revealed that it was associated with improved self-efficacy and adherence (11). A limitation of this study was that the intervention was not only limited to receiving SMS. Similarly, a study regarding a website and test messaging platform named MyDi-aText was done to assess its feasibility and functionality. The result of the study showed that text message reminders were acceptable to the subjects (12). However, its limitation was that it did not mention the effect of the application on the adherence or glycemic control of the subjects. A meta-analysis by Huang et al (2019) explored the effect of short message service intervention on glycemic control in diabetes (13). However, the studies included in the meta-analysis have both type 1 and type 2 patients. One study had also utilized interventions other than short message service, such as self-tracking tools and virtual visits (14).

This study aimed to evaluate the effect of SMS reminders on improving glycemic control in adolescents with Type 1 Diabetes Mellitus. It specifically aimed to determine the effect of SMS reminder on adherence to standards of care in terms of blood glucose monitoring, insulin injection, DM diet and exercise and to compare adherence to

to standards of care in terms of blood glucose monitoring, insulin injection, DM diet and exercise and to compare adherence to standards of care between the intervention group (SMS) and the control group (no SMS) in terms of blood glucose monitoring, insulin injection, DM diet and exercise. The null hypothesis was that SMS reminders will not significantly improve the glycemic control and adherence to standard of care.

Materials and Methods

Figure 1. Methodology Flow

Figure 1 summarizes the methodology used for this study. This was a randomized controlled trial among adolescents ages 10 to <19 years old with T1DM diagnosed for at least 6 months who are on multiple daily insulin injection (MDII) regimen and seen at the charity and private clinics of the Philippine Children's Medical Center (PCMC). Subjects were expected to have access to insulin and DM supplies, owned a cellular phone (subjects for ages 15 to 18 and caregiver for ages 10 to 14), and expressed willingness to do a follow up consult after three months. Exclusion was made for those who do not own a cellular phone and with intellectual disability. After screening, they also passed the biochemical criteria of having a glycosylated hemoglobin (HbA1c) done in PCMC with levels 8 to 14%. The International Society for Pediatric and Adolescent Diabetes (ISPAD) recommended the level <7% as the target HbA1c for people with diabetes (15). To see the effect of SMS, those included in the study were patients with poorly controlled HbA1c with the range 8 to 14.%. The upper limit was set to 14% because the PCMC laboratory was only able to detect HbA1c until 14 % and anything above this was reported to be >14%.

The enrollment commenced after PCMC Institutional Research-Ethics Committee (IR-EC) approval. Enrollment was noncoercive and voluntary, held at the PCMC Endocrinology private and charity clinic. Questions were entertained to ensure adequate information before consent was given. For subjects ages 18 years, an informed consent form was secured. For subjects 15 to <18 years old, informed consent co-signed by their parents were secured by the primary investigator or co-investigator. For subjects 12 to <15 years old, a simplified verbal assent and a parental consent were obtained. For subjects 10 to <12 years old, a verbal assent script and parental consent was be obtained. Withdrawal from the study could be made anytime without compromising the standard of care received at the outpatient clinic. The cost needed to reply was reimbursed but if the subjects expressed willingness to shoulder the cost of the SMS, the study team allowed it. However, no monetary compensation was be given for their

participation.

All subjects enrolled in the study underwent DM education. The subject's order of enrollment was assigned to be their control number. Computer-generated simple randomization was done using the website https://www.randomizer.org/#randomize where a set of 32 unique number were picked from numbers 1 to 64. Those numbers picked by the randomizer were assigned to the SMS group.

The standard of care includes education on insulin regimen, blood glucose monitoring, diet and exercise given as instruction in the clinics. This was individualized per patient. Diabetic education was also given to all patients in the form of a pamphlet. The control group received standard of care and SMS group received standard of care with once-a-day daily SMS reminder regarding DM self-management. The messages were sent between 5:30 to 8 in the morning. To ensure connectivity, the research team sent once-a-week SMS asking if the daily SMS reminders were being received. The subjects were expected to reply within 24 hours. If there was no response by then, they will be called for a maximum of three phone call daily for three consecutive days (maximum of 9 calls). If they were unable to answer the call, they would be dropped from the study. The SMS group received one SMS reminder per day, and one confirmatory SMS per week for the next 12 weeks.

A questionnaire was used to collect information such as age at diagnosis, recent insulin dose, type of insulin, frequency of insulin administration, previous hospitalizations for diabetic ketoacidosis (DKA), access to insulin and medical supplies, presence of adult supervision during insulin injection, adherence to DM diet and exercise, and frequency of annual consult. All patients were asked to fill out a self-reported adherence form for the next 12 weeks to measure adherence. The adherence form had to be filled out for at least 10 weeks, with 5 days in a week, for it to be valid and processed for data analysis. From the last day of intervention, they were given a month to pass the adherence form. Validity of the form was assessed, and patients were given request for HbA1c which was extracted at the PCMC laboratory. The lab personnel who did the HbA1c levels was blinded to the patient's group assignment. The confidentiality of all data obtained and honesty in all phases of the study were maintained. All identifiers of the individual or caregiver were removed for anonymity.

At 95% confidence level and 80% power of test, minimum sample size needed to detect a minimum difference of 2.8 on HbA1c level (%) between the control and intervention group 26 per group, with a total of 52 subjects. To account for 20% attrition rate, a total of 64 subjects was the recommended sample size.

A total of 56 subjects completed the study, yielding 82% statistical power.

The data were encoded in Microsoft Excel which was password protected and analyzed via Statistical Package for the Social Services (SPSS). Test for normality was done using Shapiro-Wilk Test. In comparing data between control and intervention group after three months, chi square was utilized for categorical variables such as adherence to standard care while t-test was used for continuous variables such as HbA1c. Wilcoxon Signed RankTest was used to compare the median scores of adherences to standard of diabetes care between SMS and control group.

RESULTS

A total of 100 subjects with Type 1 diabetes mellitus were screened, wherein 27 were excluded from the study and 9 refused to participate. Sixty-four patients were randomized, with a 12.5% dropout rate. One data from the control group was not processed because she was eventually treated as a case of DM Type 2. A total of 56 subjects completed the study, yielding 82% statistical power.

The flowchart of the study was shown below:

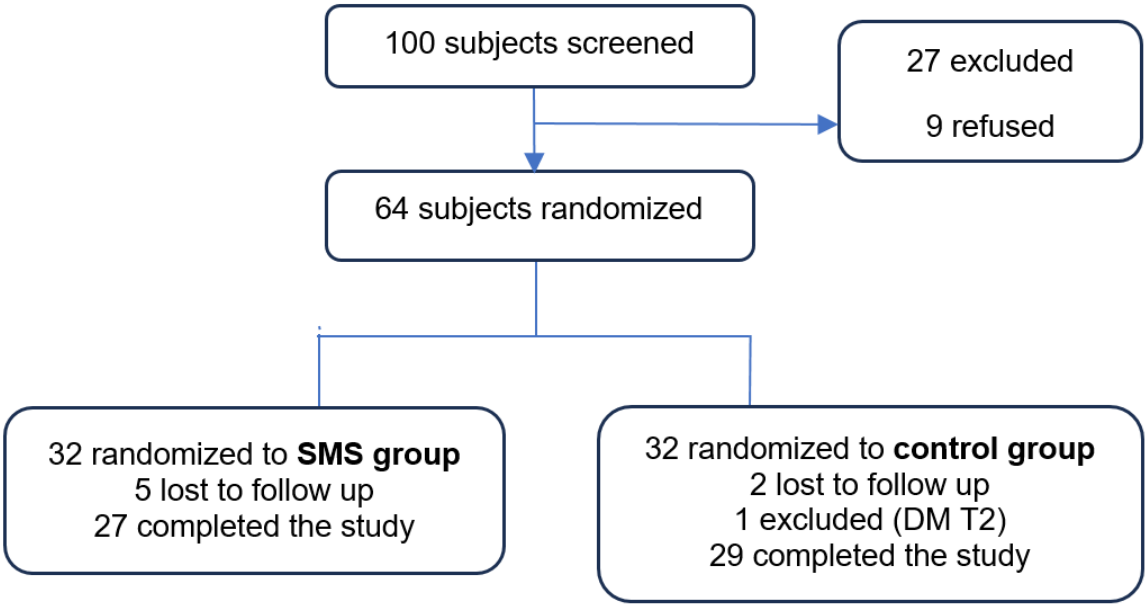

Figure 2. *Subject Recruitment*

Shapiro-Wilk Test was performed for both groups to test for normality. Control group had normal distribution of HbA1c at baseline (p=0.338) and postintervention (p=0.099). The SMS group also had normal distribution of HbA1c at baseline (p=0.147) and postintervention (p=0.159). For the HbA1c, distribution of mean was normal and parametric test such as t -test was used. For the adherence to the standards of care (insulin injection, blood glucose monitoring, diet and exercise, the results were reported as categorical data and does not satisfy the use of parametric test thus Wilcoxon Signed Rank test was used.

Table 1 showed the baseline demographic profile of the subjects. A total of 27 subjects were under the SMS group who were mostly 10 to 14 years old (55.6%) and majority were female (51.9%). For the 29 subjects in the control group most of them were also 10 to 14 (58.6%) years of age and were female (69%). There was no difference between the two groups on the distribution of educational background of their caregiver. Almost half of the subjects of both groups finished high school (44.4% SMS vs 51.7% control) or college/ postgraduate (55.6% SMS vs 41.4% control). Majority of each group had 0 to 4 family dependents (81.5% SMS vs 89.7% control).

Table 1. *Demographic profile of subjects*

	SMS N = 27		**Control (No SMS)** N= 29		**P value**
	n	**%**	**n**	**%**	
Age					
10 to 14 years old	15	55.6	17	58.6	0.819
15 to 18 years old	12	44.4	12	41.4	
Sex					
Male	13	48.1	9	31.0	0.194
Female	14	51.9	20	69.0	
Educational background of caregiver					
No formal education	0	0.0	0	0.0	0.273
Primary School	0	0.0	0	0.0	
Elementary	0	0.0	2	6.9	
Highschool	12	44.4	15	51.7	
College or Postgraduate	15	55.6	12	41.4	
No. of family dependents					
0 to 4	22	81.5	26	89.7	0.387
5 or more	5	18.5	3	10.3	

Table 2 showed the baseline clinical profile of the subjects. For both groups, majority were diagnosed with diabetes for at least 5 years (40.7% SMS vs 44.8% control). More than half of the two groups had at least one history of admission due to DKA (63% SMS vs 51.7% control).

Furthermore, majority of subjects from both groups did not have any DM complication (92.6% SMS vs 86.2% control). The type of insulin used in both groups was mostly split mixed (48.1% SMS vs 48.3% control). This was followed by biphasic isophane insulin (33.3% SMS vs 34.5% control). Majority of the subjects inject insulin with the presence of an adult (85.8% SMS vs 72.4% control).

Insulin injection was at least 2 times a day in both groups (85.2% SMS vs 75.9% control). Majority of subjects from SMS group monitor their BG 0-2 times a day (63%), while those from the control group monitor for 3 or more times (65.5%). Diabetic diet compliance was also not significantly different, but among SMS group, 74.1% comply 0 to 3 times per week which was slightly higher than the control group (55.2%). Similarly, the most common frequency of exercise in both groups was 0 to 3 times per week (77.8% SMS vs 75.9% control). Majority of the subjects used their own funds for buying insulin and/or supplies. Some of them used other means in order to procure DM supplies, such as government assistance program. In both groups, the frequency of consult was 4 or more times a year, but slightly higher among SMS (77.8%) as compared to control (62.1%).

Table 2. *Clinical profile of patients*

	SMS N = 27		**Control (No SMS)** N= 29		**P value**
	n	**%**	**n**	**%**	
Duration of diabetes					
6 months to <2 years	4	14.8	7	24.1	0.729
2 to <5 years	12	44.4	9	31.0	
5 years and up	11	40.7	13	44.8	
History of admission due to DKA					
0	2	7.4	3	10.3	0.888
1	17	63.0	15	51.7	
2	1	3.7	5	17.2	
3 or more	7	25.9	6	20.7	

	SMS N = 27		Control (No SMS) N= 29		P value
	n	%	n	%	
DM Complication					
None	25	92.6	25	86.2	0.729
DM Retinopathy	2	7.4	2	6.9	
DM Nephropathy	0	0.0	2	6.9	
DM Neuropathy	0	0.0	0	0.0	
High BP	0	0.0	0	0.0	-
High Cholesterol	0	0.0	0	0.0	-
Type of Insulin					
Biphasic Isophane Insulin 70/30	9	33.3	10	34.5	0.991
Split Mixed Insulin	13	48.1	14	48.3	
Others	5	18.5	5	17.2	
Presence of an adult during insulin injection					
Yes	23	85.2	21	72.4	0.403
No	4	14.8	8	27.6	
No. of Insulin injection per day (excluding rescue doses)					
1	0	0.0	1	3.4	0.842
2	23	85.2	22	75.9	
3	0	0.0	1	3.4	
4 or more	4	14.8	5	17.2	
No. of BG monitoring per day					
0 to 2	17	63.0	10	34.5	0.063
3 or more	10	37.0	19	65.5	
Diabetic diet compliance/ week					
0 to 3	20	74.1	16	55.2	0.232
4 or more	7	25.9	13	44.8	
Frequency of exercise/ week					
0 to 3	21	77.8	22	75.9	0.888
4 or more	6	22.2	7	24.1	
Source of insulin / supplies					
Own Funds	17	62.9	17	58.6	0.742
Malasakit Center	1	3.7	6	20.7	0.057
Own Funds and Malasakit Center	6	22.2	2	6.9	0.105
Own Funds and Others	2	7.4	1	3.4	0.515
Malasakit Center and Others	0	0.0	2	6.9	0.492
Others	1	3.7	1	3.4	1.000
Frequency of consult					
0 to 3 times a year	6	22.2	11	37.9	0.325
4 or more times a year	21	77.8	18	62.1	

Table 3 shows the effect of SMS reminder on glycemic control of SMS and control group. It should be noted that the PCMC laboratory can only detect HbA1c until 14% and values greater than this were reported to be >14%. Three subjects from the control group had an HbA1c>14% after 12 weeks and for statistical analysis, it was reported to be 14%. The mean HbA1c during baseline was not significantly different between SMS (10.3) and control group (10.87). Both groups had lower HbA1c after 12 weeks (9.98 for SMS and 10.54 for control) but was not significantly different.

Table 3. *Effect of SMS reminder on Glycemic Control*

HbA1c	SMS		Control (No SMS)		P value
	Mean	SD	Mean	SD	
Baseline	10.3	1.72	10.87	1.67	0.225
After 12 weeks	9.98	2.12	10.54	2.13	0.305
Difference	0.36	1.44	0.33	1.55	0.937

Baseline Shapiro wilk=.0458, After 12 weeks = 0.181, Difference = 0.6532

Table 4 shows the comparison of adherence to standard of care of SMS reminder on adherence to standards of care. There was no significant difference between SMS and control group on number of insulin injection during baseline and post intervention. In terms of BG monitoring, the control group had significantly higher frequency than SMS group on baseline. During post intervention, there was no significant difference between the two groups on frequency of BG monitoring. Moreover, there was no significant difference on the median adherence to diabetic diet during baseline and post intervention. On exercise, the frequency of exercise post-intervention in the control group was significantly higher (4 and up) than the SMS group (0 to 3).

Table 4. *Comparison of SMS Reminder on Adherence to Standards of Care*

	SMS		Control (No SMS)		p value
	Median	**Average Rank**	**Median**	**Average Rank**	
Insulin regimen					
Baseline	2	27.15	2	28.82	0.563
Post Intervention	2	29.11	2	27.93	0.728
BG monitoring					
Baseline	0 to 2	24.37	0 to 2	32.34	***0.035****
Post Intervention	3 and above	25.37	3 and above	31.41	0.109
Diabetic Diet					
Baseline	0 to 3	25.76	0 to 3	31.05	0.144
Post Intervention	0 to 3	28.02	0 to 3	28.95	0.805
Exercise					
Baseline	0 to 3	28.22	0 to 3	28.76	0.866
Post Intervention	0 to 3	22.72	4 and up	33.88	***0.003****

**significant*

	SMS		Control (No SMS)		p value
Post Intervention	**n**	**%**	**n**	**%**	
Insulin regimen					
1	2	7.4	3	10.3	0.890
2	20	74.1	21	72.4	
3	1	3.7	2	6.9	
4 or more	4	14.8	3	41.4	
BG monitoring					
0 to 2	17	63.0	12	41.4	0.106
3 or more	10	37.0	17	58.6	
Diabetic Diet					
0 to 3	13	48.1	13	44.8	0.803
4 or more	14	51.9	16	55.2	
Exercise					
0 to 3	21	77.8	11	37.9	***0.003****
4 or more	6	22.2	18	62.1	

**significant*

Table 5 shows the comparison of post-intervention adherence of SMS and control group on the standards of care. Post intervention, there was no significant difference between SMS and no SMS group in terms of insulin injection (100% vs 100%), CBG monitoring (37% vs 58.6%) and diabetic diet (51.9% vs 55.2%). On the other hand, adherence on exercise is significantly higher in the control group (62.1%) as compared to SMS (22.2%).

Table 5. *Comparison of Adherence Standards of Care between SMS and no SMS groups*

	SMS		Control (No SMS)		P value
	n	%	n	%	
Insulin regimen					
Adherent	27	100	29	100	-
Not adherent	0	0	0	0	
CBG monitoring					
Adherent	10	37.0	17	58.6	0.106
Not adherent	17	63.0	12	41.4	
Diabetic Diet					
Adherent	14	51.9	16	55.2	0.803
Not adherent	13	48.1	13	44.8	
Exercise					
Adherent	6	22.2	18	62.1	***0.003****
Not adherent	21	77.8	11	37.9	

**significant*

DISCUSSION

This study showed that a 12-week daily SMS reminder did not improve glycemic control and adherence to standard of care such as insulin injection, blood glucose monitoring, diet, and exercise. After three months of intervention, both SMS and control groups had lower HbA1c than baseline, but the difference was not statistically significant. This was c onsistent with the study of Ibrahim et al. (8) and Markowitz (16), where both intervention and control groups had small but insignificant improvement from baseline HbA1c.

Adolescence is a time of suboptimal glycemic control due to multiple factors. Different interventions have been studied to improve glycemic control, including use of mobile phone technology (10-14,16-18). Different studies have mixed results regarding the effect of text messaging on glycemic control. One study elaborated that the majority (80%) of the patients allocated to the intervention group were willing to receive text messages. Two-thirds of the patients in the intervention arm also answered a satisfaction survey and stated that they wanted to continue receiving the messages (8). This study analyzed 45 adolescent patients with poorly controlled T1DM. Among the SMS group, no one opted to withdraw from the study, suggesting that the patients and their caregivers were willing to receive a once-a-day SMS reminder. Thus, this could be an indicator of good acceptability of this method to remind adherence to the patients.

Other similar studies used more than one intervention for adolescents with T1DM. The study which used Sweet Talk, a text-messaging system, used other interventions aside from the text messaging system (11). This study used SMS as an exclusive intervention, which enabled assessing its effectiveness contrasted with the standard of care. Unlike other studies including children and adults (8,9,19), all subjects in this study were adolescents with type 1 diabetes mellitus only. Although not statistically significant, any decrease in HbA1c is likely to be associated with a decrease in risk of having DM complications (20).

Receiving SMS did not improve the adherence to standard care and the glycemic control of the patients. One possible reason was that the messages sent were tailored depending on the day of the week. Thus, when sent continuously it became monotonous. This was similar to the study of Akhu-Zaheya where some of the subjects, although adults, find the messages repetitive and boring (21). In the study of Ibrahim, satisfaction was reported in majority of adolescents who received messages however it was personalized, having goal-specific prompts tailored to the age, sex, and insulin regimen of the subjects. The personalized messages sent were chosen by the subjects with regards to its frequency (one to four) and timing. The type of insulin (long acting or short acting insulin analogs) that they used was also specified in the message (8). For ages 10 to 14 years old, the messages were sent to the primary caregivers and its conveyance to the patient was not certain.

Another possible reason was that the patients were already compliant to insulin injection at baseline. Hence, there was no effect on adherence to insulin injection. The Philippines was deemed as the texting capital of the world (22). Thus, high volume of SMS received could have also made it a less effective mode of reminder regarding diabetes self-management.

In both groups, there was no significant difference in baseline and post- intervention adherence to standards of care such as insulin injection, blood glucose monitoring, and diabetic diet. However, during post-intervention the frequency of exercise in the control group was significantly higher than the SMS group. Median frequency of insulin injection was twice a day and majority uses split mixed insulin followed by biphasic isophane insulin 70/30. Hence, it could be inferred that majority of the patients were already adherent to insulin injection at the baseline. As for other standards of care, the SMS reminders could have had a very minimal effect especially if it becomes repetitive and monotonous already.

Post-intervention, there was no significant difference in adherence to insulin injection, blood glucose monitoring, and diabetic diet between SMS and control groups. However, adherence to exercise of those in the control group was significantly higher than SMS group. Newton, et al observed that the use of a pedometer, together with text message motivation for 12-week intervention did not increase physical activity in adolescents with type 1 diabetes (23). On the other hand, the study of Bin Abbas showed that missed insulin injection and frequency of BG monitoring improved post-trial in children receiving SMS messages. To reiterate, the effect of the SMS reminder could have had a minimal impact since the messages were general and not personalized.

Conclusion and Recommendations

This study showed that a 12-week daily SMS reminder did not improve glycemic control and adherence to standard of care such as insulin injection, blood glucose monitoring, diet, and exercise. Future studies could consider having a longer study duration evaluating the impact of SMS reminder and mobile technology in glycemic control and adherence. More personalized messages could also be considered in future research. Feedback from adolescents could be useful to tailor future interventions.

One limitation of this study includes a small sample size. Hence, the power of the study could be improved if more participants were enrolled. Generalizability is limited only to those subjects who have access to mobile messaging. Acceptability and cost effectiveness of using SMS reminders was also not formally assessed in this study.

Although there was no gold standard for reporting adherence, this study used self-reporting, and the risk of potential biases such as social desirability and memory biases was inherent (24). More objective ways to measure adherence could be considered in future studies such as setting the date and time of glucometer and confirming self-reporting with glucometer check associated with hba1c.

Smart watches or pedometers could be used to assess physical activity. Delivered meals with exact caloric count tailored for the subjects could also be considered to ensure diet adherence.

Dose adjustments and shifting of insulin regimen that happened between baseline and postintervention was also not assessed. Other parameters of diabetic control such as episodes of emergency consults or admissions during the intervention period were not included in this study. These factors could be assessed in future studies. Lastly, other options for mobile technology could also be considered such as electronic mail, social media, video calls or even smart phone applications for possible intervention.

Acknowledgements

The primary author would like to thank the Philippine Children's Medical Center clinical research department for the HbA1c funding. Much gratitude would like to be expressed to the section of Endocrinology staff: Dr. Caridad M. Santos, Dr. Lorna R. Abad, Dr. Eve G. Fernandez, and Dr. Marichu P. Mabulac, for their invaluable contribution to the conceptualization and data gathering of this research. The primary author would also like to thank Dr. Ma. Cecilia C. Ferriols for the help during data collection and Mr. Reginald Arimando for the assistance in statistical analysis.

References

1. Haller MJ. Silverstain JH and Rosenbloom AL. Type 1 Diabetes in the Child and Adolescent. In: Liftshitz F, editor. Pediatric Endocrinology Fifth Edition. New York, NY: Informa Healthcare; 2007. p. 63–76.

2. Diabetes facts & figures [Internet]. International Diabetes Federation. 2021 [cited 2023 Mar 5]. Available from: https://www.idf.org/aboutdiabetes/what-is-diabetes/facts-figures.html

3. Hood, K. K., Peterson, C. M., Rohan, J. M., & Drotar, D. (2009). Association between adherence and glycemic control in pediatric type 1 diabetes: a meta-analysis. Pediatrics, 124(6), e1171–e1179. https://doi.org/10.1542/peds.2009-0207

4. Foster, N. C., Beck, R. W., Miller, K. M., Clements, M. A., Rickels, M. R., DiMeglio, L. A., Maahs, D. M., Tamborlane, W. V., Bergenstal, R., Smith, E., Olson, B. A., & Garg, S. K. (2019). State of Type 1 Diabetes Management and Outcomes from the T1D Exchange in 2016-2018. Diabetes technology & therapeutics, 21(2), 66–72. https://doi.org/10.1089/dia.2018.0384

5. Nathan, DM and for the DCCT/EDIC Research Group. The diabetes control

and complications trial/epidemiology of diabetes interventions and complications study at 30 years: overview. Diabetes Care [Internet]. 2014;37(1):9–16. Available from: dc13-2112

6. Akhu-Zaheya, L. M., & Shiyab, W. Y. (2017). The effect of short message system (SMS) reminder on adherence to a healthy diet, medication, and cessation of smoking among adult patients with cardiovascular diseases. International journal of medical informatics, 98, 65–75. https://doi.org/10.1016/j.ijmedinf.2016.12.003

7. Herbert, L., Owen, V., Pascarella, L., & Streisand, R. (2013). Text message interventions for children and adolescents with type 1 diabetes: a systematic review. Diabetes technology & therapeutics, 15(5), 362–370. https://doi.org/10.1089/dia.2012.0291

8. Ibrahim, N., Treluyer, J. M., Briand, N., Godot, C., Polak, M., & Beltrand, J. (2021). Text message reminders for adolescents with poorly controlled type 1 diabetes: A randomized controlled trial. PloS one, 16(3), e0248549. https://doi.org/10.1371/journal.pone.0248549

9. Bin-Abbas, B., Jabbari, M., Al-Fares, A., El-Dali, A., & Al-Orifi, F. (2014). Effect of mobile phone short text messages on glycaemic control in children with type 1 diabetes. Journal of telemedicine and telecare, 20(3), 153–156. https://doi.org/10.1177/1357633X14529244

10. Vaala SE, Hood KK, Laffel L, Kumah-Crystal YA, Lybarger CK, Mulvaney SA. Use of Commonly Available Technologies for Diabetes Information and Self-Management Among Adolescents with Type 1 Diabetes and Their Parents: A Web-Based Survey Study. Interact J Med Res. 2015;4(4):e24. Published 2015 Dec 29. doi:10.2196/ijmr.4504

11. 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(12):1332-1338. doi:10.1111/j.1464-5491.2006.01989.x

12. Kaushal, T., Montgomery, K. A., Simon, R., Lord, K., Dougherty, J., Katz, L., & Lipman, T. H. (2019). MyDiaText™: Feasibililty and Functionality of a Text Messaging System for Youth With Type 1 Diabetes. The Diabetes educator, 45 (3), 253–259. https://doi.org/10.1177/0145721719837895

13. Huang L, Yan Z, Huang H. The effect of short message service intervention on glycemic control in diabetes: a systemat-

a systematic review and meta-analysis. Postgrad Med. 2019 Nov;131(8):566-571. doi: 10.1080/00325481.2019.1668723. Epub 2019 Sep 28. PMID: 31524035.

14. Hsu WC, Lau KH, Huang R, et al. Utilization of a Cloud-Based Diabetes Management Program for Insulin Initiation and Titration Enables Collaborative Decision Making Between Healthcare Providers and Patients. Diabetes Technol Ther. 2016;18(2):59-67. doi:10.1089/dia.2015.0160

15. de Bock M, Codner E, Craig ME, Huynh T, Maahs DM, Mahmud FH, Marcovecchio L, DiMeglio LA. ISPAD Clinical Practice Consensus Guidelines 2022: Glycemic targets and glucose monitoring for children, adolescents, and young people with diabetes. Pediatr Diabetes. 2022 Dec;23(8):1270-1276. doi: 10.1111/pedi.13455. PMID: 36537523; PMCID: PMC10107615.

16. Markowitz JT, Cousineau T, Franko DL, et al . Text messaging intervention for teens and young adults with diabetes. J Diabetes Sci Technol. 2014 Sep;8(5):1029-34. doi: 10.1177/1932296814540130. Epub 2014 Jun 22. PMID: 25172879; PMCID: PMC4455383.

17. Foster, N. C., Beck, R. W., Miller, K. M., Clements, M. A., Rickels, M. R., DiMeglio, L. A., Maahs, D. M., Tamborlane, W. V., Bergenstal, R., Smith, E., Olson, B. A., & Garg, S. K. (2019). State of Type 1 Diabetes Management and Outcomes from the T1D Exchange in 2016-2018. Diabetes technology & therapeutics, 21(2), 66–72. https://doi.org/10.1089/dia.2018.0384

18. Deacon, A. J., & Edirippulige, S. (2015). Using mobile technology to motivate adolescents with type 1 diabetes mellitus: A systematic review of recent literature. Journal of telemedicine and telecare, 21(8), 431–438. https://doi.org/10.1177/1357633X15605223

19. Dobson, R., Whittaker, R., Pfaeffli Dale, L., & Maddison, R. (2017). The effectiveness of text message-based self-management interventions for poorly-controlled diabetes: A systematic review. Digital health, 3, 2055207617740315. https://doi.org/10.1177/2055207617740315

20. Stratton IM, Adler AI, Neil HA, Matthews DR, Manley SE, Cull CA, Hadden D, Turner RC, Holman RR. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. BMJ. 2000 Aug

12;321(7258

21. Akhu-Zaheya LM, Shiyab WY. The effect of short message system (SMS) reminder on adherence to a healthy diet, medication, and cessation of smoking among adult patients with cardiovascular diseases. Int J Med Inform. 2017 Feb;98:65-75. doi: 10.1016/j.ijmedinf.2016.12.003. Epub 2016 Dec 8. PMID: 28034414.

22. Cedran, D. (2002). The Philippines: SMS and citizenship. Development Dialogue, 1, 91-103.

23. Newton KH, Wiltshire EJ, Elley CR. Pedometers and text messaging to increase physical activity: randomized controlled trial of adolescents with type 1 diabetes. Diabetes Care. 2009 May;32(5):813-5. doi: 10.2337/dc08-1974. Epub 2009 Feb 19. PMID: 19228863; PMCID: PMC2671105.

24. Stirratt MJ, Dunbar-Jacob J, Crane HM, et al. Self-report measures of medication adherence behavior: recommendations on optimal use. Transl Behav Med. 2015 Dec;5(4):470-82. doi: 10.1007/s13142-015-0315-2. Epub 2015 Jul 9. PMID: 26622919; PMCID: PMC4656225.