Text2Floss: the feasibility and acceptability of a text messaging intervention to improve oral health behavior and knowledge

Tony S. Hashemian, DDS[1]; Donna Kritz-Silverstein, PhD[2]; Ryan Baker, BS[1]

1 Global Oral Health Program, Arizona School of Dentistry & Oral Health, Mesa, AZ, USA
2 Department of Family and Preventive Medicine, University of California, San Diego, La Jolla, CA, USA

Keywords
dental health education; dental floss; oral hygiene; oral health; text messaging.

Correspondence
Dr. Tony S. Hashemian, Arizona School of Dentistry & Oral Health, 5835 E. Still Circle, Mesa, AZ 85206. Tel.: 480-245-6243; Fax: 480-323-2647; e-mail: thashemian@atsu.edu. Tony S. Hashemian and Ryan Baker are with the Global Oral Health Program, Arizona School of Dentistry & Oral Health. Donna Kritz-Silverstein is with the Department of Family and Preventive Medicine, University of California, San Diego.

Received: 6/5/2013; accepted: 6/24/2014.

doi: 10.1111/jphd.12068

Journal of Public Health Dentistry •• (2014) ••–••

Abstract

Objective: Text messaging is useful for promoting numerous health-related behaviors. The Text2Floss Study examines the feasibility and utility of a 7-day text messaging intervention to improve oral health knowledge and behavior in mothers of young children.
Methods: Mothers were recruited from a private practice and a community clinic. Of 156 mothers enrolled, 129 randomized into text ($n = 60$) and control groups ($n = 69$) completed the trial. Participants in the text group received text messages for 7 days, asking about flossing and presenting oral health information. Oral health behaviors and knowledge were surveyed pre- and post-intervention.
Results: At baseline, there were no differences between text and control group mothers in knowledge and behaviors ($P > 0.10$). Post-intervention, text group mothers flossed more ($P = 0.01$), had higher total ($P = 0.0006$) and specific ($P < 0.05$) knowledge, and tried to improve their child's oral health behaviors ($P = 0.03$) and decrease their soda and sugary snacks ($P = 0.05$) more than control mothers. Text messages were accepted and perceived as useful.
Conclusions: Mothers receiving text messages improved their own oral health behaviors and knowledge as well as their behaviors regarding their children's oral health. Text messaging represents a viable method to improve oral health behaviors and knowledge. Its high acceptance may make it useful for preventing oral disease.

Introduction

Previous studies have demonstrated the utility of text messaging for promotion of health-related activities. For example, Armstrong *et al.* (1) found that adherence to sunscreen application was 56.1% in 35 participants receiving daily text message reminders, but only 30.0% in 35 participants not receiving text message reminders. London (2) reported that parents receiving text message reminders were 2.5 times more likely to get their child needed vaccinations than those not receiving texts. A review (3) of 25 trials showed that text message reminders can lead to improvement in numerous health-related behaviors and outcomes, including compliance with medication use, smoking cessation, and exercise programs; fewer missed appointments; and decreased asthma symptoms, hemoglobin A1C, and stress. Lastly, among pregnant women and new mothers enrolled in Text4Baby – a platform designed to provide maternal and child health information via text messages – over 60% reported that the text messages helped them remember appointments and immunizations, over 75% reported that the messages educated them about medical warning signs not previously known, and over 71% reported talking to their physician about a topic raised in a text (4).

It is conceivable that use of text messaging could represent a viable means to influence people to take better care of their teeth. However, while numerous studies have shown an improvement in health and related behaviors through use of text messages, few have examined the feasibility and utility of mobile technology, including text messaging, for the promotion of oral health behaviors and for increasing knowledge about oral health (5,6).

The purpose of this randomized controlled trial is to determine the feasibility and utility of a 7-day text message intervention for the improvement of oral health knowledge and behavior in mothers of children aged 5 years and younger.

Methods

Study design

A randomized controlled trial (Text2Floss) was designed with two groups: a) an intervention (text) group that received text messages asking whether they had flossed and presenting oral health information over 7 days along with the usual print materials from the clinic; and b) a usual-care comparison (control) group that received only the usual print materials from the clinic. Individuals were assigned to either the intervention or comparison group by a computerized process using simple randomization. Neither study staff nor participants were blinded to participants' allocation. While planning the present study, we were unable to find any published studies using text messaging to improve oral health, so we did not have guidance on sample size for powering the study; we based enrollment numbers on a combination of sample sizes reported in previous text messaging studies for promotion of other health behaviors and convenience sampling. Post hoc analyses for the total sample size showed that the power to detect differences using two-sided tests at $\alpha = 0.05$ for flossing and knowledge items ranged from 0.81 to 0.88.

Participants

A total of 182 women were screened for eligibility at a private pediatric dental practice between June 16 and July 25, 2012, and at a pediatric dental clinic in a community clinic between July 5 and July 18, 2012. To be eligible for inclusion in Text2Floss, women had to be mothers bringing a child aged 5 years or younger for dental care, have a cell phone capable of receiving texts, and indicate willingness to receive text messages and respond to both a preintervention survey and a postintervention survey one week post-randomization. Of 182 women screened, 12 (6.6%) refused to participate, and 14 (7.7%) were excluded because their cell phones were unable to receive text messages. Of the 156 eligible women randomized to the intervention (text) group ($n = 77$) and control group ($n = 79$), 27 (17.3%; text, $n = 17$; control, $n = 10$) were lost to follow-up and did not complete the postintervention survey. Thus, the 129 mothers who completed this study are the focus of this report. As shown in Figure 1, of these participants, 60 were in the text group (44 private practice, 16 community clinic) and 69 were in the control group (47 private practice, 22 community clinic).

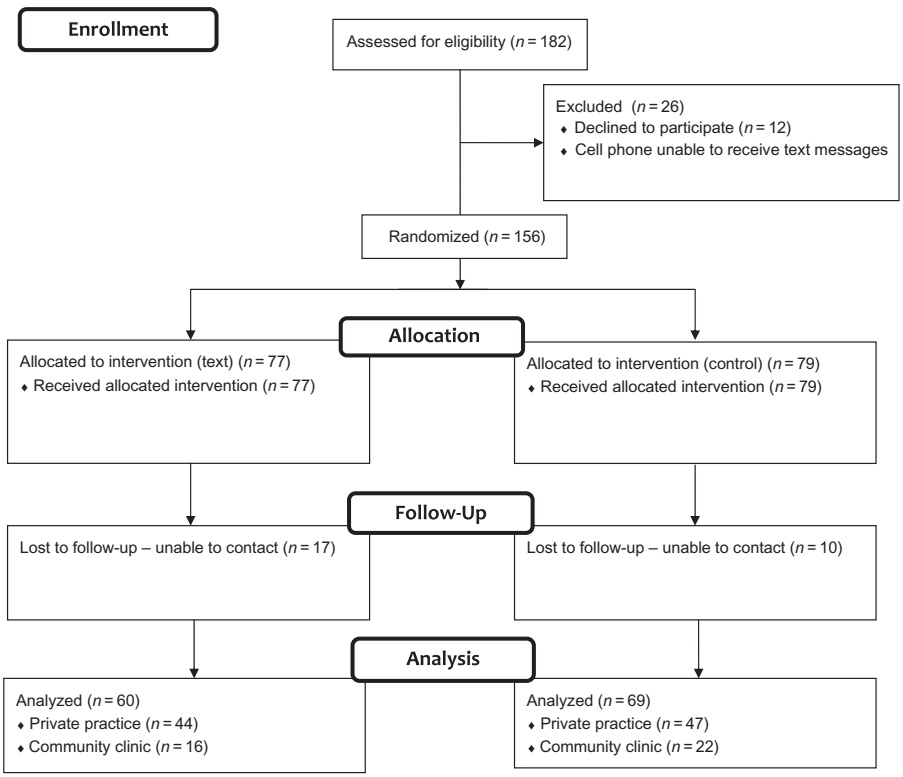

Figure 1 Flow diagram for Text2Floss Study.

This study was approved by the Human Research Protections Program at the sponsoring university; all participants gave written informed consent (English or Spanish) prior to participation.

Procedures

A preintervention survey was developed that included questions on demographics and mothers' current oral health behavior. Oral health knowledge, assessed with questions based on information found in American Academy of Pediatric Dentistry brochures (7), asked participants how often a child should see a dentist each year, along with a series of statements to which they responded "true" or "false."

A postintervention survey was developed that contained the same oral health behavior and knowledge questions as the preintervention survey plus additional questions about whether, since joining the study, they had tried to improve the oral health behaviors of their children and to decrease the amount of soda, candy, and other sugary snacks their children consumed. To assess acceptance and perceived utility of the text messaging program, mothers in the text group were also asked to indicate their agreement or disagreement with the following statements: "I found the text messaging useful"; "I feel this program helped me floss more often"; "I feel that the text messaging responses were an accurate representation of my behavior"; and "I would recommend this program to a friend or family member." Both preintervention and postintervention survey questions, initially in English, were translated into Spanish, then back-translated into English to ensure that the meaning was retained.

The text messaging system used for this study was the Text2Floss platform, an automated system available through CellTrust Company (Scottsdale, AZ, USA), a multichannel, two-way SMS gateway service provider with global coverage. Individuals opt into this system through a secure website or by sending a text message to a designated short code number. After participants had opted into this platform, a text message was generated each day at a specific time requesting a response to the query "Did you floss yesterday?" After a "no" or "yes" response, an additional message was sent containing oral health/oral hygiene information such as "Did you know tooth decay or cavities are common, preventable problems for people of all ages?" or "Good job! Don't forget to see your dentist twice a year for professional cleanings and oral exams."

At both the private practice and the community clinic, a staff member identified mothers of children aged 5 years and younger from scheduled appointments. Each mother was individually recruited and screened for eligibility by a hygienist after her child was seated for an exam. After the child's dental visit was completed, mothers willing to participate were escorted to a private room where the investigator or a study staff member explained the trial, answered questions, and obtained informed consent. Participants were then randomized into either the intervention group receiving text messages (text) or the comparison group not receiving any texts (control), and the preintervention survey was administered as an interview in either English or Spanish.

After completing the preintervention survey, mothers in the text group were added by the investigator or study team member to the Text2Floss platform, either via the participant's cell phone by texting "text2floss" or online. Shortly afterward, participants received a text and were asked to respond "floss" to ensure they were opted into the platform.

All mothers, regardless of group assignment, were also given an informational pamphlet about oral health containing answers to the knowledge questions on the survey. An incentive consisting of a sample-sized bottle of mouthwash, tube of toothpaste, and toothbrush was offered upon completion of the postintervention survey.

Approximately 8 days later, mothers were contacted via phone by a research team member who administered the postintervention survey. At least three attempts were made to contact each mother for follow-up.

Statistical analysis

For each mother, a total knowledge score was calculated for the preintervention and postintervention surveys by summing the number of true-or-false knowledge items correctly answered. Analysis was performed on an intent-to-treat basis. Means were calculated for continuous variables; frequency distributions were calculated for categorical variables. Comparisons between text and control groups on demographic characteristics and on preintervention and postintervention oral health behaviors and knowledge were performed with *t*-tests for continuous variables and chi-square analyses for categorical variables. Within-group differences on knowledge and behaviors were examined with paired *t*-tests and chi-square analyses, performed separately within the text and control groups. Analyses were performed with and without stratification for type of practice (private versus community clinic). To test for selection bias, paired *t*-tests were used to compare mothers who did and did not complete the postintervention survey. All statistics were performed using VassarStats (8); tests were two-tailed, with $P < 0.05$ considered statistically significant.

Results

Comparisons showed that there were no differences between text and control groups in characteristics or oral health behaviors pre-intervention. However, after a 7-day intervention using text messaging, mothers in the text group reported greater increases in flossing and other oral health behaviors

Table 1 Characteristics of All Participants and Comparisons of Text and Control Groups

	All (n = 129)			Text (n = 60)	Control (n = 69)	Comparison (Text vs. Control)	
Continuous Variables	Mean	(SD)	Range	Mean	Mean	t	P
Age (years)	33.9	(6.8)	18.0–56.0	32.8	34.3	–1.44	0.15
Child's age (years)	3.5	(1.4)	0.5–7.0	3.3	3.6	–1.34	0.18
Education (years)	14.1	(3.1)	5.0–20.0	14.4	13.8	1.09	0.28
Categorical Variables	n		% of Total n	% of Text n	% of Control n	χ^2	P
Practice type						0.21	0.64
Private	91		70.5	73.3	68.1		
Community	38		29.5	26.7	31.9		

Comparisons performed with independent t-tests for continuous variables and chi-square analysis for categorical variables.

and knowledge than mothers in the control group. Participants rated the text messaging intervention as acceptable and useful; compliance was 78.3%. Results were not due to selection bias, as there were no differences between those lost to follow-up and those finishing the study. Women recruited from the community health clinic had lower educational levels than women recruited from the private practice, but there were no differences in other characteristics.

Table 1 shows the characteristics of text and control participants. The average age of mothers was 33.9 years; the average child's age was 3.5 years, and average education was 14.1 years. The majority (70.5%) of participants came from the private practice; 29.5% came from the community clinic. Comparisons showed there were no significant differences between text and control groups in age, child's age, education, or type of practice attended ($P > 0.10$).

Comparisons of text and control groups on oral health behaviors before and after the text intervention are shown in Table 2. Pre-intervention, there were no significant differences between the groups in any of the oral health behaviors ($P > 0.10$). However, post-intervention, text group mothers reported flossing significantly more than control group mothers ($P = 0.01$). Additionally, compared to control group mothers, more text group mothers reported trying to improve their child's oral health behaviors (73.9% versus 90.0%, respectively; $P = 0.03$) and decreasing their child's soda, candy, and sugary snack intake (58.8% versus 83.6% respectively, $p = 0.05$).

Table 3 shows comparisons of the text and control groups on preintervention and postintervention oral health knowledge. As shown, before intervention there were no differences between the groups on any of the specific oral health knowledge questions ($P > 0.10$). However, after intervention, more text group mothers than control group mothers knew that dental caries is the most common childhood disease ($P = 0.04$) and that tooth decay is an infection ($P = 0.03$). Additionally, text group mothers had significantly higher total knowledge scores than control group mothers ($p = 0.0006$).

Text and control groups were compared on postintervention behaviors and knowledge after stratification by practice type (see Table 4). Among 91 mothers

Table 2 Preintervention and Postintervention Comparisons of Text and Control Groups for Reported Oral Health Behaviors

	Preintervention				Postintervention			
Behavior	Text (n = 60)	Control (n = 69)	Comparison (Text vs. Control)		Text (n = 60)	Control (n = 69)	Comparison (Text vs. Control)	
Continuous Variables	Mean	Mean	t	P	Mean	Mean	t	P
Brush own teeth (times/day)	2.2	2.1	0.63	0.53	2.2	2.1	0.83	0.41
Floss teeth (times/day)	1.2	1.1	1.38	0.17	1.5	1.2	2.48	**0.01***
Use mouthrinse (times/day)	1.2	1.0	1.61	0.11	1.2	1.0	1.43	0.16
Brush child's teeth (times/day)	1.9	1.8	0.80	0.43	2.0	2.0	–0.02	0.98
Categorical Variables					% Yes	% Yes	χ^2	P
Tried to improve child's oral health behaviors					90.0	73.9	4.47	**0.03***
Tried decreasing child's soda, candy, and snacks					76.6	59.4	3.60	**0.05***

* $P < 0.05$.

Comparisons performed with independent t-tests for continuous variables and chi-square analysis for categorical variables.

Table 3 Preintervention and Postintervention Comparisons of Text and Control Groups for Oral Health Knowledge

	Preintervention				Postintervention			
	Text ($n = 60$)	Control ($n = 69$)	Comparison (Text vs. Control)		Text ($n = 60$)	Control ($n = 69$)	Comparison (Text vs. Control)	
Categorical Variables†	%	%	χ^2	*P*	%	%	χ^2	*P*
Child should see dentist 2×/year	93.3	85.5	1.30	0.25	98.3	88.4	3.46	0.06
Most common chronic childhood disease?			1.46	0.48			6.48	0.04*
Asthma	13.3	11.6			1.7	13.0		
Diabetes	6.7	13.0			3.3	5.8		
Cavities	80.0	75.3			95.0	81.2		
Untreated cavities can lead to sickness	91.7	95.7	0.40	0.53	100.0	98.6	0.00	1.00
Untreated cavities can damage child's adult teeth	95.0	89.9	0.58	0.45	100.0	89.9	1.92	0.17
Tooth decay is an infection	86.7	78.3	1.03	0.31	98.3	87.0	4.33	0.03*
Soda, candy, high-sugar food cause cavities	98.3	100.0	0.00	1.00	100.0	100.0	0.00	1.00
Continuous Variables	Mean	Mean	*t*	*P*	Mean	Mean	*t*	*P*
Total knowledge score‡	5.5	5.2	1.62	0.11	5.9	5.5	3.50	0.0006*

* $P < 0.05$.

† Comparisons performed with chi-square analyses; $0.05 < P < 0.10$ is defined as borderline significance.

‡ Total knowledge score was calculated as the number of knowledge questions answered correctly; scores could range from 0 to 6. Comparisons performed with independent *t*-tests.

Table 4 Postintervention Comparisons of Text and Control Groups for Reported Oral Health Behaviors and Knowledge after Stratification by Practice Type

	Private Practice ($n = 91$)				Community Clinic ($n = 38$)			
	Text ($n = 44$)	Control ($n = 47$)	Comparison (Text vs. Control)		Text ($n = 16$)	Control ($n = 22$)	Comparison (Text vs. Control)	
Continuous Behavior Variables	Mean	Mean	*t*	*P*	Mean	Mean	*t*	*P*
Brush own teeth (times/day)	2.1	2.0	0.82	0.41	2.6	2.4	0.84	0.41
Floss teeth (times/day)	1.4	1.0	3.41	0.001*	1.6	1.5	0.33	0.74
Use mouthrinse (times/day)	1.1	0.8	2.02	0.05*	1.6	1.5	0.36	0.72
Brush child's teeth (times/day)	1.9	1.8	0.88	0.38	2.2	2.4	–0.55	0.59
Categorical Behavior Variables	% Yes	% Yes	χ^2	*P*	% Yes	% Yes	χ^2	*P*
Tried to improve child's oral health behaviors	88.6	61.7	7.36	0.007*	93.8	100.0	0.03	0.86
Tried decreasing child's soda, candy, and snacks	65.9	46.8	2.63	0.10	100.0	86.4	0.86	0.35
Categorical Knowledge Variables	% correct	% correct	χ^2	*P*	% correct	% correct	χ^2	*P*
Child should see dentist 2×/year	100.0	91.4	2.15	0.14	93.8	81.8	0.35	0.55
Most common chronic childhood disease?			6.72	0.03*			1.56	0.46
Asthma	2.3	14.9			0.0	9.1		
Diabetes	0	4.3			6.2	4.5		
Cavities	97.7	80.9			94.1	86.4		
Untreated cavities can lead to sickness	100.0	100.0	0.00	1.00	100.0	95.5	0.03	0.86
Untreated cavities can damage child's adult teeth	100.0	91.4	2.15	0.14	100.0	100.0	0.00	1.00
Tooth decay is an infection	100.0	83.0	6.23	0.01*	93.8	90.1	0.08	0.78
Soda, candy, high-sugar food cause cavities	100.0	100.0	0.00	1.00	93.8	100.0	0.03	0.86
Continuous Knowledge Variables	Mean	Mean	*t*	*P*	Mean	Mean	*t*	*P*
Total knowledge score	5.9	5.4	3.48	0.0008*	5.8	5.5	0.98	0.33

* $P < 0.05$.

Comparisons performed with independent *t*-tests for continuous variables and chi-square analysis for categorical variables; $0.05 < P < 0.10$ is defined as borderline significance.

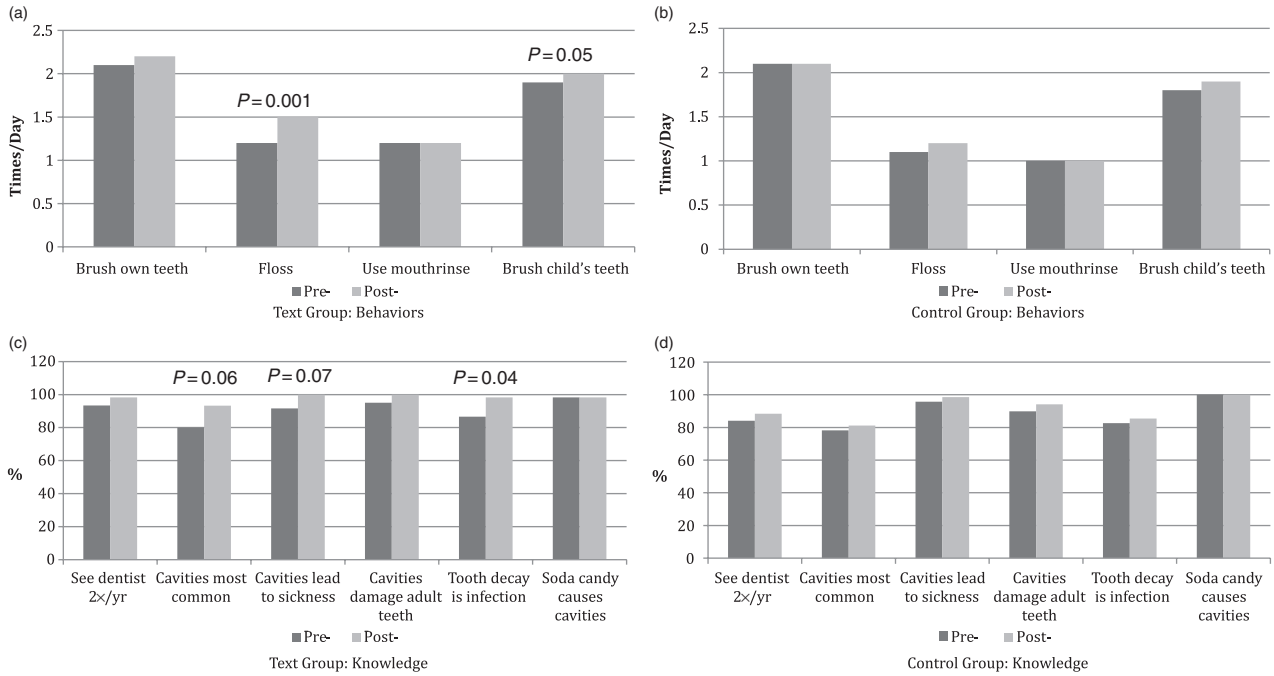

Figure 2 Within-group differences before and after intervention. (a) Text group: behaviors. (b) Control group: behaviors. (c) Text group: knowledge. (d) Control group: knowledge.

from the private practice, those in the text group reported flossing significantly more times per day ($P = 0.001$) and using mouthrinse more often than control group mothers ($P = 0.05$). Additionally, compared with control group mothers, a greater proportion of text group mothers reported trying to improve their child's oral health behaviors (61.7% versus 88.6%, respectively; $P = 0.007$) and knew that the most common chronic childhood disease is caries (80.9% versus 97.7%, respectively; $P = 0.03$); text group mothers also had a higher total knowledge score ($P = 0.0008$). Among the 38 mothers from the community clinic, no significant differences were observed in knowledge or behaviors between the text and control groups ($P > 0.10$).

Figure 2 shows comparisons of preintervention and postintervention survey responses within the text group and, separately, within the control group. As shown, within the text group, oral health behaviors and knowledge improved after the intervention. Total knowledge scores were also higher after the intervention ($P = 0.0001$). In contrast, within the control group, there were no differences between preintervention and postintervention responses for either behaviors or knowledge.

Overall, mothers were accepting of the text messages and believed in their utility. The majority (95%) of text group mothers believed the messages were useful; 96.7% would recommend this program to friends and family; 81.7% agreed the program helped them floss more often; and 98.3% believed their text message responses accurately represented their behavior. Comparisons by practice type showed that community clinic mothers reported that the program helped them floss more often than did the private practice mothers ($P = 0.04$), but there were no other differences in acceptance or perceived utility ($P > 0.10$).

Compliance, defined as responding to one or more text messages post-randomization, was 78.3% overall within the text group (81.8% in private practice participants and 68.8% in community clinic participants). Compliant mothers responded to the text messages querying whether they had flossed the previous day on an average of 5.25 out of the 7 days.

Of 156 mothers initially enrolled, 27 were lost to follow-up. To test for selection bias, demographic characteristics of mothers who did and did not complete the postintervention survey were compared. Independent *t*-tests showed there were no significant differences between mothers who were and were not lost to follow-up on age (means = 33.9 versus 31.7, respectively; $P = 0.13$), education (means = 14.1 versus 13.9 years, respectively, $P = 0.79$), or child's age (means = 3.5 versus 3.1 years, respectively; $P = 0.79$).

Comparisons of the community clinic and private practice samples showed there were no significant differences between the groups in age (32.6 versus 34.5, respectively; $t = 1.45$, $P = 0.15$), flossing ($P > 0.80$), or mouthrinse use, the last in

fact being nonsignificantly higher among women from the community clinic than women from the private practice (preintervention: 73.4% versus 67.0%, respectively, $P = .06$; postintervention: 86.8% versus 74.7%, respectively; $P = 0.20$). Women from the community clinic sample had a lower educational level than women from the private practice (15.1 years of school versus 11.8; $t = 6.28$, $P < 0.0001$). No information was obtained on income.

Discussion

The results of this study show that a short 7-day text message intervention was able to increase flossing behavior and oral health knowledge. Additionally, among participants from a private practice, text messages increased the use of mouthrinse. Mothers' behaviors with respect to their children also changed; more text group mothers than control group mothers reported trying to improve their child's oral health behaviors and decreasing their child's soda, candy, and sugary snack intake. Although some inconsistency exists (9), studies suggest that flossing can reduce as well as remove interproximal plaque, leading to a reduction in caries prevalence, especially that of interproximal caries (10,11). Studies dating as far back as 1948 show that flossing, mouth-rinsing, and other such oral hygiene measures are less commonly practiced compared with brushing and use of fluoridated toothpastes (10). Caries is the most common chronic childhood disease (12-14), and in adults, poor oral health has been linked to diabetes and cardiovascular disease (12,15-20). Thus, any intervention that can improve oral health has important public health implications.

In 2008, it was estimated that over 80% of the US population owned a cell phone and that over 28 billion text messages were sent per month (21), rates that are likely higher today. Text messages can provide cues to action, prompts, reminders, reinforcement, and feedback, all of which are important promoters of behavior change (22). The highest rates of cell phone use have been reported among adolescents, younger adults, the socioeconomically disadvantaged, and the less educated, suggesting that text messaging might be a viable means for interventions to improve health in these individuals (23). In this study, use of text messages to remind about flossing and deliver oral health information was considered acceptable by almost all participants, including those from the community clinic.

The use of mobile technology (text messages, video messages, voice calling, and the Internet) to provide health care (mHealth) has been applied to improve the practicality, rapidity, and precision of diagnostic tests; monitor specific medical conditions; improve medication adherence; send appointment reminders; and deliver medical test results (21). The results of this study are in accord with those of others showing that text messaging can be an effective intervention (via prompts and reminders) to improve health behaviors such as sunscreen application (1) and vaccination (2). Although numerous other studies show the utility of text messaging with regard to improving health behaviors such as exercise, this is one of only a few studies (5,6) to show that mobile technology such as text messaging can be used to improve behaviors and knowledge related to oral health. Additionally, our study shows that sending text messages for as little as 1 week is sufficient to effect change.

It is of note that all mothers in the present study, regardless of group assignment, were given a pamphlet containing the correct answers to the knowledge questions after completing the preintervention survey. While there were no preintervention group differences, text group mothers had higher knowledge scores post-intervention than control group mothers. These results are in accord with those found by Sharma *et al.* (5) in a sample of mothers from India and suggest that just giving patients written material containing oral health information is not sufficient to improve knowledge. A more active approach, such as that involved in answering text messages, may be needed to effect change in knowledge.

This study is limited in that it included a relatively small, statistically underpowered sample of mothers from a community clinic. Therefore, it is impossible to determine whether the lack of significant preintervention-versus-postintervention differences in knowledge and behaviors in the community clinic text group mothers is due to inadequate statistical power or a true lack of differences. However, the high ratings of acceptance and agreement with the statement that "the program helped me floss more often" by text group mothers from the community clinic supports the former rather than the latter explanation. It seems reasonable to believe that mothers of children treated in the community health clinic tended to be of lower income, although this was not queried directly. Thus, given the lack of significant differences within the community clinic sample, it is also unclear whether results observed for the sample as a whole would generalize to mothers of a lower socioeconomic status. However, regardless of the added expense, there were no significant differences between community clinic and private practice mothers in flossing and mouthrinse use, and random assignment ensured that any differences (e.g., education) were distributed equally between the text and control groups (see Table 1). Although messages from the Text2Floss platform can be received by the majority of the national wireless carriers, participation was limited, as some mothers were deemed ineligible because their wireless carrier was unable to receive Text2Floss messages. Finally, this study included only a 1-week follow-up. Thus, long-term behavior changes cannot be evaluated.

This study also had several strengths. For instance, it included a large sample of mothers recruited from two

distinct types of practices. Surveys and text messages were available in both English and Spanish, allowing mothers to be queried and to respond in the language with which they were most comfortable and eliminating language as a barrier to participation. Lack of differences between the text and control groups in preintervention responses suggests that randomization was adequate. Furthermore, the lack of differences in characteristics between mothers who were and were not lost to follow-up suggests that results were unaffected by selection bias.

In conclusion, the results from this study suggest that text messaging represents a feasible method to improve oral health behaviors and knowledge. Mothers who received text messages for one week improved their own oral health behaviors and knowledge, as well as their behaviors regarding their children's oral health. The high acceptance of text messaging in the intervention group suggests its potential utility in the prevention of oral disease. Longer studies of diverse groups of individuals are needed to validate these results and determine whether and how long changes persist after text messages are discontinued.

Acknowledgments

The authors wish to thank San Ysidro Community Health Center, which provided access to community clinic patients, and Bruce B. Baker, DMD, who provided access to private practice patients. CellTrust Corporation (Scottsdale, AZ, USA) provided the text messaging platform and technical support for an unrestricted study; no funding was provided for this study.

References

1. Armstrong AW, Watson AJ, Makredes M, Frangos JE, Kimball AB, Kvedar JC. Text-message reminders to improve sunscreen use. *Arch Dermatol*. 2009;**145**(11):1230-6.
2. London S. Text message reminders boost teen vaccination. 2010 [cited 2012 Mar 13]. Available from: http://ped.imng.com/fileadmin/content_pdf/ped/archive_pdf/vol44iss9/70400_main.pdf.
3. Krishna S, Boren SA, Balas EA. Healthcare via cell phones: a systematic review. *Telemed J E Health*. 2009;**15**(3):231-40.
4. Jordan ET, Johnson P, Evans WD. Text4Baby: using text messaging to improve maternal and newborn health. *Nurs Womens Health*. 2011;**15**(3):206-12.
5. Sharma R, Hebbal M, Ankola AV, Murugabupathy V. Mobile-phone text messaging (SMS) for providing oral health education to mothers of preschool children in Belgaum City. *J Telemed Telecare*. 2011;**17**:432-6.
6. Hurling R, Claessen JP, Nicholson J, Schafer F, Tomlin CC, Lowe CR. Automated coaching to help parents increase their children's brushing frequency: an exploratory trial. *Community Dent Health*. 2013;**30**:88-93.
7. American Academy of Pediatric Dentistry. Health care provider brochures. [cited 2012 Jun 1]. Available at: http://www.aapd.org/publications/brochures/.
8. Lowry R. VassarStats: website for statistical computation. 1998-2012 [cited 2012 Sept 18]. Available at: www.vassarstats.net.
9. Hujoel PP, Cunha-Cruz J, Banting DW, Loesche WJ. Dental flossing and interproximal caries: a systematic review. *J Dent Res*. 2006;**85**:298-305.
10. Bakdash BM. Current patterns of oral hygiene product use and practices. *Periodontol 2000*. 1995;**8**:11-4.
11. Bellamy P, Barlow A, Puri G, Wright KI, Mussett A, Zhou X. A new in vivo interdental sampling method comparing a daily flossing regime versus a manual brush control. *J Clin Dent*. 2004;**15**:59-65.
12. U.S. Department of Health and Human Services. Oral health in America. A report of the Surgeon General. 2000 [cited 2012 Nov 15]. Available at: http://silk.nih.gov/public/hck1ocv.@www.surgeon.fullrpt.pdf.
13. Guido JA, Martinez Mier EA, Soto A, Eggertsson H, Sanders B, Jones JE, Weddell JA, Villanueva Cruz I, Anton de la Concha JL. Caries prevalence and its association with brushing habits, water availability, and the intake of sugared beverages. *Int J Paediatr Dent*. 2011;**21**:432-40.
14. Roberts MW. Dental health of children: where we are today and remaining challenges. *J Clin Pediatr Dent*. 2008;**32**:231-4.
15. Institute of Medicine. Advancing oral health in America. 2011 [cited 2012 Nov 15]. Available at: http://www.hrsa.gov/publichealth/clinical/oralhealth/advancingoralhealth.pdf.
16. Ship JA. Diabetes and oral health: an overview. *J Am Dent Assoc*. 2003;**134**:4S-10S.
17. Taylor GW, Borgnakke WS. Periodontal disease: associations with diabetes, glycemic control and complications. *Oral Dis*. 2008;**14**:191-203.
18. Shrihar TG. Potential correlation between periodontitis and coronary heart disease – an overview. *Gen Dent*. 2012;**60**:20-4.
19. Manjunath BC, Praveen K, Chandrashekar BR, Rani RM, Bhalla A. Periodontal infections: a risk factor for various systemic diseases. *Natl Med J India*. 2011;**24**:214-9.
20. de Oliveira C, Watt R, Hamer M. Toothbrushing, inflammation, and risk of cardiovascular disease: results from Scottish Health Survey. *BMJ*. 2010;**340**:c2451. doi: 10.1136/bmj.c2451.
21. Cole-Lewis H, Kershaw T. Text messaging as a tool for behavior change in disease prevention and management. *Epidemiol Rev*. 2010;**32**:56-69.
22. Norman GJ, Kolodziejczyk JK, Adams MA, Patrick K, Marshall SJ. Fruit and vegetable intake and eating behaviors mediate the effect of a randomized text-message based weight loss program. *Prev Med*. 2013;**56**:1-7.
23. Fjeldsoe BS, Marshall AL, Miller YD. Behavior change interventions delivered by mobile telephone short-message service. *Am J Prev Med*. 2009;**36**:165-73.

