Research Article

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Journal of Healthcare Communications

2021
Vol.6 No.4:14

Early Cardiovascular Health Outreach SMS (ECHOS): A Preventive Health Text Messaging Program Pilot Study

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Citation: Makaroff ABKE, Woo JP, Uehisa BSK, Branche K, Press M, et al. (2021) Early Cardiovascular Health Outreach SMS (ECHOS): A Preventive Health Text Messaging Program Pilot Study. J Health Commun Vol.6 No.4:14.

Abstract

Context: Early adoption of healthy habits has shown reduced cardiovascular morbidity and mortality later in life. Providing heart-healthy information while encouraging positive lifestyle changes in adolescents and young adults is challenging but important preventive health goal.

Objective: We hypothesized text messaging may be an effective method of increasing preventive health knowledge among young people. Early Cardiovascular Health Outreach SMS (ECHOS) evaluated the effectiveness and feasibility of text messaging to promote awareness and encourage positive lifestyle behaviours using elements of "nudge theory."

Design: We performed a prospective cohort study in 3 phases.

Setting: Community-based.

Participants: Individuals between 13 and 25 years of age.

Intervention: Over periods of 30 to 90 days, participants received daily to weekly text messages educating them on cardiovascular health and encouraging engagement in various heart-healthy behaviours.

Main outcome measures: Knowledge about heart health and health behaviours were assessed pre- and post- intervention using 5-point Likert scales.

Results: In Phase 1 the ECHOS program resulted in both increased knowledge about heart health and self-efficacy surrounding preventive health behaviours. Phase 2 addressed sleep quantity and quality and we observed improvement in both parameters. Phase 3 focused on stress management. Results showed improvement within certain lifestyle domains associated with stress but lack of improvement in others.

Conclusion: These data suggest that text messaging interventions based on "nudge theory" are a feasible and scalable mode of communication promoting heart health among adolescents and young adults. Positive feedback and high satisfaction from ECHOS participants suggest that similar digital health interventions may be an effective approach to improving cardiovascular health in this population.

Keywords: Cardiovascular health; Lifestyle; Public health; Mobile health technology

Received: June 28, 2021; **Accepted:** July 13, 2021; **Published:** July 20, 2021

Introduction

More than 25% of American adolescents and young adults currently have high cholesterol, high blood glucose, and hypertension; yet over 75% are unaware of their cardiovascular risk factors [1]. According to the National Health and Nutrition Examination Survey, individuals between 18-39 years old have the lowest hypertension control rates [2]. Late adolescence to early adulthood is a critical developmental period in establishing health-related attitudes and behaviours [3]. Lifestyle choices become increasingly consolidated during these years and these long-term patterns are associated with health outcomes later in life [3-6]. Thus, research into preventing heart disease beginning early in life is a major priority in the field.

Lifestyle behaviours including, healthy eating, maintaining a healthy weight, regular physical activity, and smoking avoidance are so powerful, that people who do all four can reduce their risk for all chronic diseases by roughly 80% [7]. In addition to these more commonly known factors, there are other ways to

prevent cardiovascular disease. Spending time with loved ones, hugging, laughing, and having a pet: all reduce stress, ease anxiety, and lower blood pressure [8-12]. The benefit of these simple behaviours has been found to produce a benefit similar to that seen with statins or aerobic exercise [8]. In particular, sleep is emerging as a significant target for improving cardiovascular risk profiles. The American Academy of Paediatrics has deemed this a "public health epidemic" with immense implications given the widespread prevalence of chronic sleep deprivation in young people [13,14]. Studies show that students who obtain less sleep have lower self-esteem and do not perform as well in school [14,15]. Further, only 2%-25% of high schoolers get a minimum of 8 hours each night as recommended by the National Sleep Foundation [16,17].

Providing heart-healthy information and encouraging positive lifestyle changes in adolescents and young adults are especially challenging [4]. One study showed that fewer than half of adolescents received hypertension education from physicians and of those that did more than half discarded educational hand-outs as soon as they left the clinic [18]. Limited knowledge and awareness of cardiovascular risk factors lead to low motivation to adopt these preventive behaviours, especially when most young people are generally healthy and do not think about how their current decisions influence their chances of living with chronic disease later in life [9].

Mobile health technology, including the use of SMS or text messaging to facilitate disease prevention, is of growing interest [19,20]. Text 4 Heart II, was a program that studied how text-messaging could improve medication adherence among adult patients with cardiovascular disease [21]. A systematic review of 45 electronic health interventions showed positive effects such as reducing smoking rates and alcohol intake while improving nutrition and physical activity in young adults, however, 80% of these were delivered *via* websites [22]. Text messaging is widely used among adolescents and young adults in the U.S with estimates of 86% using a smartphone [22]. According to the Pew Research Centre young adults (18-24) send or receive an average of 50 text messages per day [23].

Our study, Early Cardiovascular Health Outreach SMS (ECHOS), evaluated the effectiveness and feasibility of providing text messaging as a tool for delivering evidence-based heart-healthy information to adolescents and young adults. We also aimed to encourage the practice of simple, yet effective behaviours known to reduce cardiovascular risk profiles with early adoption in life. "Nudge theory" is a behavioural science concept, which proposes that positive reinforcement and indirect suggestions (without restricting choice) can predictably influence behaviour [24].

Nudge interventions have been applied in British and American public health policy to change behaviour and are highly appealing as they are low cost and typically do not require on-going resources to sustain. [25] We hypothesized that text-messages would be an effective means of "nudging" participants to reflect briefly on how well their current behaviour aligns with a heart-healthy lifestyle and to consider taking action now to improve their current and future cardiovascular health.

Methods and Design

We performed a multi-phase, prospective, cohort study of adolescents and young adults between 13 and 25 years of age. Eligible participants were smartphone owners with a text messaging plan. Participants received texts on evidence-based preventive cardiovascular strategies and habits for 30-90 days. Text messages were crafted by young adults (a medical student and undergraduate student) with active feedback from faculty cardiologists **(Figure 1)**. Feedback from a high school student helped to make the texts as relevant and engaging as possible for the teen targeted age group. Participants were recruited from U.S. middle schools, high schools, and colleges *via* email dissemination of recruitment materials, as well as in-person recruitment on the campus of the University of California Los Angeles (UCLA). Text messages were delivered through a web-based application called Chorus created at UCLA. All participants were emailed a survey created with Survey Monkey before and after receiving ECHOS text messages. The surveys collected demographic data, used open-ended questions (e.g., hours slept), and 5-point-rating scales to assess health knowledge. Participation under the age of 18 required parental consent in addition to standard personal consent. Each phase was approved by the UCLA Medical Institutional Review Board (#16-001393) **(Figure 1)**.

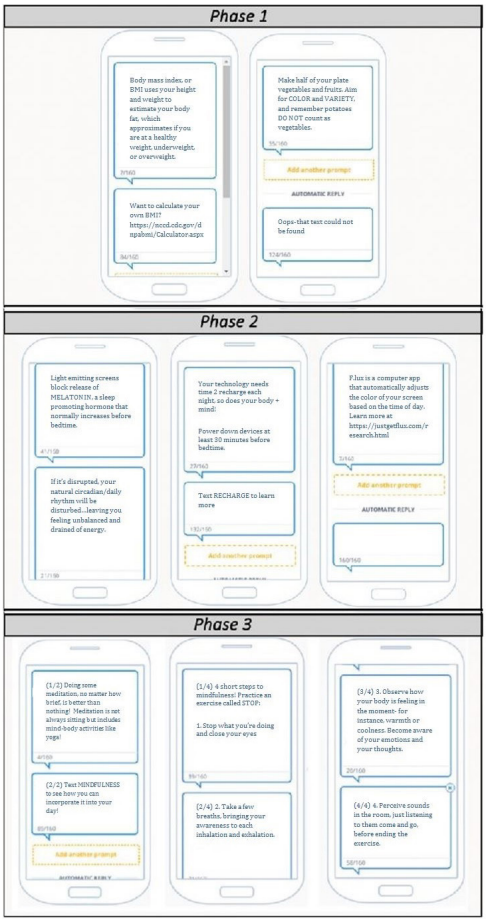

Figure 1: A Sample text messages from 3 phases of early cardiovascular health outreach SMS pilot trials. Each text message was limited to 160 characters. The Chorus app did not support images or emojis.

Data analysis

Quantitative data were analysed using two-tailed t-tests, linear regression models, and significance levels of $p<0.05$. At the end of each phase, the survey also asked participants for feedback about the ECHOS program. These free-text responses were qualitatively coded and analysed for themes.

Phase 1

Phase 1 (spring 2018) served as a pilot study to test the platform. We aimed to enrol at least 20-25 participants after using Whitehead's stepped rules of thumb for determining optimal sample size for a pilot study [26]. This method took into account the likely size of a future trial designed around a small effect size (such as 0.2) and desired 80-90% power. Phase 1 consisted of sending weekly texts (over 90 days) about broad topics such as smoking cessation, nutrition, physical activity, stress management, sleep, and heart-healthy habits. Sleep deficiency was identified as a significant health threat to participants from Phase 1 of the ECHOS project, supporting the literature that this is a major targetable approach for improving cardiovascular health in adolescents and young adults [14-17]. Thus, we focused on sleep for Phase 2 of ECHOS (summer 2018).

Phase 2

In Phase 2 we sought to hone-in on one topic rather than many and explore the response to a program with more frequent text-messages over a shorter total length of time. 14 sleep-specific text messages were sent to enrolled participants over a period of 30 days. Pre and post-survey responses were analysed for changes in sleep hygiene knowledge, quantity, and quality of sleep. To measure the quality of sleep and the extent of sleep disturbances in this population, we applied the Medical Outcomes Study (MOS) Sleep Scale-Revised (MOS Sleep–R), which is a previously validated and reliable tool for assessing psychometric properties contributing to overall sleep quality [27,28]. Briefly, this includes questions about the participant's sleep in the past 3 months across 3 domains: disturbance, somnolence, and adequacy. Summing the scores across these domains generates the Sleep Problems Index (SPI) with higher scores indicating more sleep problems overall. Using the mean SPI and standard deviation for a representative sample of the US adult population, an effect size of at 0.1-0.2 (given that a meaningful change of SPI would be at least 1.5 points) we estimated needing a sample size of at least 150 participants per arm for a full-scale study [27]. A controlled trial of this scale did not align with our research team's goals at the time and was infeasible (due to lack of funding), so we decided to proceed with phase 2 and 3 of ECHOS with revised pilot protocols.

Phase 3

Phase 3 of this project (winter 2019) was the final iteration of ECHOS pilot testing. Previous research supports the use of the Lifestyle and Habits Questionnaire-Brief (LHQ-B) [6] to assess lifestyle behaviours and attitudes in young adults 18-25 [6]. Each item contained a statement about different lifestyle behaviours and attitudes. For each item, participants were asked to broadly examine their own lifestyle behaviours and attitudes, then rate their level agreement with the given statement (e.g., "I avoid smoking cigarettes"). The scale ranged from 1 "strongly disagree" to 5 "strongly agree" with higher scores indicating healthier habits and attitudes. A modified LHQ-B with six of eight original domains was adapted for pre and post-surveys, including physical activity, psychological health, substance use, nutrition, social concern, and sense of purpose. According to the authors, the LHQ-B domains of psychological health and social concern were the top two domains that predicted stress levels [6]. Twenty-four text messages were sent over a month-long period, and participants received texts three times a week. $10 Amazon gift cards were provided to help increase cohort size during this phase.

Results

Recruitment and demographics

ECHOS enrolled a total of 260 participants between 13 and 25 years of age in 3 separate cohorts. The average age was 19 years. There were 195 females, 63 males, and 2 transgender participants. The demographics of participants are shown in **Figure 2** and **Table 1**.

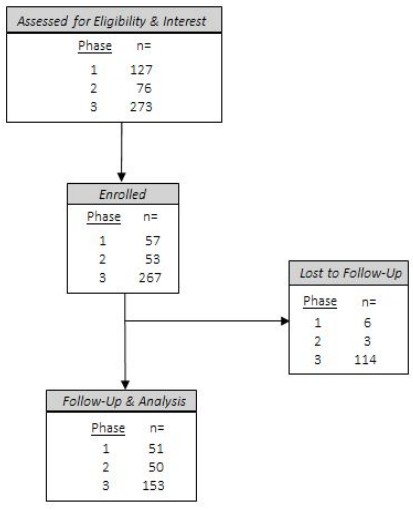

Figure 2: Early cardiovascular outreach SMS CONSORT diagram.

Characteristics					
Phase 1		**Phase 2**		**Phase 3**	
n=51		**n=50**		**n=153**	
Mean age (years) ± SD	19.6 ± 1.9	Mean age (years) ± SD	19.3 ± 2.94	Mean age (years) ± SD	19.7 ± 1.6
Sex (% Female)	67%	Sex (%Female)	64%	Sex (%Female)	82%

Race and ethnicity		Race and ethnicity		Race and ethnicity	
Asian or Pacific Islander	71%	White, not Hispanic	46%	Asian or Pacific Islander	56%
Caucasian	20%	Asian or Pacific Islander	22%	Caucasian	23%
Hispanic/Latino	3.50%	Latino/Hispanic	14%	Hispanic/Latino	11%
American Indian/ Alaskan	3.50%	Black/African American	6%	Other multiracial	10%
African American	2%	Middle Eastern	4%		
		Other multiracial	8%		
School grade		**School grade**		**Year in college**	
Middle school	1.80%	Middle school	2%	First	37%
High school	8.80%	High school	9%	Second	22%
College	75.40%	College	75%	Third	12%
Other	14%	Other (graduate school)	14%	Fourth	22%
				Graduate	13%

Table 1: Recruitment results for each of the 3 Phases of ECHOS.

Individuals completed interest forms which prompted them to verify their eligibility and provide their contact information. They (or their parents for participants under 18 years old) were then emailed the consent form. Enrolled participants were those that consented to begin receiving ECHOS text messages and completed the pre-intervention survey. Follow-up included completion of the post-intervention survey, which contained the same questions but also asked for feedback about the ECHOS program. In the third phase, there were a disproportionate number of participants that did not complete the post-survey. This may have been due to the survey being sent during final examination of the academic quarter at the university. Only participants that responded to both pre- and post-intervention surveys were included in analyses.

Phase 1

Pre-intervention results: Pre-intervention surveys established a baseline by asking participants about their behaviours, on average, over the past 3 months. At baseline participants "felt stressed" or "had trouble relaxing" about 50% of the time. The reported average nightly hours of sleep were 6.5 ± 1.7 hours and participants felt they received enough sleep only 50% of the time. Pre-intervention surveys demonstrated that few participants (12.2%) smoked cigarettes or e-cigarettes. Participants reported a high level of attention to portion size during meals and reported consuming a low-fat diet "some of the time," on average. Participants reported an average of 6-10 days of exercise over the past 3 months. On average, adolescents and young adults felt somewhat knowledgeable about heart disease, cancer, and nutrition. The internet was the most cited source of health information (73%), followed by family and physicians (22%), and finally schools (5%).

Post-intervention results: Thirteen text-messages were sent over 90 days. Overall, participants reported that they read the text messages "most of the time." The ECHOS program resulted in an increase in heart knowledge by 16% [p=0.004]. There was a 21% [p=0.007] increase in perception of heart disease prevention knowledge by the end of the intervention, corresponding to "somewhat knowledgeable" on the Likert scale. There was also a 19% [p=0.02] increase in how often participants thought about portion sizes and a 21% [p=0.03] increase in how often they ate a low cholesterol diet. There was no significant difference in nutrition knowledge, sense of happiness, stress, sleep quality, and exercise. Interestingly, our early results showed that tobacco smoking and vaping interventions were less relevant in this sample; but rather there was a need to address sleep and stress management.

For heart disease and nutrition, surveys used the following scale of 1 is not knowledgeable, 2 is somewhat knowledgeable, and 3 is very knowledgeable. Participants answered the question "do you know how to prevent heart disease?" with a scale of 1 being no, 2 being some of the time, 3 being half of the time, 4 being most of the time, and 5 being yes. There was a statistically important increase in heart disease knowledge from not knowledgeable to somewhat knowledgeable and heart disease prevention from knowing how to prevent heart disease some of the time to half of the time **(Table 2)**.

	Pre-intervention	Post-intervention	p-value
Where do you rank yourself about your knowledge on heart disease?	1.8 ± 0.3	2.1 ± 0.3	0.004
Where do you rank yourself about your knowledge on nutrition?	2.2 ± 0.4	2.17 ± 0.3	0.6
Do you know how to prevent heart disease?	2.9 ± 1.5	3.5 ± 0.7	0.007

Table 2: ECHOS Phase 1: Health knowledge.

Adolescents and young adults were asked how often questions using the following scale of 1 is never, 2 is some of the time, 3 is half of the time, 4 is most of the time, and 5 is always. There is a statistically significant increase in how frequently participants thought about portion control and consumed low-fat foods. There was no difference in mood, stress, sleep, and exercise **(Table 3).**

	Pre-intervention	Post-intervention	p-value
In the last 3 months, how often were you happy with your life?	3.6 ± 0.9	3.6 ± 0.6	0.9
In the last 3 months, how often were you stressed (or did you have had trouble relaxing)?	2.9 ± 0.7	3.0 ± 0.9	0.8
In the last 3 months, how often did you get enough sleep/wake up feeling refreshed?	2.8 ± 0.8	3.0 ± 0.9	0.2
In the last 3 months, how often did you think about the portion size of your snack or meal?	2.6 ± 1.6	3.1 ± 1.0	0.02*
In the last 3 months, how often did you eat a low-fat diet or low cholesterol diet?	1.9 ± 0.9	2.3 ± 0.9	0.03*
In the last 3 months, how often did you exercise enough to sweat, raise your beat, or make you sweat for more than 20 minutes?	3.6 ± 1.4	3.8 ± 1.2	0.3

Table 3: ECHOS Phase 1: Behavioral health changes.

Phase 2

Pre-intervention results: Prior to the intervention, participants reported that, on average, they were "unsure" to "somewhat knowledgeable" about healthy sleep habits (3.65 ± 0.7) and the impact of sleep on heart health (3.38 ± 0.92). In the 3 months prior to the intervention, patients averaged 7.4 ± 0.9 hours. We noted a moderate negative correlation (r=-0.55) [p<0.005] between stress level and average hours of sleep. The average pre-intervention MOS Sleep Problem Index (SPI) was 8.3 (out of a maximum possible score of 15), indicating considerable sleep disturbances. There was a moderate positive correlation (r=0.52) [p=0.005] between stress level and sleep problem index. Participants stated they were "unsure/slightly motivated" to get enough sleep.

Post-Intervention Results: After the ECHOS phase 3 intervention there was no significant difference in knowledge about healthy sleep habits [p=0.08] or knowledge about the impact of sleep on heart health [p=0.1] **(Table 4)**. There was also no significant change in motivation to improve sleep habits [p=0.5] **(Table 4)**. There was a statistically significant increase in average total quantity of sleep [p=0.003] and a decrease in average individual sleep problems index score [p<0.005] **(Tables 4 and 5)**.

	Pre-intervention	Post-intervention	p-value
Where do you rank yourself about your knowledge on healthy sleep habits?	3.7 ± 0.7	3.5 ± 1.2	0.08
Where do you rank yourself about your knowledge on the impact of sleep on your heart and overall health?	3.4 ± 0.9	3.6 ± 1.2	0.6
How motivated are you to get more/enough sleep?	3.5 ± 1.0	3.7 ± 1.1	0.5
Average quantity of sleep per night	7.4 ± 0.9	7.8 ± 0.9	0.003*
Sleep Problem Index Score	8.3 ± 2.0	7.0 ± 1.7	<0.005*

Table 4: EECHOS Phase 2 results.

	Pre-Intervention	Post-Intervention	P-value
Sleep disturbance	2.4 ± 0.8	2.0 ± 0.7	0.04*
Somnolence	2.8 ± 0.8	2.3 ± 0.6	0.002*
Sleep adequacy	3.2 ± 0.9	2.7 ± 0.8	0.005*

Table 5: ECHOS Phase 2: Average individual change in Sleep Problem Index Score (by domains).

There was no significant difference in knowledge about healthy sleep habits [p=0.08] or knowledge about the impact of sleep on heart health [p=0.1] **(Table 4)**. There was no significant change in motivation to improve sleep habits [p=0.5] **(Table 4)**. There was a statistically significant increase in average total quantity of sleep [p=0.003] and a decrease in average individual sleep problems index score [p<0.005].

Summing the scores across these three domains generates the Medical Outcomes Study (MOS) Sleep Scale-Revised Sleep Problems Index (SPI). Higher scores indicate more sleep problems overall. A six-item questionnaire assessed three domains or dimensions of sleep over the past 4 weeks. Respondents self-reported how often they experienced the "sleep problem" specified in the item using 5-point scales ranging from "none of the time" to "all of the time." Sleep disturbance included three items: subjective feeling that sleep was not quiet/restful, trouble falling asleep, and awakening during sleep time, and having trouble falling asleep again. Somnolence referred to feeling drowsy during the day and how common it was for them to take daytime naps. Finally, adequacy was defined by the item about "waking up feeling unrested."

Phase 3

Pre-intervention Results: Building on our previous phases, the LHQ-B was administered to assess various lifestyle behaviours of participants. Higher scores on the LHQ-B suggest stronger adoption of healthy patterns of behaviour for each particular lifestyle domain, while lower scores represent less optimal, health-compromising behaviour. There was a predominance of female participants in this phase (n=125) compared to males (n=28). Females tended to have higher scores in all of the domains except psychological and physical health **(Table 6)**.

Post-intervention Results: While there tended to be a statistically significant change on individual questions within each lifestyle domain between pre- and post-surveys, the aggregate score of each domain was less sensitive to significant change. Of note, psychological health, one of the domains suggestive of stress levels, showed four significant sub-domain changes for females and 1 for males from pre- to post-responses **(Table 7)** [6]. On the whole, female scores tended to increase, suggesting improved lifestyle over the course of study. In particular, females showed scores significantly lower on the social concern (p=0.04) and sense of purpose (p=0.004) domains from pre- to post-surveys. For males, there were no statistically significant changes in any of the six lifestyle domain scores **(Tables 6 and 7).**

Male (n=28)				Female (n=125)		
Domains	**Pre**	**Post**	**P-value**	**Pre**	**Post**	**P-value**
Physical Activity	20.4	19.9	0.4	17.7	18.5	0.09
Psychological health	26.7	26.2	0.3	23.7	24.7	0.06
Substance Use	34.2	36	0.1	35.7	36.3	0.1
Nutrition	11.4	11.8	0.3	11.8	12.6	0.1
Social Concern	19.8	20	0.4	20.7	20.1	0.04*
Sense of Purpose	11.5	11.3	0.4	11.8	10.9	0.004*

Table 6: ECHOS Phase 3: Lifestyle and Health Questionnaire-Brief (LHQ-B) results.

Sub-Domain Statements	Male (n=28)			Female (n=25)		
	Pre	**Post**	**P-value**	**Pre**	**Post**	**P-value**
I am able to manage the stress in my life.	3.9	3.7	0.09	3.2	3.5	0.003*
I am able to relax and unwind.	4	4	0.4	3.6	3.6	0.3
I am hopeful about the future.	4.2	3.9	0.08	3.8	3.8	0.4
I have clear direction in life.	3.8	3.8	0.5	3.2	3.4	0.04*
I am able to concentrate on my work at school or on the job.	3.9	3.9	0.3	3.6	3.7	0.1
I get at least 7-8 hours of sleep at night and wake up feeling rested and refreshed.	2.9	3.1	0.02*	2.8	3.1	0.004*
I am able to assert myself in a responsible way and not allow others to take advantage of me.	3.9	3.9	0.5	3.6	3.8	0.04*

Table 7: ECHOS Phase 3: Changes for psychological health domain in males and females.

The Lifestyle and Habits Questionnaire-Brief (LHQ-B) 6 assesses lifestyle behaviours and attitudes in young adults 18-25. A modified LHQ-B with six of eight original domains was adapted for pre- and post-surveys, including physical activity, psychological health, substance use, nutrition, social concern, and sense of purpose. According to the authors, the LHQ-B domains of psychological health and social concern were the top two domains that predicted stress levels. The study team was interested in sex differences in response to the intervention, however, our sample did not allow for this. Females did; however, tend to have higher relative scores in all of the domains except psychological and physical health.

While there tended to be a statistically significant change on individual questions within each lifestyle domain between pre and post-surveys, the aggregate score of each domain was less sensitive to significant change. Psychological health, one of the domains suggestive of stress levels 6, which was the main outcome of interest to the study team in phase 3, showed four significant sub-domain changes for females and one for males from pre- to post-responses.

Satisfaction with the text-messaging intervention

Phase 1: Participants shared what they learned from ECHOS with family and friends some of the time (2.18 ± 0.13). A majority (80%) were satisfied with the weekly text messages, but the remaining 20% preferred more than one text-message a week. Text messages were the appropriate length for 92% of participants. 94% would recommend the intervention to others.

Phase 2: 67% of participants liked receiving text messages every other day during the month-long study while 33% would have preferred to receive messages less frequently. 79% felt that the texts were an appropriate length while 21% felt the texts were too long. 60% read the majority of texts, but most participants (71%) rarely or never attempted to interact with the text messages by replying or clicking on a link to a resource provided. The open-ended responses suggested that it was not necessarily the way the texts were written, but rather that the participants lacked a sense of accountability or motivation to engage with the intervention and change their behaviours, "I think people might be more motivated to change their sleep habits if this was a 'challenge' system along with the facts provided." 90% would recommend the intervention to others.

Phase 3: Most participants "strongly agreed/agreed" that the messages: increased their knowledge on how to live a heart-healthy lifestyle (80%), were relevant to them (86%), increased their awareness about their health (86%), and liked receiving the messages (82%). Many participants expressed similar sentiments as seen in the following example, "I started taking a bit more control on relieving myself from stress."

Discussion

This intervention focused on providing heart-healthy education to adolescents and young adults using mobile health technology. With the use of text messages, ECHOS brought cardiovascular disease prevention to the fingertips of an otherwise difficult to engage group, similar to previously reported interventions employing text messaging or "nudge theory" [29-31].

ECHOS received positive feedback from participants, and high satisfaction suggesting high acceptance of the use of digital health and media among adolescents and young adults.

ECHOS demonstrated a modest increase in knowledge about heart disease prevention. We observed changes consistent with steps toward a heart-healthy lifestyle. While these were encouraging findings, without any control group, there are many possible confounding factors and threats to the internal validity of the study. For example, phase 2 was conducted in summer months, in which young people are less likely to have school and work obligations governing sleep practices.

There was no significant difference in nutrition knowledge, a sense of happiness, or exercise. There are several possible explanations for the lack of significant differences. First, participants' baseline ratings for health knowledge were relatively high suggesting a potential ceiling effect. Second, the intervention intensity and length may not have been sufficient to detect a difference in outcomes of interest. Another limitation is that our use of non-probability, convenience sampling may mean that our cohorts were not representative of general youth behaviour and health literacy. Future research should include greater heterogeneity of participants, including more male participants (our sample sizes were too small to accurately assess sex differences). Given the

wide access to mobile devices across different ages, races, and socio-economic statuses, it is likely that this type of intervention would produce similar findings. However, it is important to reach underserved populations, in which the risk of chronic disease is even greater.

While this mobile health intervention allowed participants to occasionally reply to a text to receive another automated message with more information, our platform could not respond to individuals directly. This could certainly have affected the participants' motivation, value, and perception of the intervention. More tailored and interactive texting may increase self-efficacy and response efficacy in future interventions. Insufficient real-time feedback for participants may represent a lost opportunity to facilitate self-guided behaviour modification. Additionally, the use of devices and interventions designed to share behavioural data with both patients and healthcare professionals could provide even more valuable insight in between clinic visits, for example. Future research could focus on further evaluation of text message attributes (e.g., tone of the messages), expanding to tracking clinical or physiological measures (e.g., weight or pulse), and the use of the resources provided in the texts.

Conclusion

The ECHOS study is one of many examples that demonstrate the potential of constantly evolving personalized, digital technology to support healthy lifestyle management and early prevention of chronic illness, including cardiovascular disease. Our three pilot trials of ECHOS can help shape and inform future full-scale studies in these arenas. Our findings indicate it is feasible and scalable for participants to use and track cardiovascular health-related data and lifestyle behaviour for at least 1-3 months *via* a text-messaging intervention. Continued efforts are needed to elucidate and eliminate barriers to awareness, education, and implementation of preventive health behaviours.

As cell phones have become ubiquitous in our daily lives, text messaging offers a quick and less daunting way to incorporate and track many holistic health behaviours, big and small. This makes improved health accessible regardless of where someone is on their health journey, whether it is through learning, trying something new, or changing up an old routine. It is a creative approach for improving cardiovascular risk profiles in adolescents and young adults, especially, but may also benefit all ages.

Conflict of Interest

"All authors have completed the Unified Competing Interest form (available on request from the corresponding author) and declare: no support from any organization for the submitted work; no financial relationships with any organizations that might have an interest in the submitted work in the previous 3 years; no other relationships or activities that could appear to have influenced the submitted work." Grant funding for research but no other competing interests.

Acknowledgements

Dr. Armen Arevian for allowing us to implement the study using his Chorus app.

Dia Collins for her tireless support of our entire research team.

Garett Collins for vetting our text messages.

Vadim Osadchiy M.D. for his assistance with phase 1.

UCLA Internal Medicine Chiefs' Summer Research Fellowship & Zekun Feng M.D. for providing mentorship, consistent feedback, and encouragement in phase 2.

UCLA Undergraduate Research Fellows Program for mentorship and for generous financial support of the UCLA Wasserman Scholarship, which made possible the gift cards in phase 3.

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