Original Article

Efficacy of Sedentary Time Reduction with Mobile Texting and Focused Educational Sessions in Patients with Coronary Artery Disease: a Randomized Controlled Trial

Deeprasertdamrong W, Swanpitak P, Sanjaroensuttikul N, Uaaree P, Kobkitsumongkol K, Sangmanee S, Ratvijitwech S and Chaianansin T
Department of Rehabilitation Medicine, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok, Thailand

ABSTRACT

Objectives: To assess the efficacy of mobile texting and focused educational session on sedentary behavior in patients suffering from coronary artery disease.
Study design: Randomized controlled trial.
Setting: Cardiac Rehabilitation Clinic, Rehabilitation Medicine Department, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok, Thailand.
Subjects: Patients with coronary artery disease who underwent cardiac rehabilitation program from November 2018 to May 2020 at Ramathibodi Cardiac Rehabilitation Clinic.
Methods: The participants were randomized to receive either a standard cardiac rehabilitation (control group), or a standard cardiac rehabilitation with mobile texting and focused educational sessions on sedentary behavior (intervention group). Sedentary time and time spent in other physical activity levels were recorded at baseline, 1, 3, and 6 months following participation in both groups. This was done using the Thai short International Physical Activity Questionnaire (Thai short IPAQ). The effects of mobile texting and focused educational sessions on sedentary behavior were analyzed by employing a mixed effects linear regression analysis.
Results: Participants spent about 13.72 hours/day engaging in sedentary behavior. The intervention group showed significantly less prevalence of diabetes compared with the control group. This baseline difference was adjusted in the regression model. The between-group comparison study found that sedentary time was significantly less at 3 months in the intervention group compared with the control group (at 3 months; difference 1.75 hour/day, p = 0.002). Mild intensity physical activity rose significantly only at the end of the study (at 6 months; difference 1.00 hour/day, p = 0.047). There was no significant difference between the two groups at all follow-up intervals for moderate-to-vigorous physical activity.
Conclusion: Additional mobile texting and focused educational sessions on sedentary behavior to a standard cardiac rehabilitation program, helped the patients with coronary artery disease reduce their sedentary time at 3 months.

Keywords: behavior, patient education, cardiac rehabilitation, physical activity, coronary artery disease

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Introduction

Sedentary behavior is described as waking behaviors consuming energy expenditure amounting to less than 1.5 metabolic equivalents (METs).[1] It comprises sitting or lying down with or without performing other activities that also entail minimal energy expenditure such as using a computer, mobile phone, or watching television. Sedentary behavior is closely linked to increased risk of cardiovascular disease, diabetes and metabolic syndrome.[1] There is no generally accepted guideline for the proper amount of time spent in a prolonged sitting, but a previous study revealed that all-cause mortality increased by about 5% for every one hour spent sitting for longer than 7 hours per day.[2]

Physical activity is any bodily movement that increases energy expenditure above the basal metabolic rate (1 MET). Sedentary behavior comprises physical activities with energy expenditure ranging from 1 to 1.5 METs. Light physical activity is defined as activities with energy expenditure of 1.6 to 2.9 METs. Moderate-to-vigorous physical activity refers to activities which require energy expenditure of 3 METs or greater.[3] Recommendations for the physical activity level in order to maintain good health include at least 150 minutes a week of moderate intensity or 75 minutes a week of vigorous intensity aerobic physical activity.[3]

Interestingly, sedentary behavior and a lack of moderate-to-vigorous physical activity should be considered as separate risk factors because they affect mortality risk independently.[1] This is because sedentary individuals who are unable to meet exercise recommendations seem to be at a high risk of mortality rate when compared to individuals with either risk factors.[1] For this reason, sedentary behavior is

Correspondence to: Pat Swanpitak, MD, FRCPhysiatrT; Cardiac Rehabilitation Unit, Department of Rehabilitation Medicine, Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok 10400, Thailand; E-mail: s_pat99@hotmail.com

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one of the modifiable risk factors for patients suffering from coronary artery disease (CAD). However, the standard cardiac rehabilitation (CR) usually focuses on increasing moderate-to-vigorous physical activity, but often fails to reduce patients' sedentary time.[4-7] Furthermore, patients and healthcare providers in cardiac rehabilitation clinics are usually concerned with increasing physical activity more than reducing sedentary time.[8] Another study reported that patients with heart disease were prone to experiencing more sedentary time compared with those without heart disease in the same age group.[9]

To evaluate physical activity, two very commonly used measurements, including self-report questionnaires (subjective method) and physical activity monitors by accelerometers (objective method), are described.[3] Between these two methods, the questionnaires are inexpensive, require less time to administer when compared to the physical activity monitors, and can access various types of physical activity (i.e. gardening, walking, etc.).[3] One standard questionnaire for describing physical activity is the International Physical Activity Questionnaire (IPAQ), which has been translated into the Thai language.[10] The validity and reliability of the Thai version of IPAQ (Thai short IPAQ) were acceptable when compared with physical activity monitors by accelerometers.[10]

Many interventions have been proposed in order to decrease sedentary behavior, including behavioral therapy. Previous studies found that behavioral therapy can significantly improve sedentary time.[9] However, this process requires specialized personnel such as behavioral therapists, who are quite rare in developing countries such as Thailand. On the other hand, text message intervention is another intervention previously reported as able to produce behavioral change.[11,12] According to the self-determination theory, which is one of the motivational theories commonly referred to in the field of health promotion, mobile texting can help provide recommendations for rationales, goals, and choices about sedentary time reduction.[13] These could be indicated as an outside source of extrinsic motivation for encouraging patients to curtail their sedentary time. Meta-analyses have demonstrated the beneficial effects of text message intervention on health behavioral change.[11,12,14,15] This method is convenient, low cost, and does not require healthcare providers with sophisticated skills.

Nevertheless, we though that text message intervention alone can provide only one-way communication since there is no feedback facility. Combined with focused educational sessions, this method could provide two-way communication which allows more patients to participate; also, one previous meta-analysis study showed that supplemented text messages with additional components including face-to-face consultations are more effective in promoting behavioral change.[11] However, another analysis exploring the effects of texting intervention in patients with CAD offered information on multiple factors for secondary prevention, but was not focused on sedentary behavior and physical activity.[12] To the best of our knowledge, no study has yet investigated the effects of combined text message intervention and focused educational sessions on sedentary behavior and physical activity.

The primary objective of the study was to evaluate the effects of mobile texting and focused educational sessions on sedentary behavior in patients with CAD who received a standard CR. We hypothesized that patients who additionally received both mobile texting and focused educational interventions could further reduce their sedentary time when compared with those who received a standard CR alone.

Methods

Ethical approval was obtained from the Ramathibodi Hospital Human Research Committee (approval ethical number/RF_62026). Patients were given information and documented their informed consent.

Participants

They were patients with CAD who received optimal treatment, visited an out-patient cardiac rehabilitation clinic of Ramathibodi Hospital from November, 2018 to May, 2020, and provided an informed consent to participate this study.

Inclusion criteria

- Stable CAD
- More than 7 hours of sedentary time per day
- Being able to read Thai
- Having a personal mobile phone with Line application (a freeware application for instant communications on electronic devices) or having other persons to receive the messages and communicate their content to them

Exclusion criteria

- Contraindication for exercise training, severe obesity, pregnancy, severe chronic obstructive pulmonary disease, orthopedics, neurological or peripheral vascular diseases that may compromise safety in improving physical activity

Interventions

The study had two interventions which were the text messages and the focused educational sessions on sedentary behavior.

1. The text messages were developed by the researchers. The content of the messages was adapted from guidelines or recommendations for CR,[3] exercise prescription,[16] and interventions for reducing sedentary behavior.[17-21]

The development of text messages involved an expert panel which included one physiatrist, one nurse who worked in the cardiac rehabilitation clinic, two physical therapists who worked in the cardiac rehabilitation clinic, one social worker, and two persons who were not medical providers. Three criteria were used in the evaluation: 1) usefulness of the messages in reducing sedentary time; 2) readability; and 3) a final open question for feedback and any suggestions. The stated messages should be approved by at least 5/7

experts for both usefulness and readability purposes. Unaccepted messages were changed in accordance with the expert group's suggestions.

2. The focused educational sessions on sedentary behavior comprised 4 sessions. The physical therapists gave information about each session to participants. Each physical therapist gave the information in the same standard of content at baseline, 1, 3, and 6 months, respectively.

The first session was concerned with the definition of sedentary behavior, physical activity and impact of sedentary behavior on health. Furthermore, the participants were encouraged to set goals to reduce sedentary time. The second session involved information regarding SMART goals (Specific, Measurable, Attainable, Realistic, and Time-Bound), and a proper environment to reduce sedentary time. In the third session, participants were informed about techniques to reduce sedentary time and how to adjust their goals appropriately. For the last session, participants reviewed all the information from the previous 3 sessions and summarized their long-term home-program with the physical therapist.

To reduce the problem of bias in this study, the physical therapists who provided focused educational sessions on sedentary behavior were not the same persons who conducted the standard CR.

Measurements

Physical activity was assessed subjectively using the Thai short International Physical Activity Questionnaire (Thai short IPAQ).[10] The Thai short IPAQ is a questionnaire designed to estimate time employed in different physical activity levels (sedentary, mild intensity, intensity, vigorous intensity) in the past week (hours and minutes). The Thai short IPAQ was validated in Thailand and demonstrated a fair correlation with accelerometers.[10] The primary outcome of this study was sedentary behavior. Other physical activity levels were the secondary outcomes.

Sample size calculation

The sample size calculation was based on the primary outcome, which was a reduction in sedentary time, according to the study by Thakkar J, et al (2016),[12] assuming an alpha level (α) of 0.05, and desired power of 80%.

The estimated sample size was calculated to be 33 individuals per group. Allowing for a 20% dropout rate, there were 40 subjects per group.

Procedures

The experiment was a randomized controlled trial study. Randomization was 1:1 ratio with a block of four. Allocation was concealed from physical activity assessors and data analysts. We recorded baseline characteristics including age, sex, nationality, BMI, level of education, current employment status, marital status, smoking status, treatment, underlying disease, risk of exercise, and sitting time (hours/day).

Participants in the intervention arm received the mobile texting, the focused educational sessions on sedentary behavior and the standard CR. The control arm received only the standard CR. The messages (1 message/day, 4 days/week, on random days, between 08:00 h and 16:00 h) offered information on definitions of physical activity and sedentary behavior, sedentary behavior health links, general encouragement, instructions, goal setting, self-monitoring, social support, etc. The messages were sent for 6 months.

The standard cardiac program consisted of patient assessment, risk stratification, detection of depressive symptoms, and educational sessions on physical activity which did not focus on sedentary behavior, nutritional status, and secondary prevention. The program took place at the 1st visit, and approximately at 1-month, 3-month, and 6-month intervals. Physical activity data assessment was conducted at the CR clinic where the CR program took place or via telephone by 2 health professionals of the same standard.

Sedentary time and time spent on other physical activity levels were assessed at baseline, 1, 3, and 6 months after having participated in the study.

Statistical analysis

We used STATA version 14. Descriptive data were reported using mean, standard deviation, frequency, and percentage. The modified intention-to-treat was used to analyze the data. If participants were lost to follow-up at all intervals, they would be considered as dropouts and excluded from the analysis. However, if they were lost to follow-up at some intervals, any collected data would be used in the analysis. To analyze the effects of the mobile texting and the focused educational sessions on sedentary behavior, mixed effects linear regression analysis was employed.

Results

One hundred participants were randomized in the study from November 2018 to May 2020. The dropouts included five participants in the control group and nine participants in the intervention group (Figure 1). Most participants were lost to follow-up due to medical and transportation problems. One patient in the intervention group died from an underlying disease while sleeping and was not associated with increased physical activity.

Most patients were males, working, married, never smoked, received CABG surgery, had hypertension, and had low risk of exercise (Table 1). On average, all participants reported sitting time, light physical activity, and moderate-to-vigorous physical activity to be about 13.72 hours/day, 1.16 hours/day, and 0.03 hours/day, respectively. The intervention group showed a significantly lower prevalence of diabetes than the control group. This baseline difference was adjusted in the regression model.

In the intra-group comparison study with the baseline (Table 2), both study arms revealed a significant decrease

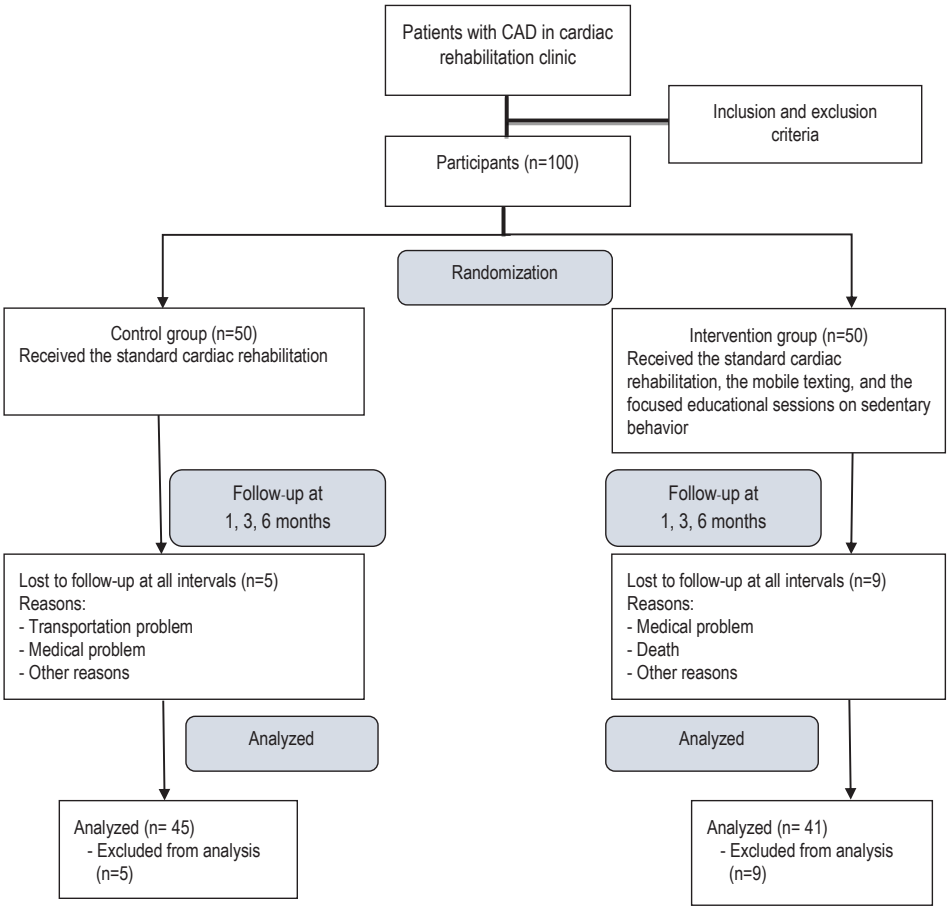

Figure 1. Flow chart of subjects' participation

in sedentary time. In the control group, sedentary time significantly dropped at 1 month (difference -1.18 hour/day, p = 0.003), 3 months (difference -1.00 hour/day, p = 0.017), and 6 months (difference -1.13 hour/day, p = 0.007). In the intervention group, sedentary time significantly decreased at 1 month (difference -1.32 hour/day, p = 0.002), 3 months (difference -2.36 hour/day, p = 0.000), and 6 months (difference -1.39 hour/day, p = 0.002).

Time spent in light physical activity significantly increased at all follow-up intervals for both groups. In the control group, light physical activity significantly increased at 1 month (difference 0.91 hour/day, p = 0.014), 3 months (difference 1.19 hour/day, p = 0.002), and 6 months (difference 0.92 hour/day, p = 0.018). For the intervention group, light physical activity significantly increased at 1 month (difference 1.14 hour/day, p = 0.005), 3 months (difference 1.56 hour/day, p = 0.000), and 6 months (difference 1.82 hour/day, p = 0.000). There were no significantly different changes in time spent on moderate-to-vigorous physical activity at baseline, and any follow–up intervals.

For the between-group comparison study (Table 2), sedentary time was significantly lower only at 3 months for the intervention group compared with the control group (difference -1.75 hour/day, p = 0.002). Light physical activity for the intervention group significantly increased only at the end of the study (difference 1.00 hour/day, p = 0.047) and there was no significant difference between the two groups at all follow-up intervals for moderate-to-vigorous physical activity.

Discussion

According to previous studies from Canada and Portugal conducted by Biwas et al.[4] and F.Ribeiro et al.[6] the mean sedentary time at baseline was 8.1 hours/day and 6.47 hours/day respectively. In our study, the mean sedentary time amounted to 13.72 hours/day. Our findings show that baseline sedentary time in patients with CAD seems to be higher than in the previous studies. The difference in baseline sedentary time compared to the previous analyses may be due to our inclusion criteria which state that the patients should have a sedentary time lasting more than 7 hours per day. There is no generally accepted guideline for significantly prolonged sedentary time. One previous meta-analysis study shows every one hour spent in a sedentary state for longer than 7 hours per day means an increase in all-cause mortality by about 5%.[2] So, we used these criteria for selecting participants who had a risk factor of too much sedentary time.

The change in sedentary time during CR in the intra-group study lasted for 6 months for both groups which corresponds with the study by Nienke, et al.[5] which shows that CR had long-term effects in reducing sedentary time. However, the improvement differed from the studies of Biwas, et al.[4] and

Table 1. General characteristics of patients in the intervention and the control groups

Characteristics	Control group (n=45)	Intervention group (n=41)
Age[1]	62.96 (7.41)	64.63 (9.32)
Male[2]	34 (75.56)	26 (63.41)
Female[2]	11 (24.44)	15 (36.59)
Thai[2]	44 (97.78)	41 (100)
BMI[1]	25.01 (4.00)	24.43 (4.07)
Level of education[2]		
None/primary	15 (34.09)	9 (23.08)
Secondary	9 (20.45)	9 (23.08)
Vocational training	8 (18.18)	9 (23.08)
University	12 (27.27)	12 (30.77)
Current employment status[2]		
Working	20 (46.51)	15 (42.86)
Not working	12 (27.91)	9 (25.71)
Retired	11 (25.58)	11 (31.43)
Marital status[2]		
Unmarried	3 (6.82)	5 (12.82)
Married	36 (81.82)	32 (82.05)
Divorced	2 (4.55)	1 (2.56)
Separated	0	0
Widowed	3 (6.82)	1 (2.56)
Smoking status[2]		
Current smoker	0	0
Ex-smoker	20 (45.45)	14 (35)
Never smoked	24 (54.55)	26 (65)
Treatment[2]		
CABG	45 (100)	40 (97.56)
PCI	0	1 (2.44)
Thrombolysis	0	0
Underlying disease[2]		
Diabetes	24 (53.33)	12 (29.27)
Hypertension	38 (84.44)	31 (75.61)
COPD	1 (2.22)	2 (4.88)
CKD	8 (17.78)	11 (26.83)
Risk of exercise[2]		
Low risk	39 (86.67)	37 (90.24)
Intermediate risk	3 (6.67)	2 (4.88)
High risk	3 (6.67)	2 (4.88)
Physical activity from Thai short IPAQ (hour/day)[1]		
Sedentary time	13.90 (1.98)	13.53 (2.14)
Light physical activity	1.12 (1.46)	1.22 (1.55)
MVPA	0.04 (0.15)	0.02 (0.06)

[1]Mean (SD), [2]number (%)

BMI, body mass index; CABG, coronary artery bypass graft; PCI, percutaneous coronary intervention; COPD, chronic obstructive pulmonary disease; CKD, chronic kidney disease; IPAQ, the international physical activity questionnaire; MVPA, moderate-to-vigorous physical activity

Ribeiro, et al,[6] both of which show the standard CR seems to fail in changing sedentary behavior. Consequently, the effect of standard CR in reducing sedentary time was unclear. Due to the lower baseline sedentary time of the previous studies,[4,6] the improvement of sedentary time for both groups in our study may be from the ceiling effect of standard CR. We assume that general standard CR may have the ceiling to reduce sedentary time. Thus, other behavioral interventions such as the mobile texting and the focused educational sessions on sedentary behavior should be added to boost the effectiveness of standard CR on sedentary time reduction.

For the between-group study, the intervention group reported a greater decrease in sedentary time than the control

Table 2. Changes in sedentary time, light physical activity, and moderate-to-vigorous physical activity from baseline to 1-month, to 3-month, and to 6-month follow-up

	1-month Coef. (95%CI)	*p*-value	3-month Coef. (95%CI)	*p*-value	6-month Coef. (95%CI)	*p*-value
Sedentary time (h/day)						
Control group	-1.18 (-1.96- -0.40)	0.003*	-1.00 (-1.82- -0.18)	0.017*	-1.13 (-1.95- -0.31)	0.007*
Intervention group	-1.32 (-2.15- -0.49)	0.002*	-2.36 (-3.20- -1.53)	0.000*	-1.39 (-2.24- -0.53)	0.002*
Between-group	-0.53 (-1.61-0.55)	0.339	-1.75 (-2.87- -0.64)	0.002*	-0.65 (-1.78- 0.48)	0.261
Light physical activity (h/day)						
Control group	0.91 (0.18-1.63)	0.014*	1.19 (0.43-1.95)	0.002*	0.92 (0.15-1.68)	0.018*
Intervention group	1.14 (0.34-1.93)	0.005*	1.56 (0.77-2.35)	0.000*	1.82 (1.02-2.62)	0.000*
Between-group	0.32 (-0.63-1.27)	0.505	0.46 (-0.52-1.43)	0.357	1.00 (0.01-1.98)	0.047*
Moderate-to-vigorous physical activity (h/day)						
Control group	0.08 (-0.05-0.20)	0.218	0.02 (-0.11-0.14)	0.803	0.04 (-0.09-0.16)	0.585
Intervention group	-0.00 (-0.14-0.13)	0.957	0.11 (-0.02-0.24)	0.091	0.11 (-0.02-0.25)	0.103
Between-group	-0.11 (-0.25-0.03)	0.127	0.07 (-0.07-0.21)	0.343	0.05 (-0.10-0.19)	0.515

*Statistically significant, $p < 0.05$

group in the 3rd month. This suggests that the information from the mobile texting and the focused educational sessions on sedentary behavior helped participants in the intervention group to become less sedentary, but without significant difference in the long-term follow-up when compared with the control group. This may be due to the rare attainment of behavioral change maintenance,[22] but there was a minimal reduction in sedentary time in the intervention group at the 6–month interval. In the future, this intervention pattern needs to be evaluated to maintain sedentary time reduction in the long-term period.

Previous studies reported an improvement in moderate-to-vigorous physical activity after CR. Nevertheless, the increase was not detected in our study. This may be because our participants were more sedentary than the patients who participated in CR in other analyses, so they decided to do light physical activity, instead of moderate-to-vigorous physical activity. Mild intensity physical activity in both control and intervention groups seemed to improve following CR and significantly improved for the intervention group compared to the control group at the end of the study. In addition, the CR program for severely stationary patients of our institute is designed to start with low-intensity exercise and to have slow progression. Therefore, our CR protocol may influence an improvement in moderate-to-vigorous physical activity. This outcome indicates that after CR, moderate-to-vigorous physical activity remains the same. The American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR) recommends 150 minutes of moderate physical activity per week,[3] but no participants attained that level.

Increase in moderate-to-vigorous physical activity and reduction in sedentary time are not the same, given that the standard CR prefers less focus on reducing sedentary time to increased exercise. For severely inactive cardiac patients, we suggest assessing sedentary time as a risk factor and monitoring it as an outcome of CR program because the patients tend to change sedentary time to light physical activity instead of increasing moderate-to-vigorous physical activity. Moreover, concentrating on reducing sedentary behavior helps reduce sedentary time greatly compared with the standard CR.

Our study was limited by the lack of access to the maintenance of sedentary behavior reduction. Long-term follow-up was not well assessed to evaluate whether the sedentary time and the physical activity decline after the completion of CR had been achieved. This is because there were studies that did find that patients within a year of CR completion were as sedentary as new CR patients.[23] Future studies should undertake long-term follow-ups to answer this question. The study did not evaluate satisfaction or dissatisfaction of the intervention. Moreover, it did not evaluate adherence of the participants in the intervention group, or whether they read or understood the messages or not. In addition, the follow-up period of some participants was not completed and there were some missing data during the study. We excluded some participants who were lost to follow-up at all intervals from our statistical analysis because we could not infer the trend of their sedentary behavior, light physical activity, and moderate-to-vigorous physical activity. Therefore, our study did not conduct a general intention-to-treat analysis.

In conclusion, mobile texting and focused educational sessions on sedentary behavior helped patients with coronary artery disease reduce sedentary time at the 3-month interval and additionally increased light intensity physical activity at 6-month interval in patients who received the standard CR. These methods can be used complementarily to the standard CR due to its efficacy, convenience, and low cost.

Disclosure

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Kunlawat Thadanipon, Department of Clinical Epidemiology and Biostatistics, Faculty of Medicine Ramathibodi Hospital, Mahidol University

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