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Original Article

Effects of small community walking intervention on physical activity, well-being, and social capital among older patients with cardiovascular disease in the maintenance phase: a randomized controlled trial

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Abstract. [Purpose] Older patients with cardiovascular disease should increase their physical activity and prioritize positive psychological and social approaches in the maintenance phase of their cardiac rehabilitation. This study aimed to clarify the effect of small community walking on physical activity, well-being, and social capital in older patients with cardiovascular disease in the maintenance phase. [Participants and Methods] We conducted a multicenter study in Kumamoto, Japan. We randomly divided 55 patients with cardiovascular disease into two groups: small community walking and walking alone. For three months, a registered cardiac rehabilitation instructor provided walking guidance to both groups using a wearable device. We measured physical activity, social capital, and subjective happiness before and after the intervention. [Results] Results revealed a statistically significant main effect of time on physical activity and social participation. In the subjective happiness scale, there was an association between group and time. [Conclusion] Our results suggest that walking guidance using a wearable device was beneficial in improving overall physical activity, regardless of whether the individual did small community walking or walking alone. Furthermore, small community walking intervention may effectively enhance well-being. The relationship between physical activity and social participation needs to be further investigated.
Key words: Small community walking, Cardiac rehabilitation, Older patients

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INTRODUCTION

The heart failure (HF) pandemic is not unique to Asia but rather a global problem[1)]. For this reason, to better manage the health care burden of HF, secondary prevention, including HF management in older patients, is important. Here, we focused on physical activity (PA) during the maintenance phase for secondary prevention as a cardiac rehabilitation (CR) measure. A previous study found that PA is related to all-cause mortality risk in a curvilinear dose-response manner in males and females with cardiovascular disease (CVD)[2)]. Additionally, in the 2017 TOPCAT trial, compared with the ideal baseline PA, poor and intermediate baseline PA was associated with a greater risk of HF hospitalization and mortality[3)]. Therefore, patients with CVD should increase their PA. However, to date, there is little evidence of an effective strategy for increasing PA in the maintenance phase of CR.

In our previous study, we suggested that social network incentives combined with financial incentives are more effective than financial incentives alone in promoting PA among older females[4)]. The method of social network incentive was to walk as "buddies" in groups of three people to harness the power of peer pressure[5)]. This study's findings suggested that three is the minimum size necessary to maximize social network incentives in a group. Accordingly, present study focused on a social network that leverages groups of three people to regulate behavior and named this walking method "small community walking" (SCW). However, it is unclear whether similar effects are achieved among patients with CVD. Moreover, the effect of SCW without financial incentives is uncertain.

Owing to the advanced age of patients with CVD, positive psychological and social approaches should be prioritized in the maintenance phase of their long-term care. Especially in the maintenance phase of older patients with CVD, we believe that positive factors (e.g., well-being and social capital) are important. The Journal of the American College of Cardiology summarized the positive impact of well-being on "cardiovascular health", which is also needed for CVD patients[6)]. However, it remains unknown how to effectively utilize PA to improve well-being, which is cited as an urgent problem among patients with CVD. Recent public health research has revealed a relationship between individual health behavior and social capital[7, 8)]. Therefore, it is possible that a particular network may affect health behavior, and it is essential to examine individual-level social capital. However, no previous studies have shown that PA enhances individual-level social capital among patients with CVD.

In recent years, the problem of frailty (physical, social, and psychological deterioration) in older patients with CVD has been reported[9)]. Therefore, physical activity, social capital, and well-being are more likely to decrease in older patients with CVD than in healthy older people; we believe that strategies to increase these attributes possess high value.

Based on the above background, we assumed that encouraging SCW should enhance not only PA but also well-being and individual-level social capital among older patients with CVD. To test this hypothesis, we sought to ascertain whether an intervention using SCW could lead to more significant changes in PA, well-being, and social capital among older patients with CVD than walking alone (WA).

PARTICIPANTS AND METHODS

This was a randomized study in which participants were recruited by handing out leaflets to 143 medical institutions in Kumamoto, Japan. A total of 55 patients with CVD aged 60–80 years were recruited between September and December 2021.

Participants were assigned to HF stages B and C according to the JCS 2017/JHFS 2017 Guidelines on Diagnosis and Treatment of Acute and Chronic Heart Failure[10)]. The inclusion criteria were those with myocardial infarction, angina pectoris, post-coronary bypass surgery, post-percutaneous coronary intervention, HF with reduced ejection fraction (left ventricle ejection fraction (LVEF) <50%), HF with preserved ejection fraction (LVEF ≤50% and early mitral filling velocity/early diastolic mitral annular velocity: E/e' ≥15, brain natriuretic peptide: BNP ≥35 pg/mL), cardiomyopathy, moderate valvular heart disease (regurgitation or stenosis), and 1–2 incidences of hospitalization for HF. The exclusion criteria were severe pain with difficulty walking, cognitive decline, those already walking in groups, and noncooperation during the research.

The interventions for patients with CVD were implemented at ten selected medical institutions in Kumamoto, Japan. Patients who agreed to an explanation by their primary care doctor participated in this study. After reviewing the applications, the secretariat informed the institutions about the study participants. Before the intervention, the secretariat randomly allocated participants to the small community walking group (SCW group) or the walking alone group (WA group) using standard computer-based procedures. Participant randomization was performed using randomly permuted blocks and stratum allocation by sex. After obtaining written informed consent prior to the study, participants were informed of the results of randomization at each institution. The final study groups comprised 29 and 27 participants in the SCW and WA groups, respectively. Figure 1 presents a flowchart of the study.

Figure 2 presents a protocol of the study. The SCW group participants walked in groups of three with their families or close friends as buddies to utilize the power of peer pressure. In previous research, when both assigned peers were close friends, the PA effects improved more with regard to normalized activity levels compared to the same condition with weaker social ties with the assigned peers[5)]. The groups of buddies remained the same over the three-month intervention period. Participants were informed that they would walk in groups of three approximately once a week. When participants in the

SCW group were unable to find buddies, we introduced volunteers to walk with them. In the SCW group, if it was impossible for the participant to have two walking buddies for whatever reason, the sample was excluded. Participants in the WA group walked alone during the intervention period. Before the intervention, each participant received an exercise guidance for target step count, walking time, frequency, heart rate, and Borg scale by a CR-registered instructor at a selected medical institution. Additionally, each participant received exercise guidance from a registered CR instructor once a month using wearable device data.

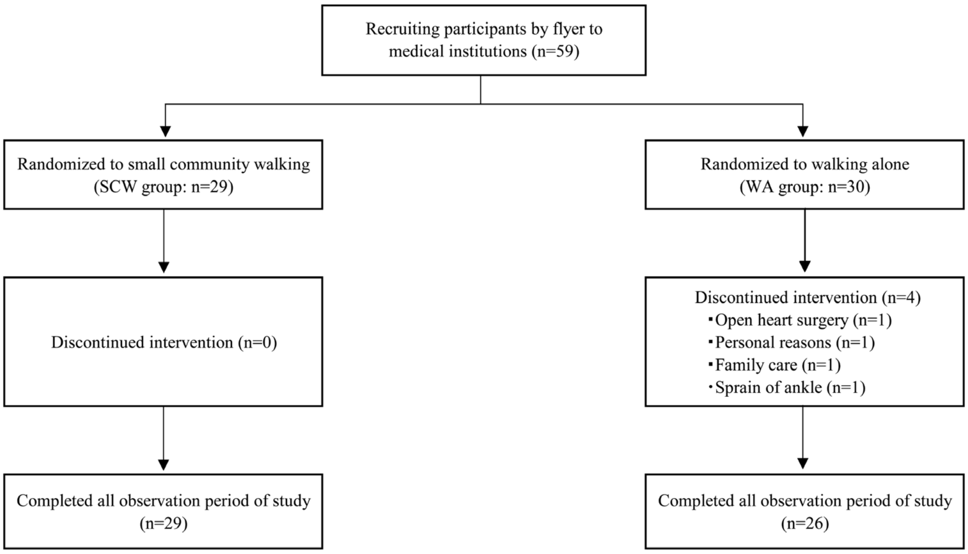

Fig. 1. Flow diagram of the two groups' progress through the phases the randomized trial.
SCW: small community walking; WA: walking alone.

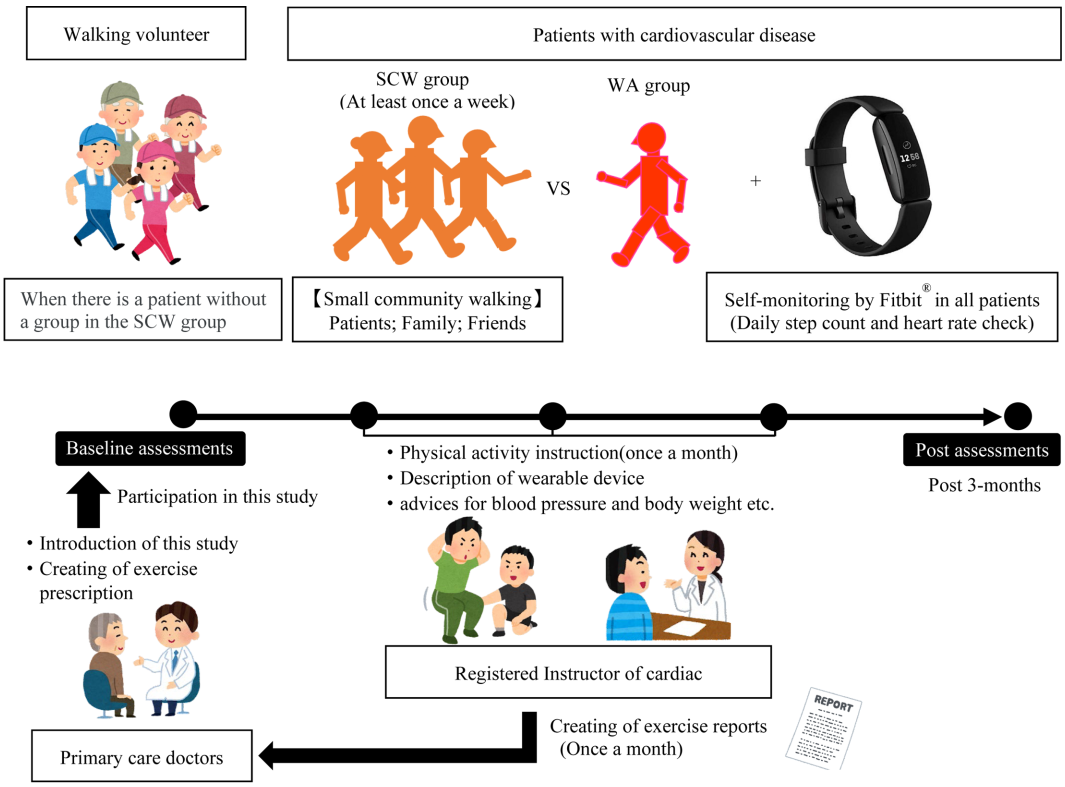

Fig. 2. Protocol of this study.
SCW: small community walking; WA: walking alone.

Both groups underwent a three-month intervention between November 2021 and March 2022. Before the intervention, each group was assessed for age, body mass index (BMI), smoking status, living alone situation, duration of maintenance phase, CR, exercise time (min/week), CAD, coronary risk factors, medication, blood pressure, heart rate, medical data, and physical function. We measured PA, well-being, and social capital before and after each intervention.

All participants provided written informed consent to participate in the study, which was approved by the Ethics Committee of Kumamoto Kinoh Hospital (JMC-347-2116).

Those assessing the outcomes were blinded to the grouping allocation; however, owing to the nature of the intervention, participants were not blinded to their allocation.

For anthropometric measurements, we measured all participants' height and body weight. BMI was calculated using the following formula: BMI=body mass (kg)/ body height (m). We measured blood pressure using the seated participants' arms after at least 10 min of rest.

To obtain medical data, we performed blood biochemistry tests by collecting blood from study participants at each medical institution. The Paso Lab Kumamoto staff collected and analyzed laboratory results from each medical institution in the same laboratory. Analyzed items were white blood cells, aspartate aminotransferase (AST), alanine aminotransferase (ALT), albumin, estimated glomerular filtration rate (eGFR), triglycerides, HDL cholesterol, LDL cholesterol, hemoglobin A1c (HbA1c), and brain natriuretic peptide (BNP) levels. We measured cardiac function using echocardiography for LVEF, which is systolic function, and E/e', which is diastolic function. The primary care doctors included cardiac function items in the exercise prescription.

We assessed physical function by six-minute walking distance (6MD) and frailty using the J-CHS criteria. For both measurements, we created a measurement form with reference to previous research and used a standardized method[11, 12)].

Before starting the study, we provided each participant with a watch-type wearable device (Fitbit Inspire2, Fitbit Japan, Tokyo, Japan) to measure the number of steps per day. The Fitbit application managed the PA data. In addition, each participant received a diary to record their daily step count. The SCW group kept diary records while three people walked together. To evaluate the number of steps, we calculated the average daily step count for two weeks using the number of steps in the application. To manage the accuracy of the total number of steps, we collated the pedometer's weekly data when participants submitted their diaries.

We measured subjective well-being using the subjective happiness scale (SHS) by referring to Lyubomirsky and Lepper's report[13, 14)]. The SHS asks respondents to rate how happy they are in general (1=not a very happy person, 7=a very happy person) and compared to most of their peers (1=less happy, 7=happier). Next, participants indicated the extent to which a description of a "very happy" person characterizes them (1=not at all, 7=a great deal). We computed well-being by averaging responses to the three items.

The measurement of individual-level social capital used civic participation, social cohesion, and reciprocity by referring to Saito's report[15)]. We selected measurement items by referring to Yang's report[16)]. We assessed civic participation using five items: (1) volunteer groups, (2) sports groups, (3) hobby activity, (4) study or cultural group, and (5) skills teaching. Participants responded to questions using a six-point scale (1=4 or more times a week, 2=2–3 times a week, 3=once a week, 4=1–3 times a month, 5=several times a year, and 6=none). We assessed social cohesion using three items: (1) community trust, (2) community contribution, and (3) community attachment. Participants responded using a five-point scale (1=very trusted/agree strongly/very attached, 2=moderately trusted/agree/moderately attached, 3=neither, 4=not very trusted/disagree somewhat/not very attached, and 5=not at all). We assessed reciprocity using three items: (1) "Do you have someone who listens to your concerns and complaints?" (2) "Do you listen to someone's concerns and complaints?" and (3) "Do you have someone who looks after you when you are sick for a few days?". Participants responded using a seven-point scale (1=spouse, 2=children living together, 3=children living separately, 4=brothers and sisters/relatives/parents/grandchildren, 5=neighbors, 6=friends, and 7=others). For individual-level social capital, we calculated individual indexes using simple addition.

In the statistical analysis, we calculated the effect size and power of 55 participants using G*Power 3.1.9.7 (Heinrich Heine University Düsseldorf, Düsseldorf, Germany). Specifically, we calculated the sample size of this study with a partial $\eta 2$ of 0.06 and a two-tailed alpha level of 0.05, resulting in an effect size of 0.25 and a power of 0.95, which is considered sufficient. For participants' backgrounds, nominal variables are indicated by nominal values and percentages, and continuous and ordinal data are indicated by the mean ± SD. We analyzed the differences before the intervention using the Mann–Whitney U-test or the χ^2 test and used the Kolmogorov–Smirnov test to identify the normality of data. We conducted two-way repeated-measures analysis of variance (ANOVA) to compare the effects of pre- and post-intervention PA, SHS, and individual-level social capital between the groups. We conducted post hoc analyses using simple main effects. We set the significance level at $p<0.05$ and analyzed the data using SPSS Statistics 20.0 (IBM Corporation, Tokyo, Japan).

RESULTS

Before the intervention, there were no significant differences in age, sex, BMI, smoking status, living alone, duration of Phase III CR, exercise time, medical history, medications, blood pressure, heart rate, LVEF, blood tests, 6MD, frailty, PA, SHS, and social capital between the WA group and the SCW group (Table 1). Table 2 shows PA, SHS, and social capital at baseline and at 3 months. A two-way ANOVA revealed that in terms of PA, there was a statistically significant main

Table 1. Comparison of clinical characteristics between SCW group and WA group before intervention

	All (n=55)	SCW group (n=29)	WA group (n=26)	p-value
Age (years)	72 .5 ± 5.3	72.4 ± 5.2	72.7 ± 5.4	0.65
Sex (male/female), n (%)	38 (69.1) / 17 (30.9)	18 (62.1) / 11 (37.9)	19 (73.1) / 7 (26.9)	0.55
BMI (kg/m^2)	23.6 ± 2.7	23.2 ± 2.9	24.1 ± 2.6	0.13
Current smoker, n (%)	4 (7.3)	2 (6.9)	2 (7.7)	0.91
Living alone, n (%)	7 (12.7)	3 (10.3)	4 (15.4)	0.44
Duration of maintenance phase CR (years)	5.6 ± 4.3	6.5 ± 4.8	4.7 ± 3.6	0.15
Exercise times (min/week)	60 (0–600)	105 (0–600)	44 (0–500)	0.19
Cardiovascular disease				
Ischemic Heart Disease, n (%)	35 (63.6)	18 (62.1)	17 (65.4)	0.51
Valvular heart disease, n (%)	4 (7.3)	2 (6.9)	2 (7.7)	0.65
Cardiomyopathy, n (%)	4 (7.3)	1 (3.4)	3 (11.5)	0.26
Heart failure, n (%)	9 (16.3)	6 (20.6)	3 (11.5)	0.27
Coronary risk factors				
Obesity (BMI ≥25), n (%)	13 (23.6)	5 (17.2)	8 (30.8)	0.20
Hypertension, n (%)	45 (81.8)	24 (82.8)	21 (80.8)	0.85
Dyslipidemia, n (%)	29 (52.7)	15 (51.7)	14 (53.8)	0.55
Diabetes Mellitus, n (%)	14 (25.5)	9 (31.0)	5 (19.2)	0.25
Medication				
ACE, n (%)	4 (7.3)	2 (6.9)	2 (7.7)	0.91
ARB n, (%)	15 (27.3)	9 (31.0)	8 (30.8)	0.60
β-blocker, n (%)	23 (41.8)	12 (41.4)	11 (42.3)	0.38
Diuretic, n (%)	12 (14.6)	7 (24.1)	5 (19.2)	0.58
Calcium-channel blocker, n (%)	34 (61.8)	19 (65.5)	15 (57.7)	0.15
Anticoagulant, n (%)	17 (30.9)	7 (24.1)	10 (38.5)	0.20
Antiplatelet, n (%)	21 (38.2)	12 (41.4)	9 (34.6)	0.27
Systolic blood pressure (mmHg)	127.6 ± 11.7	125.4 ± 12.4	130.0 ± 10.6	0.11
Diastolic blood pressure (mmHg)	71.5 ± 8.1	69.9 ± 9.0	73.3 ± 6.8	0.15
Heart rate (bpm)	69.6 ± 9.4	71.5 ± 9.8	67.6 ± 8.7	0.16
LVEF (%)	60.7 ± 11.1	59.1 ± 11.3	62.4 ± 10.8	0.11
E/e’	11.4 ± 4.1	10.9 ± 3.0	11.9 ± 5.1	0.66
Laboratory examinations				
WBC (×10^3/μl)	6.2 ± 1.2	6.1 ± 1.1	6.2 ± 1.4	0.82
AST (IU/L)	26.3 ± 8.0	27.8 ± 9.3	25.0 ± 6.5	0.32
ALT (IU/L)	24.2 ± 10.9	26.5 ± 12.8	22.2 ± 8.5	0.19
Albumin (g/dl)	4.4 ± 0.3	4.4 ± 0.3	4.4 ± 0.3	0.73
eGFR(mL/min)	66.8 ± 14.9	66.4 ± 14.8	67.2 ± 15.3	0.69
TG (mg/dl)	156.9 ± 80.3	158.6 ± 77.5	155.2 ± 84.8	0.73
HDL-cholesterol (mg/dl)	55.8 ± 13.7	55.9 ± 13.4	55.8 ± 14.2	0.99
LDL-cholesterol (mg/dl)	101.6 ± 33.3	103.6 ± 37.4	99.5 ± 28.7	0.87
HbA1c(%)	5.9 ± 0.5	5.9 ± 0.5	5.8 ± 0.4	0.59
BNP(pg/ml)	30.5 ± 26.8	27.9 ± 23.0	32.8 ± 30.0	0.70
Physical activity (steps/days)	7,245.9 ± 3,134.6	6,854.3 ± 2,370.2	7,566.9 ± 3,965.9	0.57
6MD (m)	414.3 ± 78.9	403.7 ± 66.1	426.3 ± 90.9	0.25
Frailty n,(%)	4 (15.4)	3 (10.3)	1 (3.8)	0.91
Subjective happiness scale	5.0 ± 1.1	5.1 ± 1.0	4.9 ± 1.2	0.53
Social capital				
Civic participation	26.2 ± 3.3	25.9 ± 3.5	26.6 ± 3.1	0.48
Social cohesion	5.9 ± 1.7	5.7 ± 1.5	6.0 ± 1.9	0.64
Reciprocity	16.3 ± 10.9	17.3 ± 11.4	15.2 ± 10.4	0.45

Data are presented as mean ± SD or number (percent). BMI: body mass index; CR: cardiac rehabilitation; ACE: angiotensin-converting enzyme inhibitor; ARB: angiotensin II receptor blocker; LVEF: left ventricle ejection fraction; E/e’: early mitral filling velocity / early diastolic mitral annular velocity; WBC: white blood cell; AST: aspartate aminotransferase; ALT: alanine aminotransferase; eGFR: estimated glomerular filtration rate; TG: triglycerides; HDL: high-density lipoprotein; LDL: low-density lipoprotein; HbA1c: Hemoglobin A1c; BNP: brain natriuretic peptide; 6MD: six-minute walking distance; SD: standard deviation. There were no significant differences in all measurement between the walking alone (WA) group and the small community walking (SCW) group.

Table 2. Comparison of intervention effect for physical activity, well-being, and social capital

	SCW group (n=29)		WA group (n=26)		Main effect of time	Interaction
	Baseline	3-months	Baseline	3-months		
Physical activity (steps/day)	6,854 ± 2,370	8,641 ± 2,003	7,567 ± 3,966	9,399 ± 3,311	<0.01	0.93
Subjective happiness scale	5.1 ± 1.0	5.7 ± 1.0**	4.9 ± 1.2	5.4 ± 1.1	<0.01	0.03
Civic participation	25.9 ± 3.5	23.1 ± 3.3	26.6 ± 3.1	24.9 ± 4.8	<0.01	0.13
Social chohesion	5.7 ± 1.5	5.9 ± 1.3	6.0 ± 1.9	6.5 ± 1.9	0.74	0.89
Reciprocity	17.3 ± 11.4	19.0 ± 14.2	15.2 ± 10.4	15.2 ± 10.7	0.36	0.39

Data are presented as average ± SD. **simple main effect compared to pre intervention, p<0.01.
SCW: small community walking; WA: walking alone; SD: standard deviation.

effect of time (F (1, 53)=38.04, p<0.01). The SHS was a statistically significant interaction between group and time (F (1, 53)=4.84, p<0.05). The SHS of the SNI+FI group increased significantly between the pre- and post-intervention periods (F (1, 53)=15.99, p<0.01). However, the WA group showed no statistically significant improvement in SHS during the intervention. In terms of social capital, a two-way ANOVA revealed that the civic participation was a statistically significant main effect of time (F (1, 53)=37.84, p<0.01). However, social cohesion and reciprocity showed no significant improvement. In the SCW group, the frequency of walking in groups of three per week was 1.2 ± 0.4 (not shown in Table1, 2).

DISCUSSION

In this study, we randomly assigned older patients with CVD in the maintenance phase of CR to the SCW and WA groups and compared the intervention effects of PA, subjective well-being, and individual-level social capital over a three-month period. A particularly interesting result was that PA increased in both groups, while subjective well-being increased only in the SCW group.

Increasing PA in patients with CVD is important for reducing all-cause mortality and the risk of hospital admission[17–19]. The increase in PA in both groups may be due to PA management and healthcare workers' guidance regarding the use of wearable devices. Recent studies have reported that CR using wearable devices increases PA[20, 21]. CR using wearable devices whose data are tracked by healthcare workers is expected to increase PA through tailor-made programs, self-monitoring, encouragement, and communication[22, 23]. However, previous studies have targeted patients who were recently discharged from hospitals. Maddison et al. investigated the effects of PA on patients who developed coronary artery disease within six months[20]. Nagatomi et al. revealed the effects of PA over three months in hospitalized HF patients[21]. While these studies focused on acute and convalescent patients, the strength of this study is that it focused on patients with CVD with a median maintenance phase of five years. In addition, 39.5% of the males and 29.4% of the females observed in the pre-intervention period of this study recorded fewer steps than the average number of steps (6,078 steps/day for males and 4,544 steps/day for females) of older patients with CVD in the maintenance phase previously reported in a multicenter cross-sectional study[24]. Therefore, in this study, we believe that interventions, such as wearing a wearable device and once-a-month exercise guidance, were effective in both groups and that it is important and valuable for healthcare professionals to provide PA guidance during the maintenance phase. Meanwhile, the SCW intervention was performed once per week, which may not have been sufficient to obtain a synergistic effect with increased PA. Previous studies showed that the PA increasing effects of SCW continues after the intervention[4, 5, 25]. Therefore, there may be differences between the SCW and WA groups regarding PA effects after the intervention.

In this study, subjective well-being increased only in the SCW group. Regarding well-being in patients with CVD, Journal of American College of Cardiology (JACC) (2018) emphasized the importance of interventions from three perspectives: I) neurobiological processes, II) health behaviors, and III) psychosocial resources[6]. Ståhle et al. conducted a three-month intervention study on well-being in patients with myocardial infarction, who were randomly divided into a training group and a control group[26]. The results suggested that group training had a greater impact on well-being and life satisfaction than the control group. However, this previous study focused only on outpatients at medical institutions. An advantage of our work is that we used SCW, which is possible for patients with CVD in the maintenance phase, without visiting a medical institution. In addition, SCW can be easily practiced in the community because it requires only three people. Therefore, we believe that SCW is crucial for demonstrating how to increase subjective well-being. In the mechanism by which the SCW intervention enhanced subjective well-being, positive affect is assumed to enhance subjective effect[27]. We believe that SCW elicits positive emotions during goal-directed walking in horizontal interpersonal relationships between patients with CVD and their peers. In addition, studies have revealed the gratitude affect[28–30]. Therefore, we speculate that patients with CVD felt gratitude toward their buddies, which increased their positive affect. In fact, in the questionnaire at the end of the intervention, approximately 60% of the patients in the SCW group expressed gratitude for walking together (not shown). Previous studies reported that this positive affect impacts self-acceptance and positive relations with others[31], thus enhancing well-being[32]. Therefore, it is possible that the SCW intervention for patients with CVD increased positive affect through horizontal interpersonal relationships and gratitude, which, in turn, affected their subjective well-being. In addition, we believe that a minimum of three people in a group is necessary to affect patients' well-being and that even numbers, such as a group of two people, carry the risk of causing division. However, the well-being-enhancing effects of SCW may be specific to patients with CVD. In recent years, type-D personality has attracted attention as a behavioral characteristic of patients with CVD. Type-D personality comprises negative affectivity and social inhibition[33]. Accordingly, future studies should examine the relationship between type-D personality and the effect of SCW.

In terms of social capital, the PA intervention improved civic participation in both groups. Social participation is of high value as an intervention because it is associated with the risk of dementia, poor nursing care status, and death among the older patients[34–37]. Moreover, although studies have suggested a relationship between social participation and PA[38, 39], a causal relationship has not been clarified. Therefore, it is necessary to examine the relationship between PA and social participation.

This study has several limitations. First, there were no restrictions other than the number of people walking (listening to music, walking with dogs, etc.). Furthermore, due to the sample size, we were unable to examine the differences between the people who walked together (family, peers, volunteers, and sex) in the SCW group. Therefore, these environmental factors may have influenced the results. Second, only groups of three people walking together were considered, while other groups were not considered. Whether similar results can be obtained with a number other than three is a subject for future research. Third, only patients who consented to a referral from their primary care doctors were enrolled in this study. Therefore, it is possible that the awareness of PA was high. Fourth, it was not possible to quantify exercise types (cycling, swimming, etc.) other than walking as PA. Finally, this study was conducted in Kumamoto, Japan; therefore, it is unknown whether similar effects can be observed in other areas and countries.

In conclusion, a three-month PA intervention by a healthcare worker using a wearable device increased PA regardless of SCW or WA among older patients with CVD in the maintenance phase of CR. In particular, SCW may effectively enhance subjective well-being. In future, the relationship between PA and social participation should be further investigated.

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Conflict of interest

The authors declare no conflict of interest.

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