Original Paper

Predictors of Walking Activity in Patients With Systolic Heart Failure Equipped With a Step Counter: Randomized Controlled Trial

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Abstract

Background: Physical activity has been shown to decrease cardiovascular mortality and morbidity. Walking, a simple physical activity which is an integral part of daily life, is a feasible and safe activity for patients with heart failure (HF). A step counter, measuring daily walking activity, might be a motivational factor for increased activity.

Objective: The aim of this study was to examine the association between walking activity and demographical and clinical data of patients with HF, and whether these associations could be used as predictors of walking activity.

Methods: A total of 65 patients with HF from the Future Patient Telerehabilitation (FPT) program were included in this study. The patients monitored their daily activity using a Fitbit step counter for 1 year. This monitoring allowed for continuous and safe data transmission of self-monitored activity data.

Results: A higher walking activity was associated with younger age, lower New York Heart Association (NYHA) classification, and higher ejection fraction (EF). There was a statistically significant correlation between the number of daily steps and NYHA classification at baseline (*P*=.01), between the increase in daily steps and EF at baseline (*P*<.001), and between the increase in daily steps and improvement in EF (*P*=.005). The patients' demographic, clinical, and activity data could predict 81% of the variation in daily steps.

Conclusions: This study demonstrated an association between demographic, clinical, and activity data for patients with HF that could predict daily steps. A step counter can thus be a useful tool to help patients monitor their own physical activity.

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KEYWORDS

heart failure; cardiovascular rehabilitation; step counters; physical activity; telerehabilitation

Introduction

Cardiovascular diseases account for 13%-15% of all deaths worldwide and 24.8% in Europe and are thereby the leading cause of mortality [1-4]. Heart failure (HF) is one of the most common cardiovascular causes of mortality [4,5], with a prevalence of 0.4%-2% among the general population and 2.3%-16% among people aged over 75 [6]. Physical activity has been proven to decrease cardiovascular mortality and morbidity [3,7,8] and has therefore been a main focus of rehabilitation programs targeting lifestyle changes [3,7] in order to improve patient recovery. Generally, cardiac rehabilitation includes interventions such as physical activity, improved diet, and weight control, with the aim of improving patients' recovery, functional capacity, psychosocial well-being, and quality of life [3,9,10]. However, participation in rehabilitation programs is often low. In order to increase adherence, rehabilitation programs have been introduced that are more accessible and individualized for the patient, such as home-based cardiac rehabilitation programs involving cardiac telerehabilitation [3,11,12]. Telerehabilitation is defined as rehabilitation activities using information and communication technologies [13].

Walking, a simple physical activity, is an integral part of our daily routine [14] and is suitable for cardiac patients. Walking is both safe and feasible for almost all patients with HF [3]. Today, many self-tracking devices provide information to users regarding their walking activity, such as the number of steps, and may therefore assist patients to monitor their walking. Such self-tracking devices are based on sensor technologies that allow continuous monitoring of physiological data by the walker in the context of everyday life [12]. Telemonitoring concepts including smart device–based monitoring, especially measurements of physical activity, are considered to be beneficial for patients with HF [3,12,15].

People are considered physically active if they perform more than 30 minutes of moderate to intense physical activity per day; this would be equivalent to approximately 7000-10,000 steps per day [3,8]. However, studies of walking activity among cardiac patients have found that these patients walked a mean number of 5889 [3], 7027 [15], and 5869 [12] daily steps. These 3 studies included patients suffering from acute coronary syndrome, coronary artery disease [15], and HF [12], as well as those who underwent coronary artery bypass repair or valve replacement [3].

Bäck et al [15] presented a step index that describes the walking activity for cardiac patients, in which less than 3000 steps per day represent low activity, 3000-9999 steps per day represent medium activity, and over 10,000 steps per day represent high activity. Bäck et al [15] found that 11.18% of the study population had a low activity level, 69.65% a medium activity level, and 19.17% a high activity level. This same tripartite classification was also used by Thorup et al [3] to categorize the walking activity of cardiac patients, where 22% of the study population were classified as having a low activity level, 64% medium, and 14% high.

Based on the initial findings from the research literature and from pilot studies, the Future Patient Telerehabilitation (FPT) program proposed a new approach to telerehabilitation for patients with HF to increase their quality of life and educate them to monitor any worsening of their symptoms. The patients used self-tracking devices for monitoring physical activity, blood pressure, sleep, respiration, and pulse [11]. In the FPT program, recorded data from the daily measurements were available on a shared web platform called the HeartPortal used by patients, their relatives, and health care professionals [11].

In this paper, we report on a substudy of FPT focusing on the walking activity of patients with HF in a telerehabilitation program over 1 year. Our aim is to explore (1) the duration of usage of the step counter devices; (2) the eventual increase in the average number of daily steps; (3) the correlation between the number of daily steps with ejection fraction (EF), New York Heart Association (NYHA) class [16], and age, respectively; and (4) whether baseline EF, NYHA class, age, or gender can be used to predict the daily number of steps.

Methods

Future Patient Telerehabilitation Program

This substudy utilizes the data from the intervention group that received telerehabilitation (TR group) of the FPT (ClinicalTrials.gov: NCT03388918 and the Danish Ethical Committee: N-20160055). The TR group participated in the telerehabilitation program, whereas the control group followed a conventional rehabilitation program at the health care center. The intervention in the FPT consisted of 3 phases: (1) Education and titration of medicine (0-3 months), (2) Telerehabilitation in health care center or call center (approximately 3 months), (3) Daily monitoring via telerehabilitation (approximately 6 months), corresponding to a follow-up of 12 months [11].

During the participation period, the patients in the TR group received a blood pressure device, weight scale, sleep sensor, step counter, and an iPad. In addition, they were also given access to the HeartPortal, which is a digital toolbox developed on the basis of patient feedback [17], that functions as an interactive learning module. The HeartPortal consists of (1) an interactive information site for patient education, (2) a communication platform enabling patients to communicate directly with health care professionals via online messages, (3) visualization of measured values, and (4) patient-reported outcomes data [11].

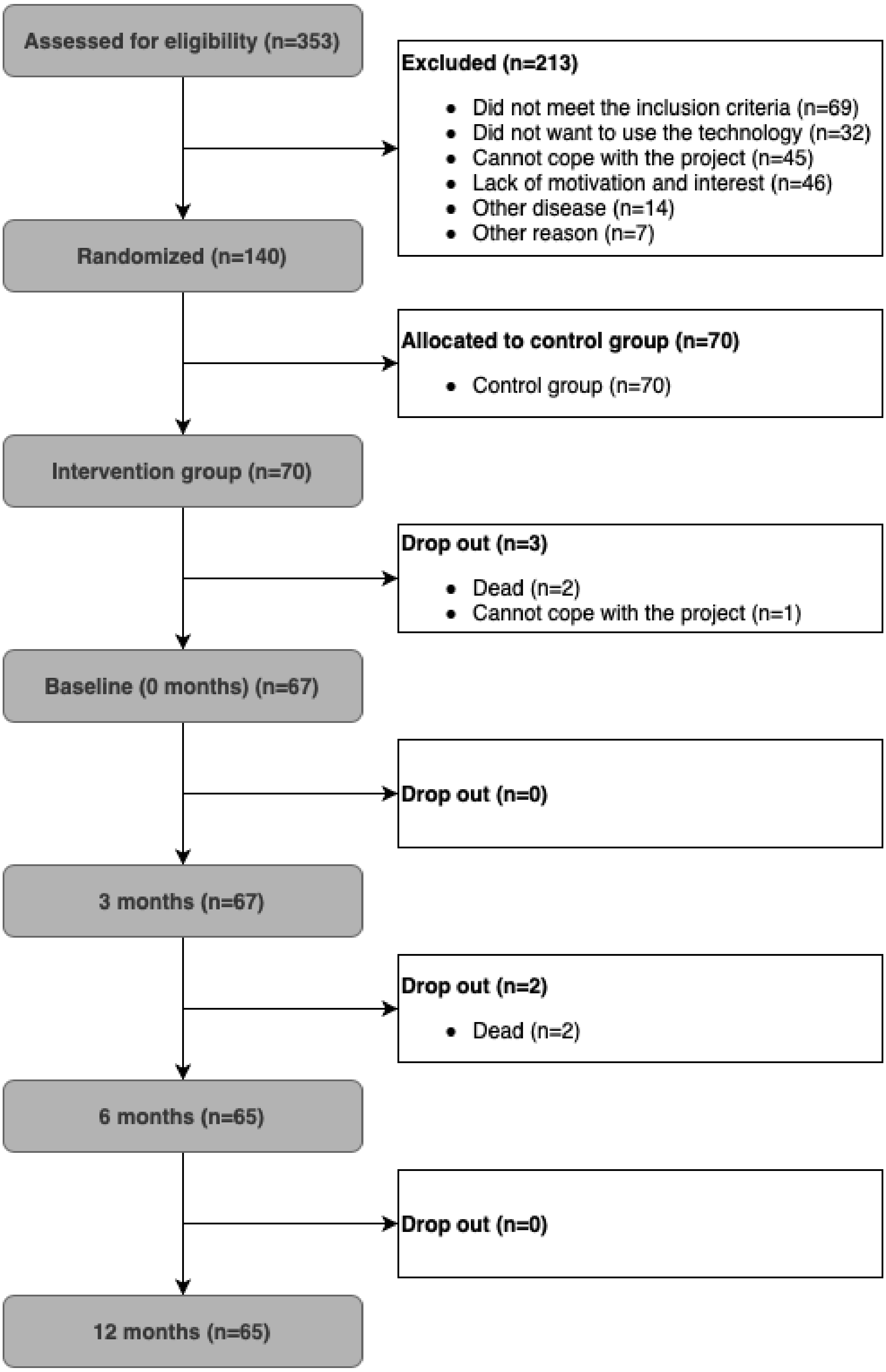
Based on the study by Munck et al [18], evaluating self-tracking devices for telerehabilitation of patients with HF, Fitbit step counters were used in the FPT, as these received the highest user evaluation and the lowest step count error percentages. The choice of the Fitbit device is consistent with the systematic review by Bunn et al [19], which concludes that Fitbit products are generally more accurate regarding step counting compared with other wearable physical activity trackers [19].

Participants and Recruitment

The target group of the FPT included patients diagnosed with HF according to the NYHA class I-IV. The patients were recruited from cardiology wards at hospitals in 4 Danish cities, all of which were part of the Regional Hospital Central Jutland [11]. Patients were eligible for the study if (1) they were diagnosed with HF according to NYHA class I-IV, hereof a maximum of 20% of the patients were allowed from NYHA class I, and had experienced an HF-related hospitalization or visit to the outpatient clinic within the past 2 weeks; (2) the patient was 18 years of age or older; (3) the patient had to live in Viborg, Skive, Silkeborg, or Randers municipality; (4) the patient was living at home and capable of caring for himself/herself; (5) they had basic computer skills or a relative who had basic computer skills; and (6) the patient was able to sign an informed consent form. Furthermore, patients were excluded if they (1) were pregnant; (2) had a drug addiction defined as the use of cannabis, opioids, or other drugs; (3) had previous neurologic, musculoskeletal, or cognitive disability or active psychiatric history (as noted in the medical record) other than depression or anxiety related to cardiac or other chronic illness; (4) lacked the ability to cooperate; or (5) did not speak Danish.

In total, 140 patients were included in the FPT, of which 70 patients were randomly allocated to the TR group and 70 to the control group [11]. Of the 70 patients from the TR group, 65 completed the FPT program. Figure 1 (CONSORT [Consolidated Standards of Reporting Trials] diagram) illustrates the randomization procedure, follow-up, and drop out reasons for the TR group. Multimedia Appendix 1 provides CONSORT-EHEALTH (Randomized Controlled Trials of Electronic and Mobile Health Applications and Online TeleHealth) checklist.

Figure 1. CONSORT diagram of the Future Patient trial. CONSORT: Consolidated Standards of Reporting Trials.



Walking Activity

One of the clinical measures used in the FPT was the patients' activity level, which was recorded using a Fitbit step counter, either Fitbit Zip or Fitbit Charge HR [11]. These step counters were selected based on the results presented in Munck et al [18], which found these Fitbit step counters to have the lowest error margin. Both devices calculate steps based on data from the internal 3-axis accelerometer, and the step data were acquired every 20 minutes using application programming interface (API). All patients were asked to wear the step counter during all waking hours, from 8 am to 9 pm, during the course of the project period.

To account for single days of missing values from the step counters, the median value of daily steps during a week has been evaluated and used as the indicator of the general activity level for the patient for that particular week.

The duration of time in which the patients have used the step counters was defined as the number of active days compared to (1) the total number of days enrolled in the study, (2) EF, and (3) NYHA classification. So-called active days have been defined as days with more than 100 steps per day. This 100-step cut-off point was the same as that presented in Thorup et al [3], in order to avoid faulty measurements when the step counter was moved around but not worn. In addition, activity levels were classified as low, medium, or high, following Bäck et al [15].

Data Acquisition

Clinical data (weight, blood pressure, heart rate, EF determined through a standardized transthoracic echocardiography, NYHA classification, and etiology of HF) and sociodemographic data (age, gender, civil status, education level, and work status) were acquired from the patient's medical journal or through self-reporting. Data on the patient's daily activity were acquired from Fitbit every 20 minutes using API and consisted of the number of steps taken.

Statistical Analysis

Prior to analysis, data were examined regarding the normality of the distribution using a Shapiro–Wilk test.

To investigate how long the patients chose to use the step counter and the progression of steps, a one-way analysis of variance (ANOVA) with repeated measures was used.

The association between the activity and clinical parameters was investigated using Pearson correlation coefficient, which determines the covariance of 2 variables divided by the product of their standard deviations.

A linear hierarchical regression analysis was used to determine whether demographic, clinical, and activity parameters can be used to explain a statistically significant amount of variance in the mean number of steps. These were presented in different blocks, of which the first block contained demographic data (age and gender), the second block contained clinical data (baseline EF and baseline NYHA), and the third block contained activity data (baseline number of daily steps).

The statistical analysis was performed using SPSS Statistics version 25 (IBM, Inc.).

Results

Patient Characteristics

The patient characteristics of the TR group are presented in Table 1.

Table 1. Patient characteristics at baseline.

Variable	Values	
	Baseline (N=65)	Follow-up[a] (N=65)
Age (years) by gender		
Men (n=49)		
Mean (SD)	61.71 (10.49)	—
Range	35-81	—
25th-75th percentile	56.5-69	—
Women (n=16)		
Mean (SD)	60.31 (11.31)	—
Range	43-81	—
25th-75th percentile	51.5-69.75	—
Men and women (n=65)		
Mean (SD)	61.37 (10.63)	—
Range	35-81	—
25th-75th percentile	55-69	—
Clinical parameters		
Weight (n=16)		
Mean (SD)	85.19 (20.55)	84.53 (22.37)
Range	56-166	51.60-168
25th-75th percentile	70.03-98.5	69.53-96.65 (n=54)
Systolic blood pressure (mmHg) (n=65)		
Mean (SD)	124.17 (17.62)	116.98 (16.45)
Range	84-172	83-152
25th-75th percentile	112.75-134.25	105-128.25 (n=40)
Diastolic blood pressure (mmHg) (n=65)		
Mean (SD)	79.08 (11.14)	72.45 (10.08)
Range	48-122	46-93
25th-75th percentile	70.75-86	66.50-78.75 (n=40)
Heart rate (beats/minute) (n=65)		
Mean (SD)	78.35 (17.72)	68.11 (16.36)
Range	46-119	41-116
25th-75th percentile	66-90.5	57-77 (n=40)
Ejection fraction (%) (n=65)		
Mean (SD)	31.74 (8.54)	43.50 (7.25)
Range	10-45	20-60
25th-75th percentile	25-40	40-50 (n=65)
NYHA[b], n (%)		
I	10 (15)	26 (40)
II	41 (63)	35 (54)
III	12 (18)	4 (6)
IV	2 (3)	0 (0)
Etiology of heart failure, n (%)		

Variable	Values	
	Baseline (N=65)	Follow-up[a] (N=65)
Ischemic	30 (46)	—
Idiopathic	17 (26)	—
Hypertension	6 (9)	—
Valvular heart disease	8 (12)	—
Alcoholic	0 (0)	—
Postpartum	0 (0)	—
Chemotherapy	0 (0)	—
Other etiology	18 (28)	—
Recruitment, n (%)		
During hospitalization	22 (34)	—
From visit in outpatient clinic	43 (66)	—
Civil status, n (%)		
Single	23 (35)	—
Married/Living with a partner	42 (65)	—
Education, n (%)		
Primary school	4 (6)	—
Unskilled	15 (23)	—
Skilled	30 (46)	—
High school	5 (8)	—
Bachelor's degree	9 (14)	—
Master's degree	1 (2)	—
PhD+	1 (2)	—
Work status, n (%)		
Unemployed	0 (0)	—
Sick leave	19 (29)	—
Works under 20 hours/week	5 (8)	—
Works 20-36 hours/week	2 (3)	—
Works full-time 37 hours/week	9 (14)	—
Retired	30 (46)	—

[a]There are missing data from some patients for the clinical parameters at follow-up. The number of patients, for whom the data were available within 2 months prior to follow-up, is stated in parentheses.

[b]NYHA: New York Heart Association.

Usage of Step Counter

Table 2 focuses on activity and its relation to clinical and demographical data. The overall period during which the patients used the step counter in relation to their activity level is shown in Table 2. This duration is presented as the total number of days in which the patients were enrolled in the study and the number of active days in which they were using the step counter. Also presented in the table are their EF and NYHA classifications and gender with regard to the different activity levels.

Table 2. Duration of step counter use with regard to the patients' activity levels.

Variable	All patients	Activity level (steps/day)			*P* value
		Low (<2999)	Medium (3000-9999)	High (≥10,000)	
Number of patients	65	8	47	10	
Days using step counter, mean (SD)					
Total days	358.18 (54.57)	384.13 (61.53)	358.04 (56.77)	338.1 (26.61)	.208
Active days	317.91 (86.34)	310.63 (90.11)	319.32 (92.32)	317.10 (55.42)	.966
Activity days/total days (%)	88.65 (19.75)	81.00 (20.56)	88.74 (20.12)	94.40 (16.94)	.365
Clinical variables					
Ejection fraction (%), mean (SD)	31.74 (8.54)	30.31 (8.50)	32.19 (8.60)	30.75 (8.98)	.788
NYHA[a] classification, n (%)					**.057**
I	10 (100)	0 (0)	8 (80)	2 (20)	
II	41 (100)	4 (10)	31 (76)	6 (15)	
III	12 (100)	3 (25)	7 (58)	2 (17)	
IV	2 (100)	1 (50)	1 (50)	0 (0)	
Sociodemographic characteristics					
Gender, n (%)					**.659**
Male	49 (100)	5 (10)	36 (73)	8 (16)	
Female	16 (100)	3 (19)	11 (69)	2 (13)	

[a]NYHA: New York Heart Association.

Table 2 shows that overall, patients used the step counter 88.65% of the total period in which they were enrolled in the study, and that the time interval in which they use the step counter increased in line with increases in the activity level.

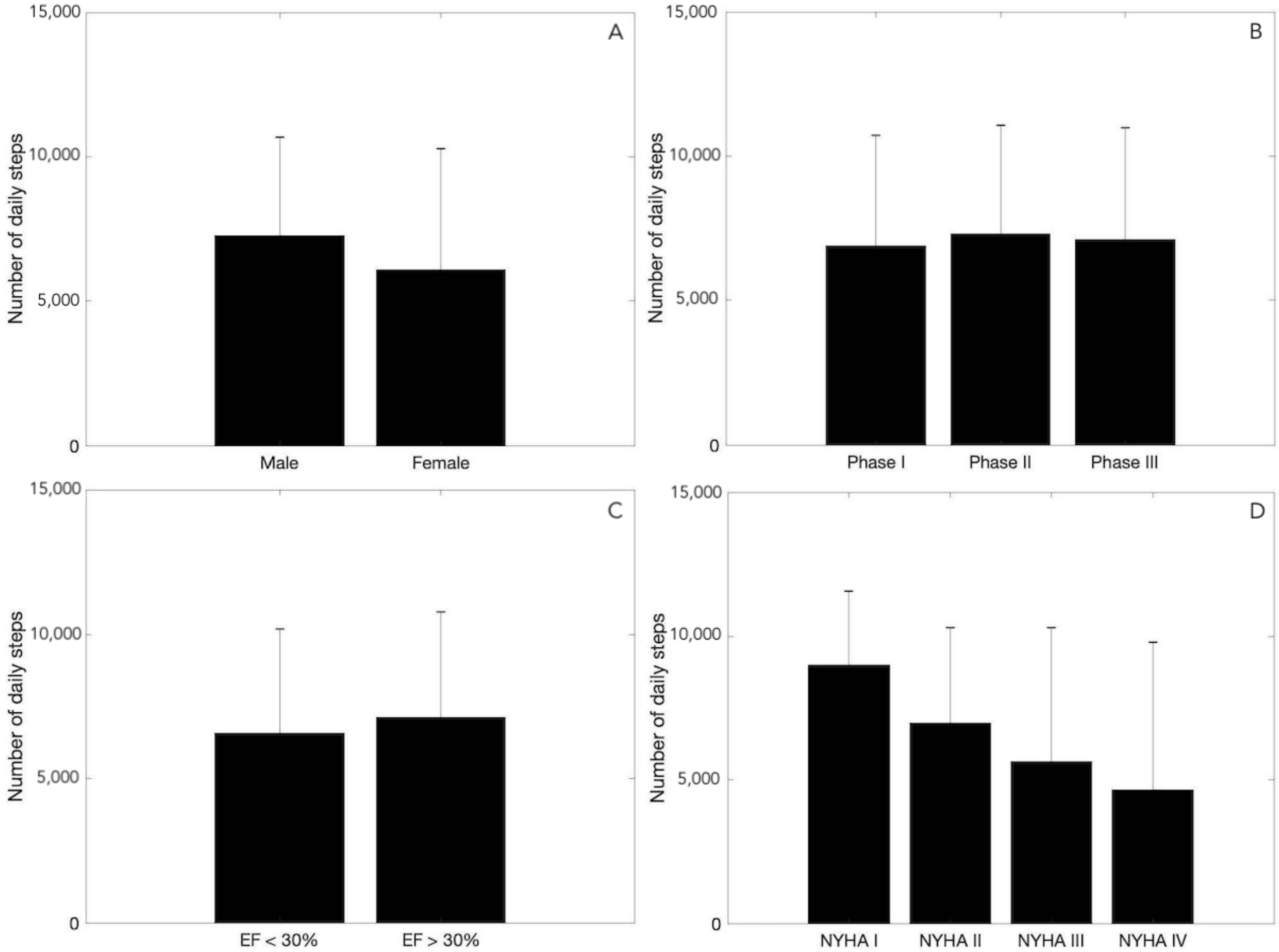
Increase in the Number of Daily Steps

During all 3 rehabilitation phases, the patients walked a mean number of 6962.81 (SD 3630.74) daily steps, with a minimum of 227 daily steps and a maximum of 25,499 daily steps. The mean number of daily steps during the 3 different phases were 5868.56 (SD 3912.34) daily steps in phase I, 7233.89 (SD 4197.36) daily steps in phase II, and 7338.58 (SD 4359.67) daily steps in phase III. These mean values are calculated from the different phases which had a duration of 0-3 months in phase I, 3 months in phase II, and 6 months in phase III.

A one-way ANOVA with repeated measures showed that the mean number of steps was not significantly different across the 3 phases ($F_{2,62}$=1.137, P=.318). Furthermore, a one-way ANOVA with repeated measures using gender ($F_{2,62}$=0.015, P=.978), EF ($F_{2,62}$=2.585, P=.87), and NYHA classification ($F_{2,62}$=2.229, P=.119) as covariates showed that the mean number of steps was not significantly different across the 3 phases.

Figure 2 presents the mean number of daily steps in bar plots with regard to the gender of the patients, the 3 phases of the FPT, EF with a threshold of 30%, and the patient's NYHA classification.

Figure 2. Bar plots of the mean number of steps with regard to (A) gender, (B) phase of the study, (C) EF, and (D) NYHA classification. The SDs are illustrated as error bars. Note: Only 63 of the 65 patients used their step counter in phase III. Hence, the mean numbers of steps illustrated in B is only a mean from these 63 patients. EF: ejection fraction; NYHA: New York Heart Association.



Although none of the differences in means are statistically significant, tendencies appear in the plots with regard to gender, EF, and NYHA. Between males and females, it appears that males have a higher mean number of daily steps than females, patients with an EF lower than 30% walk less than patients with an EF over 30%, and patients with a lower NYHA classification walk more than patients with a higher NYHA classification.

Correlation Between Daily Steps and Clinical Parameters

The correlation between daily steps and demographic and clinical parameters was investigated using Pearson correlation coefficient. The investigated parameters were age, gender, baseline EF, change in EF, baseline NYHA, change in NYHA, mean number of steps, and change in number of daily steps. The correlation values (*r*) and corresponding *P* values are presented in Table 3.

Table 3. Pearson correlation coefficients (r) and significance levels.

Variables	Age	Gender	Baseline EF[a]	Change in EF	Baseline NYHA[b]	Change in NYHA	Mean number of daily steps	Change in daily steps
Age	1.000	0.057	–0.105	–0.123	0.093	–0.044	–0.188	–0.112
Gender		1.000	0.033	0.052	–0.187	–0.065	0.140	0.003
Baseline EF			1.000	–0.742[c]	–0.224[d]	–0.198	0.071	–0.427[c]
Change in EF				1.000	0.004	0.096	0.120	0.314[e]
Baseline NYHA					1.000	0.581[c]	–0.288[f]	0.116
Change in NYHA						1.000	0.033	0.065
Mean number of daily steps							1.000	0.053
Change in daily steps								1.000

[a]EF: ejection fraction.
[b]NYHA: New York Heart Association.
[c]*P*<.001.
[d]*P*=.037.
[e]*P*=.005.
[f]*P*=.010.

Based on the correlation coefficients and significance levels in Table 3, a statistically significant correlation of *P*<.05 appears between the following variables: (1) the baseline EF and change in EF, (2) the baseline EF and baseline NYHA, (3) the baseline EF and change in the number of daily steps, (4) change in EF and change in the number of daily steps, (5) the baseline NYHA and change in NYHA classification, and (6) the baseline NYHA classification and mean number of daily steps.

Regression Analysis

Hierarchical regression analyses have been performed with the following purposes: (1) predicting the variation in the mean number of steps and (2) predicting the variation in the change in EF. Both analyses consisted of 3 models in which demographic data were entered in the first block, clinical data in the second block, and activity data in the third block. The results from the analyses are presented in Table 4.

Table 4. Hierarchical regression analyses to predict the mean number of steps, depicted as model statistics and coefficients.

Model and variables	Prediction of variation in the mean number of steps							
	Test statistics				Coefficients			
	R^2	ΔR^2	ΔF (*df*)	*P* value	β	*t* (*df*)	*P* value	pr^2
1	**0.058**	**0.058**	**1.910 (2, 62)**	**.157**				
Age					–0.197	–1.592 (2,62)	.116	0.039
Gender					0.151	1.223 (2,62)	.226	0.024
2	**0.119**	**0.060**	**2.080 (2, 60)**	**.134**				
Age					–0.171	–1.395 (4,60)	.168	0.031
Gender					0.102	0.827 (4,60)	.412	0.011
Baseline EF[a]					–0.008	–0.061 (4,60)	.952	<0.001
Baseline NYHA[b]					–0.255	–2.005 (4,60)	.049[c]	0.063
3	**0.810**	**0.691**	**215.132 (1, 59)**	**<.001[c]**				
Age					–0.089	–1.553 (5,59)	.126	0.039
Gender					0.021	0.362 (5,59)	.719	0.002
Baseline EF					–0.168	–2.832 (5,59)	.006[c]	0.120
Baseline NYHA					0.003	0.052 (5,59)	.959	<0.001
Baseline steps					0.911	14.667 (5,59)	<.001[c]	0.785

[a]EF: ejection fraction.

[b]NYHA: New York Heart Association.

[c]*P*<.05.

The squared correlations (R^2) shown in Table 4 indicate the proportion of variation accounted for when using the variables listed under the model numbers, which in these cases increases with the complexity of the model. The result in model 3 prove that 81% of the variation in the mean steps can be predicted. The correlation for model 3 is highly influenced by the baseline EF and baseline steps variables, as these were the statistically significant predictors (*P*=.006 and *P*<.001, respectively), based on the *P* values.

Discussion

Principal Findings

The aim of this FPT substudy was to investigate the walking activity of patients with HF participating in a telerehabilitation program for 1 year as measured by step counters. There was no statistically significant difference (*P*>.05) between the mean number of daily steps in the 3 phases of the intervention. This may be due to the step counters not being designed to capture different modes of physical activity (eg, cycling and swimming). As a result, not all physical activities may have been documented.

This study has shown a significant correlation between the mean number of daily steps and NYHA classification (*P*=.01), between the increase in daily steps and EF (*P*<.001), and between the increase in daily steps and reduction in EF (*P*=.005). These correlations indicate a relationship between a higher level of physical activity and an improvement in the HF condition. Furthermore, the findings indicate that demographic, clinical, and activity data can be used to predict 81% of the variation in the mean number of daily steps.

A study by Albert et al [20] investigating the requirements from patients with HF regarding devices for monitoring their health and activity found that the patients with HF requested devices that could give them immediate feedback and an overview of data over time [20]. In our study, we used 2 Fitbit step counters, both of which fulfilled these requests. Hence, they gave the patients immediate feedback through the device and an overview of their own data using the HeartPortal [17]. These commercially available devices could therefore be used to encourage the patients to be more active in their daily lives. During this period, the patients participated in a mean total duration of 358.18 (SD 54.57) days, and they used the step counters for mean 88.65% (SD 19.75%) of this time (they were asked to use the Fitbits every day). However, the percentage of time using the step counter differed between the predefined activity levels because patients with a low activity level used the step counter for 81.00% (SD 20.56%) of the participation period, whereas those patients with a high activity level used the step counter for 94.40% (SD 16.94%) of the participation period. These results seem to indicate that a higher adherence is associated with a higher activity level. These findings are consistent with those reported by Thorup et al [3], wherein 72% of the low-activity level cardiac patients walked a minimum of 100 steps with a Fitbit step counter, compared to 88% of those with a medium activity level and 91% of those with a high activity level.

The patients in the FPT walked a mean number of 6962.81 steps daily, which is approximately the same as the mean number of 7027 daily steps reported by Bäck et al [15], whose study also included patients with coronary artery disease. However, the mean number of steps in this study is higher than the mean number of 5889 and 5869 steps reported by Thorup et al [3] and Werhahn et al [12], who either included different cardiac patients (including patients with HF) or only patients with HF.

The hierarchical regression analyses demonstrated that it is possible to predict 81% of the variation in the mean daily steps. However, only the baseline EF (P=.006) and the baseline number of daily steps (P<.001) were statistically significant predictors when predicting variation in the mean number of daily steps.

The relations between clinical variables and daily steps presented in this study can be of value in clinical practice first for the patients. Besides, in collaboration with health care professionals, these data can help facilitate the rehabilitation of patients with HF. This is in alignment with a previous study conducted by the Laboratory for Welfare Technology, which reported that the use of step counters motivated cardiac patients to do more physical activity and made the physical activity visible for the patient [21]. A qualitative study by Andersen et al [22] showed that activity data from wearable devices used by cardiac patients may be a tool for self-care.

To our knowledge, no other studies have included patients with HF and measured and analyzed step counts over a 1-year period.

We believe that this study offers a picture of how an activity tracker can be used to document the change in the physical activity over time for patients with HF in their daily lives.

Limitations

Some limitations of this study should be considered. The echocardiograph was not blinded for other clinical information, which may have led to biases. Two different kinds of step counters were used due to patient preferences. However, the 2 types of step counters used in the FPT were among those models with the lowest error margin, as described in Munck et al [18], and are therefore considered valid.

Conclusions

The patients in this study who walked more tended to be of a younger age, had lower NYHA classification, and a higher EF. There was a statistically significant correlation between the mean number of daily steps and the NYHA classification at baseline (P=.01), between the increase in daily steps and EF at baseline (P<.001), and between the increase in daily steps and improvement in EF (P=.005). The patients' demographic, clinical, and activity data can be used to predict 81% of the variation in the mean number of daily steps. These results suggest that a step counter may be a useful tool for patients in helping them to monitor their own physical activity during a telerehabilitation program and a means to help enhance their recovery.

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Authors' Contributions

The study was designed by BD, HS, MH, and JR. JG and BD have drafted the manuscript. Feedback for the manuscript was provided by all authors. All authors approved the final manuscript before submission.

Conflicts of Interest

None declared.

Multimedia Appendix 1

CONSORT-EHEALTH checklist (V 1.6.1).
[PDF File (Adobe PDF File), 1088 KB-Multimedia Appendix 1]

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Abbreviations

ANOVA: analysis of variance
API: application programming interface
CONSORT: Consolidated Standards of Reporting Trials
CONSORT-EHEALTH: Randomized Controlled Trials of Electronic and Mobile Health Applications and Online TeleHealth
EF: ejection fraction
FPT: Future Patient Telerehabilitation
HF: heart failure
NYHA: New York Heart Association

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