8-21-2018

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Recommended Citation

Deka, P., Pozehl, B., Williams, M. A., Norman, J. F., Khazanchi, D., & Pathak, D. (2019). MOVE-HF: an internet-based pilot study to improve adherence to exercise in patients with heart failure. European Journal of Cardiovascular Nursing, 18(2), 122–131. https://doi.org/10.1177/1474515118796613

MOVE-HF: An Internet-Based Pilot Study to Improve Adherence to Exercise in Patients with Heart Failure

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Introduction

Congestive Heart Failure (HF), with 24.7% hospital readmissions within 30 days, has the highest re-hospitalization rates among all chronic diseases [1]. Exercise training has been utilized to improve upon these findings, with the physiological benefits of this resulting in reduced mortality and hospitalization rates in these patients[2]. Nonetheless, patient adherence to exercise in this population has been found to be low [2, 3]. Unfortunately, the primary aim in many of the studies purporting to describe adherence to exercise in patients with HF, primarily focused on the physiological and psychological effects of exercise, and leaft adherence to be described as participation or attendance to the exercise program [4]. Strategies and interventions to improve adherence to exercise in a community-setting have not been adequately studied [4]. Additionally, reports of exercise adherence in HF patients have been primarily based on subjective data from exercise diaries, and methods to validate these exercise diaries with objective exercise data, especially in a community-setting have been lacking [4].

Adherence to an exercise program is often difficult to achieve as it requires one to make both behavioral and lifestyle changes. However, it has been suggested that theory-based interventions and strategies may be effective in making such changes [4]. Studies focusing on the provision of social support have demonstrated improvements in adherence to exercise [4]. However, the use of the internet to provide synchronous face-to-face video peer group support, as a method to improve adherence to exercise in this population has not been investigated [4]. Information sharing and applied social pressure can positively impact behavior [5] and perceived social isolation has been shown to negatively impact health-related behavior including participation in physical activity [6, 7]. HF patients appear to experience social isolation [8]; however,

the use and effectiveness of the internet to socially connect HF patients and its impact on exercise adherence are unknown.

The impact of providing regular objective feedback on physical activity including exercise and exercise adherence in HF patients, with the use of modern wrist-worn activity monitors such as the Fitbit Charge HR (FCHR, Fitbit®, San Francisco, USA) has not been investigated. The **Move on Virtual Engagement (MOVE-HF)** is a theory-based intervention to improve exercise adherence in patients with HF that incorporates the use of the internet as a strategy to provide peer group support and feedback on physical activity to improve exercise adherence. For this study, the internet-based-synchronous-face-to-face-video (IBSF2FV) group discussion/education and support was provided using Vidyo software. Objective feedback on exercise and daily activity was provided with the FCHR.

The purpose of this pilot study was to investigate whether adherence to exercise in a community-setting could be improved using the MOVE-HF intervention in patients with HF. Study aims were to compare the experimental and comparison groups on: 1) Adherence to recommended exercise guidelines (150 minutes/week of moderate intensity exercise); 2) Intention to adhere to recommended exercise guidelines; and 3) outcomes including: a) functional status, b) self-efficacy for exercise, and c) perceived social isolation.

Methods

Design

The MOVE-HF study (Figure 1) is an 8 week experimental, randomized controlled two group (experimental and comparison) repeated measures design to pilot test the impact of the MOVE-HF intervention on improving adherence to the recommended exercise guidelines.

Fig. 1: **MOVE-HF study design. NYHA: New York Heart Association Functional Class; MOVE-HF: Move on Virtual Engagement-Heart Failure; FCHR: Fitbit Charge HR; HF: Heart Failure**

Participants

Patients were recruited from two cardiology practices in the Midwest. Inclusion criteria required a diagnosis of NYHA Class I-III HF with no change in clinical history is the past 30 days and receiving standard pharmacological treatment with a stabilized dose of beat-blocker to elicit stable HR response, access to electronic devices (desktop/laptop/iPad/tablet/smartphone) with internet connectivity and cardiologist clearance to exercise. Participants were excluded if they were restricted from participating in aerobic exercise (orthopedic or neuromuscular disorders, and clinical evidence of decompensated HF) and were involved in any formal exercise (three times a week for 30 min or more) in the past 30 days.

Theoretical Framework:

The MOVE-HF intervention is based on Bandura's Social Cognitive Theory (SCT) and Ajzen's Theory of Planned Behavior (TPB), the most widely used theories in internet-based studies for behavioral change [9]. The TPB states that internal factors such as intention, which can be improved using the self-efficacy determinant of SCT [10-12], can influence performance of the

behavior [13]. The theory-based intervention used in this study integrated the TPB and the SCT to study the impact of peer social support to improve self-efficacy and intention to adhere to exercise. Reduced perceived social isolation and verbal persuasion through the IBSF2F group support is hypothesized to improve exercise adherence behavior.

MOVE-HF Intervention

The components provided to participants in *both* the experimental and comparison group included:

Exercise routine. The exercise routine consisted of a community walking program to meet the recommended guidelines of 150 minutes/week of moderate intensity aerobic exercise [14-16]. A Borg Scale rating of perceived exertion (RPE) between 10-14 was primarily used to guide moderate exercise intensity [17]. To ensure safety during exercise, participants were provided with the average HR from their six min-walk-test at baseline. They were asked to monitor their HR during exercise and not to exercise at an intensity that caused the HR to exceed that number. Details regarding the exercise program and steps taken for safety of the participants in a community-setting have been described previously [18].

Fitbit® Charge HR (FCHR). The FCHR and the Fitbit® software installed in the participants' electronic devices were used to provide objective feedback on daily physical activity and to objectively validate the self-reported exercise diaries. The FCHR tracks, records and delivers information on step-count, HR, and active minutes in real-time and provides the option of manually recording exercise sessions via an inbuilt stopwatch. Participants were asked to manually record all of their exercise sessions and to sync the FCHR to the Fitbit® software to

validate self-reported data. Details about the FCHR and objective validation strategies have been previously described [18].

Exercise diaries. All participants were provided with paper exercise diaries. For 8 weeks on a daily basis they were asked to record: exercise sessions (with date, duration and RPE), barriers faced, strategies used to overcome those barriers, and their intention to adhere to the recommended exercise guidelines on a scale of 1 to 5 at the beginning of the week.

Education on HF self-care. A web-link along with a handout on 8 modules of HF self-care from Heart Failure Society of America (HFSA) were provided. These modules included: understanding HF, exercise and activity with HF, how to follow a low sodium diet, heart failure medication, dealing with HF symptoms, depression and anxiety with HF, managing lifestyle changes along with other chronic conditions and heart rhythm problems [19].

Social support through Vidyo (provided *only* to the experimental group). The 15 participants in the experimental group were further sub-divided into 3 cohort groups with 5 members each. For 8 weeks, each cohort met weekly for a 45-60 min long IBSF2FV education/discussion session using Vidyo. Vidyo is a software-based video conferencing application used to connect participants in distant locations for a face-to-face group audio/video conference. Each week, education was provided on one topic of self-care from the handout provided to the participants. Participants were encouraged to interact with other group members. These social interactions, targeted towards exercise performance and achieving adherence to the recommended guidelines, were intended to influence self-efficacy for exercise in the group members. The primary investigator (PI), who moderated these education/discussion sessions, provided encouragement to follow the exercise routine and suggestions on overcoming exercise barriers.

Measures

Table 1:

Procedures

The study complied with the *Declaration of Helsinki* and was approved by the institutional IRB at the University of Nebraska Medical Center. Informed consents were signed and cardiologist approval was obtained prior to enrollment, which happened in three phases. In each phase, enrollment started after at least 10 participants met screening criteria. This was done to ensure that the experimental group participants, after randomization, did not have to wait more than a week to attend the first IBSF2FV meeting. At baseline, all participants were asked to bring their electronic devices for the PI to set up the Fitbit and Vidyo software. They were trained on using the FCHR, performed the 6MWT wearing the FCHR, and responded to two questionnaires (BESES and the Friendship scale). The average HR during the walk was recorded using the FCHR and provided to the participants. After providing adequate rest, the PI performed a 10 min long walk with the participants to familiarize them with using the FCHR to record exercise sessions, and regulating exercise intensity using the Borg scale and the HR from the FCHR and to download data using the Fitbit software.

Apart from 2 participants who used desktop computers at home, the participants were able to set-up all electronic devices during the PI baseline visit. Participants in the experimental group were trained on using the Vidyo software. To ensure that participants were competent in operating the software, a handout containing operational instructions was provided and the PI connected with them via Vidyo within two days of enrollment. Participants having difficulty connecting for this session were provided with instructions over the phone. The PI asked the 15

participants to indicate several times during the week for their availability for the IBSF2FV group meetings and the time that worked best for each cohort was selected. The first week of the meeting was considered to be the start of the 8 weeks of intervention for each cohort.

All participants were also provided with educational materials (web link and handout) on 8 educational modules on self-care in HF from HFSA. Participants were asked to follow the exercise routine for the 8 weeks. At the end of 8 weeks, all participants performed the 6MWT, responded to the two questionnaires (BSES and the Friendship scale), and completed the survey describing their experience of participating in the study.

Data Analysis

Table 2: Aims, outcome measures for the aim, and statistics used for analysis

Analysis was done using IBM SPSS 23. The level of significance was set at α=0.05.

Results

Subjects in both groups were predominantly Caucasian, married, retired and living in urban areas.

Table 3: Demographic and Clinical Characteristics of Participants at Baseline. Data are number of subjects unless otherwise indicated.

Aim 1: Table 4 and Figure 2 show the results of the MOVE-HF intervention on adherence to exercise between the two groups. No significant difference was observed in the interaction and individual effects of group and time.

Table 4: RMANOVA Results of Mean Duration of Exercise (Min/Week) across the 8 weeks

Figure 2: **Mean duration of exercise (min/week) across the 8 weeks between the two groups**

Aim 2: Table 5 and Figure 3 show the results of the intervention on intention to adhere to the recommended guidelines. A significant correlation (r= .488; p=.006) was found between intention to adhere to the recommended exercise guidelines and actual adherence scores for all

participants. No significant difference was observed in the interaction and individual effects of group and time.

Table 5: RMANOVA Results of Mean Intention Scores for the Two Groups

Figure 3: **Intention to adhere to recommended exercise between the groups across the 8 weeks**

Aim 3a: Two participants did not perform the 6MWT at the post-8 week assessment and were excluded from analysis. No significant difference was observed between the groups over time but RPE scores were reduced in both groups at post intervention assessment (Table 6).

Table 6: RMANOVA Results of the 6MWT Score (meters) and RPE scores. F and p values are for the 6MWT scores

Aim 3b and 3c: No significant differences were observed between the groups on exercise self-efficacy and social isolation as outlined in Table 7.

Table 7: Comparison of Exercise Self-efficacy and Social Isolation Scores for the Two Groups

Discussion

This study investigated the use of a theory-based intervention to improve adherence to exercise in patients with HF by providing feedback on physical activity and an IBSF2F group discussion/education meeting. Based on the recommended guidelines of 150min/week of exercise [15], the study found participants in both the experimental (88 min/week; 58.8%) and

comparison (86 min/week; 57.2%) groups to be partially adherent [21] with no significant difference in the mean weekly exercise time with an effect-size of 0.013. Other studies that prescribed exercise programs of 90 min/week of low-moderate intensity exercise have reported higher levels of adherence than found in this study [4]. It may be that, barriers experienced by HF patients can make adherence more difficult to achieve when exercising 5 days/weeks. Health, use of diuretics, personal and professional issues, and weather were identified as barriers to adherence to exercise by participants. During enrollment, most participants reported not being active with two participants in the comparison group reporting inconsistent exercise about 1-2 days a week.

The overall attendance to the IBSF2FV meetings was 68% with 73.3% of participants attending 5 or more of the 8 possible sessions. Reasons for absence included: being busy, forgot meeting time, on vacation, audio/video problems, internet issues, being sick and not interested in attending group meetings. It is noteworthy that 6 of the 15 participants in the experimental group lived in rural areas and reported that the ability to attend the meetings from their homes was immensely helpful for attending the meetings on a weekly basis.

It may be that the dose of once a week for the group meeting was not strong enough and the experimental group participants, mostly leading sedentary lives, needed more group meeting sessions to facilitate full adherence to the recommended exercise guidelines. Thirteen of the fifteen participants in this group mentioned no previous interaction with anyone with HF and found it interesting to get to know and engage with other HF patients. Learning about the unique and common barriers to exercise other participants faced and being able to learn more about their own disease condition during the discussion/educational sessions are aspects of the MOVE-HF intervention that participants reported as beneficial. As example, five of the fifteen participants

also indicated that the weekly group meetings made them "accountable" towards the other members of the group. Additionally, during the 6th week of the intervention, two participants in the experimental group exchanged telephone numbers and connected with each other to walk together at a local mall. These anecdotal references indicate that participants did perceive receiving some social support, although the sample size was too small to detect any significant change in behavior.

Both groups received a FCHR for objective feedback on physical activity and an educational handout on self-care in HF, which included a module on exercise in HF. The Transtheoretical model refers to these interventions as "awareness raising," which leads to contemplation about making behavioral change [26]. It may be that the interventions, which participants in the comparison group received, were significant in leading to exercise adherence levels comparable to the experimental group. The survey showed that the feedback on step-count and heart rate received from the FCHR, made participants in both groups more conscious of their activity levels and accountable to themselves, and was instrumental in helping them become more active. Participants in both groups found the target of walking 30 min/day to be a motivator, while others found the step count information to be motivating. Twenty seven of the 30 participants indicated that, even on days that they did not exercise, the FCHR provided them with a constant reminder of their activity levels and prompted them to follow the exercise routine. It is noteworthy that nearly 83% of participants had already bought an FCHR or a similar activity monitor or were planning to buy one by the time they completed the study.

No significant difference in intention to adhere to exercise was observed between the two groups. A significant positive correlation existed between strength of intention and exercise adherence validating the assertions made by the Theory of Planned Behavior. However, the high

mean intention scores did not translate into achievement of the desired outcome behavior of high exercise adherence. Factors may exist that prevent HF patients from adhering to exercise in spite of having strong intentions. In this study, two participants in the experimental group self-reported of depression in the survey. One among them stated that his strong intentions did not result in exercise behavior because of being acutely depressed. It is a prevalent co-morbidity in HF [27-29] that influences functional decline [28] and has been identified as a barrier to exercise adherence in this population [21]. In fact, the presence of depression is associated with 3-fold increase in non-adherence to medical treatment [30]. HF patients suffering from depression may require additional support to become adherent to exercise.

HF patients may require personalized interventions to overcome unique barriers in achieving exercise adherence. Unfortunately, in the present study the effect of social support in the form of an IBSF2FV group discussion/education on exercise adherence and intention to adhere to recommended exercise guidelines could not be determined because of inadequate power.

Functional status, determined by the 6MWT, was not significantly different between the groups. Although the mean 6MWT score did not change significantly from baseline in either groups, the 6MWT RPE scores post-completion did change ($p=.0001$). These findings indicate that participants were less fatigued and perceived less exertion when walking a similar distance. Although the study purpose did not focus on improving exercise capacity, since RPE improved, it may be that a longer intervention with a larger sample size might have led to measurable functional improvement. Also, performing the 6MWT on two separate days at baseline and at 8 weeks may have also helped to negate any error that occurred in conducting the test.

Self-efficacy scores were not significantly different within and between groups pre and post-intervention. It is possible that the educational material and exercise monitoring devices in both groups had an impact on self-efficacy. It may also be that participants overestimated their confidence scores at baseline. These claims are made cautiously due to the small sample size and lack of adequate power.

Similarly, no difference was observed in perceived social isolation scores between groups. The lack of difference or effect may be related to the low levels of perceived social isolation found in the sample at baseline. Unlike NYHA Class IV HF patients, which were not included in the present study, NYHA class I-III HF patients may experience less social isolation. The literature shows that NYHA Class III HF patients and HF patients with EF >30% have reported to not experiencing loneliness[31]. From the anecdotal observation from participants, it appears that participants did perceive some aspect of social support from the intervention. However, due to lack of power with the small sample size, it is unclear whether the intervention was actually not effective in improving social isolation or whether the tool used to measure social isolation was not sensitive to the changes.

Limitations

The small sample size of 30 with 8 repeated measures is a limitation of the study as it did not provide sufficient power to detect between group differences in exercise adherence and resulted in only a small effect size. It is noteworthy, that the comparison group also received a FCHR and educational material. Had the comparison group not received this intervention, the effect size may have been larger. Activity levels at baseline were determined from subjective response to inclusion criteria during screening. As such, it is unknown whether there was any difference in activity levels between the two groups at baseline. The length of the intervention of

8 weeks may not have been long enough for the study purpose. As a post-intervention follow-up was not performed, the long-term effects on adherence after completion of the intervention are unknown.

Conclusion and

This pilot study was designed to improve exercise adherence in patients with HF and is the first to test whether social support provided through an IBSF2FV group discussion/education can help these patients to become adherent to recommended exercise guidelines. The long-term impact of an IBSF2FV intervention on exercise adherence using a larger sample should be investigated. Future research should also incorporate strategies for overcoming unique exercise barriers in HF and goal setting for minute/week of exercise or step count over time to help progress participants towards meeting recommended exercise guidelines. It is important to investigate ways to help patients with HF become more adherent to exercise. Providing objective feedback on exercise and physical activity may be an important factor for promoting adherence to exercise.

Implication for Practice

- IBSF2FV interventions to provide social support and education is feasible in the HF population.
- Objective feedback on physical activity with the use of activity monitors such as the FCHR can be a motivator for HF patients to adhere to exercise.
- Feedback received on step count and HR from the FCHR is appreciated in this population.

Funding Acknowledgement: The study was funded by the Midwest Nursing Research Society/Center for the Advancement for Nursing Sciences (MNRS/CANS) dissertation grant for 2016.

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Tables and Figures

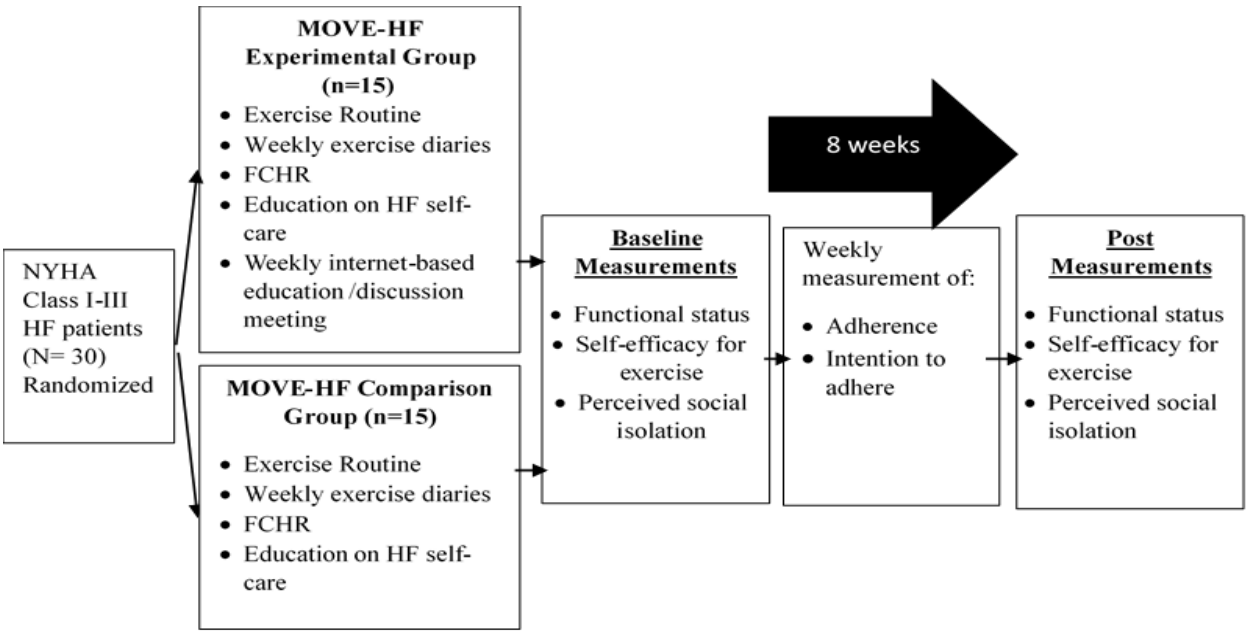

Fig. 1: **MOVE-HF study design. NYHA: New York Heart Association Functional Class; MOVE-HF: Move on Virtual Engagement-Heart Failure; FCHR: Fitbit Charge HR; HF: Heart Failure**

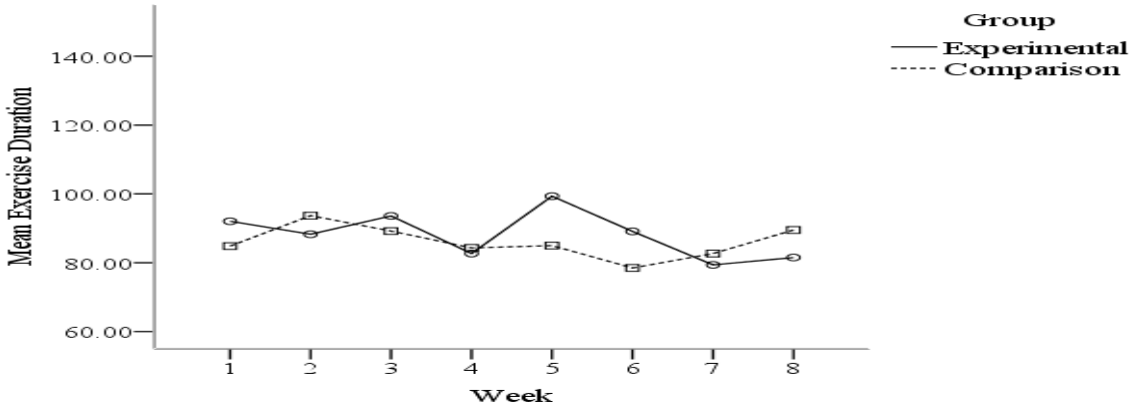

Figure 2: **Mean duration of exercise (min/week) across the 8 weeks between the two groups**

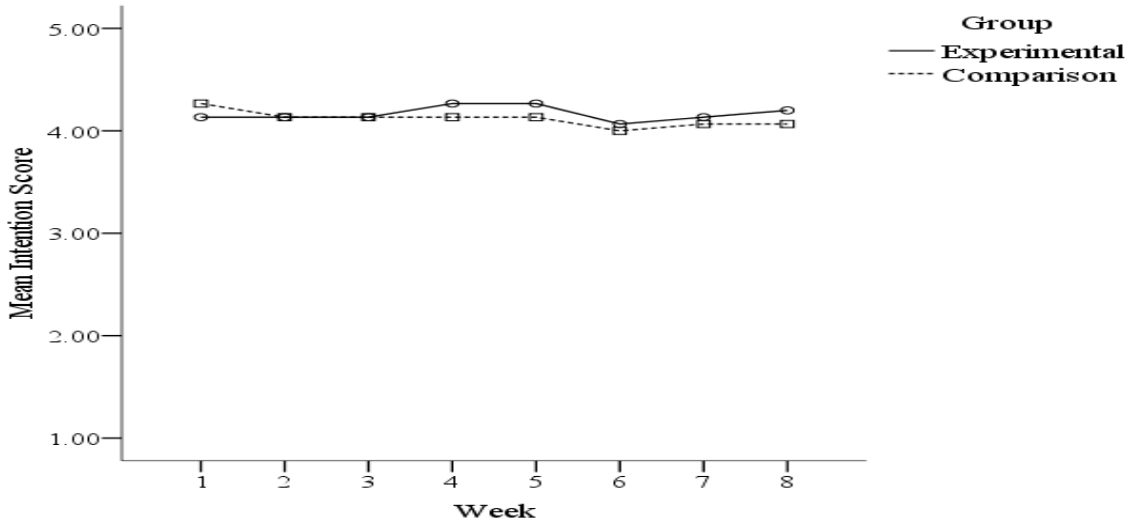

Figure 3: **Intention to adhere to recommended exercise between the groups across the 8 weeks**

Table 1: Measures Used for the Study Outcomes

Outcome	Measure	Details
Adherence to exercise	Mean adherence achieved over the 8 weeks based on self-report documentation (exercise diaries).	Exercise adherence = [(actual # of min/wk) / (150 min/wk target goal) x 100] [20]. Categorization: adherent (>80%), partially adherent (20%-80%) and non-adherent (<20%) [21].
Intention to adhere to exercise	Subjective reporting from exercise diaries.	A 5 point Likert rating scale with (1) indicating weak and (5) indicating very strong intention to adhere.
Attendance to Vidyo group meetings	PI maintained attendance records.	Overall attendance in percentage was calculated out of the possible 120 group meetings (15 participants x 8 scheduled meetings).
Participant perception of MOVE-HF intervention	Investigator-developed survey completed at end of study	The survey captured: i) participants perceptions of participating in the MOVE-HF study; ii) their experience in using the Vidyo software to connect with other participants; and iii) their experience on the use of the FCHR.
Functional status	Six-min-walk test (6MWT). Valid and reliable for measuring function in cardiac patients in general (Cronbach α= 0.97; r = 0.687; p<0.001) [22] and valid for patients with HF (r=0.579; p=0.001) [23].	Participants were asked to walk laps in a 30m long hallway and cover as many laps as possible in 6 min. The total distance walked in meters in 6 minutes was recorded.
Self-efficacy for exercise	Bandura's exercise self-efficacy scale (BESES) containing 18 potential barriers to exercise. The tool has documented reliability with a Cronbach α=0.95 and validity with change in 6MWT distance score (r=0.28; p=0.035) [24].	Participants indicated their confidence level, on a scale of 0-100%, for exercising 30 min a day for 5 or more days a week when facing those barriers.
Perceived Social Isolation	Friendship scale. The tool contains 6 questions in Likert scale format and has been found to be reliable (Cronbach α=0.83) and valid (r=0.44, p<.001)[25]	A lower score indicates a higher perceived level of social isolation.

Table 2: Aims, outcome measures for the aim, and statistics used for analysis

Aim	Outcome	Statistic Used
1	Adherence to recommended exercise guidelines across 8 weeks	Repeated measures analysis of variance (RMANOVA), with week as the measure of time. In total there were 8 repeated measures. Effect size was calculated from the between group differences.
2	Intention to adhere to recommended exercise guidelines	RMANOVA measured across 8 weeks, with week as the measure of time.
3a	Functional status from 6MWT scores	RMANOVA with 2 repeated measures across time (baseline and post-8 weeks).
3b & c	Self-efficacy for exercise and perceived social isolation	Non-parametric Mann-Whitney U test with change scores (post – baseline) to compare experimental and comparison groups for differences

Table 3: Demographic and Clinical Characteristics of Participants at Baseline. Data are number of subjects unless otherwise indicated.

	Experimental (n=15)	Comparison (n=15)
Age	61.7±11.3 yrs	67.8±11.4
Gender (M/F)	10/5	9/6
Race (Caucasian)	100%	100%
Marital Status:		
Married	13	9
Single or Divorced	2	6
Working/Retired or Did Not Work	6/9	5/10
Place of dwelling		
Rural	6	1
Urban	9	11
NYHA		
Class I	0	3
Class II	10	7
Class III	5	5
Ejection Fraction	41±12.6%	44±10.8%
HFpEF	4	3
HFrEF	11	12
Etiology of HF		
Ischemic	1	3
Non-ischemic	14	12
Medical History		
Hypertension	9	11
Hypercholesterolemia	13	9
Diabetes Type II	7	3
COPD	3	2
Renal Disease	2	5
Arthritis	0	2

M=Male; F=Female; NYHA: New York Heart Association Functional Class; HFpEF: Heart failure with preserved ejection fraction; HFrEF: Heart failure with reduced ejection fraction; COPD: Chronic obstructive pulmonary disease. No significant difference was found between the two groups.

Table 4: RMANOVA Results of Mean Duration of Exercise (Min/Week) across the 8 weeks

	Group	N	Mean	SD	Std. Error Mean	F value (df)	p-value	Effect Size (partial η^2)
Adherence	Experimental	15	88.2	81.9	21.2			
	Comparison	15	85.9	44.2	11.4			
	Group*Time					0.361(7, 196)	0.924	0.013
	Time					0.394(7, 196)	0.905	0.014
	Group					0.009(1, 28)	0.925	0.000

Table 5: RMANOVA Results of Mean Intention Scores for the Two Groups

Group	N	Mean	SD	Std. Error Mean	F value (df)	p-value	Effect size (partial η^2)
Experimental	15	4.17	1.03	.27			
Comparison	15	4.12	0.97	.25			
Group*Time					0.319(7, 196)	0.732	0.007
Time					0.210(7, 196)	0.823	0.11
Group					0.019(1, 28)	0.892	0.001

Table 6: RMANOVA Results of the 6MWT Score (meters) and RPE scores. F and p values are for the 6MWT scores

	Experimental			Comparison				
	N	Mean	RPE	N	Mean	RPE	F value (df)	p-value
Aim 3a: Functional status								
Baseline	15	399±102	16±2	15	356±142	16±2		
Post-8 weeks	15	399±96	13±2	13	368±131	13±2		
Group*Time							0.908 (1, 28)	0.349
Group							0.333 (1, 28)	0.569
Time							0.724 (1, 28)	0.403

Table 7: Comparison of Exercise Self-efficacy and Social Isolation Scores for the Two Groups

	N	Median		*Z*	p-value
Aim 3b: Exercise Self-Efficacy		Baseline	Post-8 weeks		
Experimental group	15	54%	50%		
Comparison group	15	62%	59%		
Mann-Whitney	30			-0.332	0.740
Aim 3c: Social Isolation					
Experimental group	15	20	22		
Comparison group	15	20	21		
Mann-Whitney	30			-0.481	0.631