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Physical activity in patients with heart failure: motivations, self-efficacy and the potential of exergaming

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To my parents, Olga & Andries
And my little brother Riks

Reading is to the mind
what exercise is to the body
Joseph Addison

CONTENTS

ABSTRACT

Background: Adherence to recommendations for physical activity is low in patients with heart failure (HF). It is essential to explore to what extent and why patients with HF are physically active. Self-efficacy and motivation for physical activity are important in becoming more physically active, but the role of self-efficacy in the relationship between motivation and physical activity in patients with HF is unknown. Alternative approaches to motivate and increase self-efficacy to exercise are needed. One of these alternatives might be using exergames (games to improve physical exercise). Therefore, it is important to obtain more knowledge on the potential of exergaming to increase physical activity.

The overall aim was to describe the physical activity in patients with HF, with special focus on motivations and self-efficacy in physical activity, and to describe the potential of exergaming to improve exercise capacity.

Methods: Study I (n = 154) and II (n = 101) in this thesis had a cross-sectional survey design. Study III (n = 32) was a 12-week pilot intervention study, including an exergame platform at home, with a pretest-posttest design. Study IV (n = 14) described the experiences of exergaming in patients who participated in the intervention group of a randomized controlled study in which they had access to an exergame platform at home.

Results: In total, 34% of the patients with HF had a low level of physical activity, 46% had a moderate level, 23% reported a high level. Higher education, higher self-efficacy, and higher motivation were significantly associated with a higher amount of physical activity.

Barriers to exercise were reported to be difficult to overcome and psychological motivations were the most important motivations to be physically active. Women had significantly higher total motivation to be physically active. Self-efficacy mediated the relationship between exercise motivation and physical activity; motivation leads to a higher self-efficacy towards physical activity.

More than half of the patients significantly increased their exercise capacity after 12 weeks of using an exergame platform at home. Lower NYHA-class and shorter time since diagnosis were factors significantly related to the increase in exercise capacity. The mean time spent exergaming was 28 minutes per day. Having grandchildren and being male were related to more time spent exergaming.

The analysis of the qualitative data resulted in three categories describing patients' experience of exergaming: (i) making exergaming work, (ii) added value of exergaming, (iii) no appeal of exergaming.

Conclusion: One-third of the patients with HF had a low level of physical activity in their daily life. Level of education, exercise self-efficacy, and motivation were important factors to take into account when advising patients with HF about physical activity. In addition to a high level of motivation to be physically active, it is important that patients with HF have a high degree of exercise self-efficacy.

Exergaming has the potential to increase exercise capacity in patients with HF. The results also showed that this technology might be suitable for some patients while others may prefer other kinds of physical activity.

Keywords: heart failure, physical activity, exercise, motivation, self-efficacy, exergame

LIST OF PAPERS

This thesis is based on the following papers, which will be referred to in the text by their Roman numerals:

I. Klompstra L, Jaarsma T, Strömberg A. Physical activity in patients with heart failure: barriers and motivations with special focus on sex differences. Patient Prefer Adherence 2015: 9; 1603-1610

II. Klompstra L, Jaarsma T, Strömberg A. Self-efficacy, motivation and physical activity in heart failure patients. (Submitted)

III. Klompstra L, Jaarsma T, Strömberg A. Exergaming to increase the exercise and daily physical activity in heart failure patients: a pilot study. BMC Geriatrics 2014; 14: 119

IV. Klompstra L, Jaarsma T, Mårtensson J, Strömberg A. Exergaming through the eyes of patients with heart failure – a qualitative content analysis study. (Submitted)

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ABBREVIATIONS

ANOVA	ANalysis Of Variance
EE	Energy Expenditure
EHFScBS	European Heart Failure Self-care Behavioural Scale
HADS	Hospital Anxiety and Depression Scale
HF	Heart Failure
s-IPAQ	short form International Physical Activity Questionnaire
METs	Metabolic Equivalent of Tasks
NYHA-class	New York Heart Association functional classification
RCT	Randomized Controlled Trial
6MWT	6-Minute Walking Test

INTRODUCTION

Regular physical activity is recognized to be important for patients with heart failure (HF).[1,2] Patients who are daily physically active are found to have an improvement in exercise capacity, are less likely to be admitted to hospital, and have a better prognosis.[3,4] However, despite these benefits of being physically active, most patients with HF are not as active as recommended.[5,6] Only 30% of the patients are found to be adhering to their physical activity recommendation after three years[4] and this may limit the effect on clinical outcomes.[7-9]

Having HF has been identified both as a barrier and as a motivation for physical activity. Individuals may want to be physically active to prevent further physical decline, but their ability to be physically active is often limited by HF.[10] Other reasons for patients with HF not being sufficiently physically active could be experiences of other barriers to physical activity. These are internal barriers to being physically active and are related to the person him/herself (e.g., lack of time).[10-14] There are also external barriers to physical activity including environmental considerations (e.g., no training facilities nearby).[10,13-16] Furthermore, motivation and self-efficacy are seen as important in becoming and staying physically active.[14,17,18] In order to promote physical activity in patients with HF, it is essential to know how physically active they are and to understand their motivations and self-efficacy beliefs and how these concepts are related.

To improve adherence to physical activity recommendations in patients with HF, alternative approaches to motivate and increase self-efficacy to physical activity are needed, e.g., exergaming. Exergaming might also be a way for patients with HF to increase physical activity, especially for people who may be reluctant to engage in more traditional forms of physical activity.

This thesis contains an exploration of how physically active patients with HF are, their motivations and self-efficacy in regard to physical activity, and the potential of exergaming to increase exercise capacity and physical activity.

BACKGROUND

It is generally recognized that being physically active is an important aspect of HF management. This management is complex, consisting of pharmacological, surgical and device treatments along with multi-displinary team management including organization of care, lifestyle advice, physical exercise and symptom monitoring.[1] In research, few patients have reported participating in regular physical activity.[6] For this reason it is important to look more in depth into the physical activity of patients with HF and their motivations to determine why they are physically active or not. Being motivated to be physically active is an important first step in becoming more physically active.[19-22] Previous research has found that motivation is not enough to improve physical activity, and self-efficacy is considered to be important in patients with HF[9,23], and could influence the gap between intention and physical activity. It is therefore also important to search for alternative approaches to motivate patients with HF and increase their self-efficacy to become more physically active.[1,2,7,14] The next paragraphs describe HF, the importance of physical activity in general and specifically in patients with HF, and motivation and self-efficacy in physical activity. Finally, exergaming as a possible alternative approach to increase physical activity will also be described.

Heart failure

Heart failure is a clinical syndrome characterized by typical symptoms (e.g., breathlessness, ankle swelling and fatigue) that may be accompanied by signs (e.g., elevated jugular venous pressure, pulmonary crackles) caused by a structural and/or functional cardiac abnormality, resulting in a reduced cardiac output and/or elevated intracardiac pressures at rest or during stress.[1] The New York Heart Association Functional Classification (NYHA-class) (Figure 1) provides a classification of the severity of HF symptoms. It places patients in one out of four categories based on how much they are limited by symptoms during physical activity.[24]

Table 1 New York Heart Association functional classification (NYHA-class)[24]

Class	Symptoms
I	No limitation of physical activity. Ordinary physical activity does not cause undue fatigue, palpitation, dyspnea (shortness of breath).
II	Slight limitation of physical activity. Comfortable at rest. Ordinary physical activity results in fatigue, palpitation, dyspnea.
III	Marked limitation of physical activity. Comfortable at rest. Less than ordinary activity causes fatigue, palpitation, or dyspnea.
IV	Unable to carry on any physical activity without discomfort. Symptoms of heart failure at rest. If any physical activity is undertaken, discomfort increases.

Recent studies suggest a prevalence of 1-3% in HF[25-27] and an incidence of 1-4/1000 person/year.[27-31] Heart failure is responsible for 1-2% of all healthcare expenditure in Western economies.[32] These costs are mainly driven by frequent, prolonged and repeated hospitalizations and pharmacy.[33] Across the globe, 17-45% of patients with HF admitted to a hospital die within one year of admission and the majority die within five years of admission.[34] Despite improvements in pharmacological treatment and HF management during the last decades, a large registry study in Sweden (5908 patients with HF) found no improvement in survival between 2003 and 2012 leaving the three-year survival rate in 2012 as high as 54%.[35]

Based on a large body of scientific evidence, current HF guidelines[1] stress the importance of a multifaceted approach to HF management consisting of optimal diagnosis, pharmacological and device treatment as well as optimized multi-disciplinary management including life-style advice, supporting self-care, optimal transition, and coordination of care.

Physical activity

Regular physical activity can bring significant health benefits to people of all ages and the need for physical activity decreases in later life.[36,37] Evidence shows that physical activity can extend years of active independent living, reduce disability and improve the quality of life for older people.[36,37] In this thesis, physical activity is defined as any bodily movement produced by skeletal muscles that results in en-ergy expenditure (EE).[38] A large-scale longitudinal eight-year study in the general population found that every additional 15 minutes of daily physical activity up to 100 minutes per day resulted in a further 4% decrease in mortality from any cause.[39] Regular physical activity prevents the development of coronary artery disease and reduces symptoms in patients with established cardiovascular disease.[40,41] Physical activity has a positive effect on all systems of the body and produces cardiovascular adaptions that increase exercise capacity, endurance and skeletal muscle strength[40] and reduces the risk of other chronic illnesses (e.g., type 2 diabetes, osteoporosis, obesity, depression, and breast and colon cancer).[42-46]

Predictors of regular participation in physical activity in healthy adults have been well documented. Lower age positively correlates with physical activity as well as higher self-efficacy, better knowledge of perceived benefits, and a positive attitude towards physical activity.[5,47] Engaging in regular physical activity, having an early history of physical activity, higher education and income level, and support from surrounding people have been described as predictors of future physical activity.[48] Being single or having a sedentary partner have been associated with lower physical activity levels in older adults.[49] Depression has also been found to be correlated with lower levels of physical activity.[50] Furthermore, there are gender differences indicating that older women's personal backgrounds are less favorable for physical activity than those of men (for instance, reported lower levels of education and income, fewer women were married, and a greater number lived alone).[51,52] In addition, women perceive their health as poorer, are more likely to experience barriers to physical activity, and indicate lower self-efficacy for physical activity than men.[51,52]

Physical activity and heart failure

Before the 1970s, patients with HF were advised not to be physically active because of concern that increased demands placed on the heart from physical activity would be harmful.[53] In the last few decades, physical activity has been studied in patients in NYHA-class I – IV and has been shown to be beneficial without worsening HF severity or increasing adverse events.[54]

Detailed recommendations on the most effective physical activity in terms of duration and level of strain in patients with HF remain unclear, but the guidelines encourage patients to undertake regular physical activity, sufficient to provoke mild or moderate breathlessness[1]. The lack of agreement among experts on universal guidelines for physical activity recommendations in this patient population is partly due to variability in physical activity protocols studied in clinical trials.[55] Furthermore, despite the benefits of being physically active, most patients with HF are not as active as recommended in the guidelines.[5,6] Data on rehabilitation in cardiac patients has shown that lower adherence to physical activity is associated with older age, lower social economic status, lack of motivation, and financial and medical concerns.[56]

Several studies have shown that both home-based physical activity (often distance walking)[57-59] and hospital based[60-62] are beneficial for patients with HF. The findings from a meta-analysis (ExTraMatch collaborative)[3] suggested that patients randomized to physical fitness were less likely to be admitted to hospital and had a better prognosis. Findings from a literature review on physical activity studies (using either aerobic exercise or combined aerobic and resistance training) showed no increase in exercise-related deaths or cardiac events.[54] In addition, there was no increase in all-cause mortality or hospitalizations from exercise training in patients with HF. This review also showed that the physical activity in patients with HF improved physiological effects of increased cardiac demand, exercise capacity, and overall health status and quality of life.

The HF-ACTION (Heart Failure: A Controlled Trial Investigating Outcomes of Exercise Training)[4,63,64] trial is the largest randomized controlled trial to date on physical activity in patients with HF (n = 2331). The study findings showed no increase in test-related deaths, worsening of HF, or development of angina symptoms resulting in hospitalization due to myocardial infarction, stroke or transient ischemic attack. Although the HF-ACTION trial did not find significant reductions in the primary end point of all-cause mortality or hospitalization, this study showed a modest improvement in exercise capacity and mental health in patients who were physically active. The main limitation in this study was the poor adherence to the prescribed training regimen, 30% after three years.

Although it is recognized that physical activity is important in patients with HF, only one study was found that described actual physical activity in this patient group. This study[5] included 68 patients with HF and showed that 44% of the patients were sedentary, 35% were moderately active, and 15% were physically active at a low level.

Motivations to be physically active

Motivation (intention to be physically active) is a key concept in several theories and models that explain healthy behaviors.[19-22] One of these theories is the self-determination theory[65], which is a theory of human motivation and personality that concerns people's inherent growth tendencies and innate psychological needs. The theory is concerned with the motivation behind choices people make without external influence and interference. The self-determination theory focuses on the degree to which an individual's behavior is self-motivated and self-determined. The self-determination theory, distinguishes between intrinsic and extrinsic motivation regulating one's physical activity. Intrinsic motivation involves engaging in physical activity for the pleasure and inherent satisfaction, whereas extrinsic motivation is defined as engaging in physical activity for instrumental reasons (e.g., when a person engages in an activity to gain a tangible or social reward or to avoid disapproval).

A recent systematic review[66] aimed to examine the relations between the key constructs in the self-determination theories and exercise and physical activity outcomes. This review showed good evidence for the value of the self-determination theory in exercise behavior, demonstrating the importance of autonomous (identified and intrinsic) regulations in adherence to and maintenance of physical activity. It is known that there is a gap between intention and physical activity showing that almost half of the people who intend to be physically active according to what is recommended in the guidelines, are not.[67]

Motivations for physical activity in adults include advice from health care providers, family influences, improvement in physical or motor competence, health benefits, and psychosocial reasons such as enjoying group interaction and meeting with friends.[10]

Patients with HF who were motivated were found to be more active and were better able to describe the benefits of exercise.[9] Motivations of patients with HF were found to be mainly related to factors associated with patients themselves (e.g., mental state), the social interaction during exercise, the physical condition of the patient, and the therapy (e.g., using diuretics).[9] Motivation was seldom related to benefits that were directly related to their HF condition e.g., outcomes or experienced benefits.[9]

Self-efficacy

Self-efficacy is defined as “the belief in one’s capabilities to organize and execute the courses of action required to produce given attainment”.[21] Self-efficacy is a central concept in the social cognitive theory[21] that emphasizes the role of observational learning and social experience in the development of personality. The social cognitive theory is a learning theory in which it is suggested that people learn by observing others, with the environment, behavior, and cognition all as factors in influencing a behavior. According to this theory, people with high self-efficacy are more likely to view difficult tasks as something to be mastered rather than something to be avoided.

Self-efficacy is described as a cognitive mechanism that mediates behavior and could also influence participation in various behaviors[21,23]. Self-efficacy determines the amount of effort and degree of persistence in pursuing being more physically active[21,23], even if barriers occur. Barriers to physical activity include internal barriers, such as lack of time, fear of injury, lack of knowledge, lack of self-discipline or motivation, and ill health or changing health status.[10-14] External barriers to physical activity include environmental considerations, e.g., no facilities nearby, safety, cost, friends/partner not interested, and barriers related to the weather.[10,13-16] Data on HF-specific barriers to physical activity have shown that experiencing symptoms and lack of energy is associated with lower adherence to physical activity.[68-70]

Exergaming to improve physical activity

If adherence to conventional physical activity is low, to stimulate patients with HF to become (more) physically active, alternative forms of physical activity should be found. One alternative approach to increase physical activity is exergaming. Exergaming is defined as an experiential activity such as playing exergames or any videogames that require physical exertion or movements that are more than sedentary activities and also include strength, balance, and flexibility activities.[71]

Except for one case study[72], no studies have been conducted on exergaming in patients with HF. A meta-analysis[73], including 18 studies with children and adults (relatively small sample sizes between 10-40), showed that exergaming significantly increased heart rate, oxygen uptake and EE compared to resting. In a scoping literature review[74] (till August 2012) including 11 studies with older adults (relatively small sample sizes between 7-63), showed that exergaming may be able to increase gait speed and motor function, and no differences were found in exergaming standing or sitting. Participants experienced a high level of enjoyment, and exergaming could be shared with the family, especially grandchildren (Table 2). These results were confirmed by studies between August 2012 till August 2016.[75-86]

Table 2 Results of a scoping literature review on exergaming in older adults[74] and updated literature from August 2012 – August 2016

Feasibility and safety
- Participants felt comfortable playing after training sessions[87,88]
- Certain games were too difficult to play[87,89]
- Adherence: 84-97.50%[76,81,88,90]
- No serious adverse events[75,91]
- Exergaming was feasible for older adults and stroke patients[85,91,92]
Physical activity
- Increase in EE[76,85,86,88,89,93,94]
- Increase in gait speed[77,80,81,84,87]
- Increase in physical status, especially cardiorespiratory fitness[77,78,84,85,88]
- Increase in motor function[77,84,91]
- No difference in EE exergaming while standing or sitting[93]
Balance
- Increase in balance[75,81,82,87]
- No relationship between EE or activity and balance status[93]
Participants' experiences
- High level of enjoyment[75,78,82,87,88,95]
- Experience that could be shared with the family, especially with grandchildren[87,89]
- Increase in mental related quality of life[80,90], sense of physical, social and psychological well-being[86,89]
- Participants perceived tasks as real tasks[83,94]

EE, Energy Expenditure

Exergames might be an option for patients with HF to increase physical activity, especially for those who may be reluctant to engage in more traditional forms of exercise (such as going to the gym). Because it is possible to exergame from home, certain barriers could be removed, such as no training facilities nearby, cost, and barriers related to the weather.

Motivations for patients with HF to be physically active may also have psychosocial reasons[10], for example if friends/partner are not interested in physical activity. Exergaming was seen as an experience that could be shared with the family, especially with grandchildren[74], which could motivate patients with HF to become more physically active.

Only three studies conducted interviews with adults about their experiences of exergaming. The first study[96] reported experiences of exergaming in patients with multiple sclerosis. Exergaming helped them build confidence in abilities and to achieve goals related to engagement in leisure activities, and removed barriers associated with going to a gym to exercise. However, exergaming also induced initial reactions of intimidation and worries about falling, and feedback during game play reminded participants of their impairments. The second study[90] looked at the experiences with exergaming of older adults with depression. The study found that some participants started out by feeling very nervous about how they would perform in exergaming and about whether they would be able to understand the technical aspects of exergaming. After learning to exergame, most participants reported that they were satisfied with their ability to play. They enjoyed the fact that exergaming was fun and varied and were challenged to do better when they saw progress. The third study[87] looked at the eperiences of older adults with impaired balance.

The study found that the participants enjoyed playing the exergames and they experienced the games as motivating.

One scoping literature review[74] and a case study[72] (including one patient with HF in an exergame intervention) showed that this field is still small and under development, but exergaming might be a promising way to enhance physical activity in patients with HF. However, further testing is needed and it is also important to get more in-depth knowledge of the patients' preferences, attitudes, use and abilities in regard to exergaming.

Rationale for this thesis

As previously described in the introduction and background, it is known that physical activity is important for patients with HF to improve well-being and exercise capacity and to decrease hospitalization and mortality. However, patients with HF are less active compared to healthy adults. In order to promote physical activity in patients with HF, it is essential to know how physically active they are and to understand their motivations and self-efficacy and how these concepts are related. Motivation and self-efficacy not only affect exercise participation, but also are critical in adherence to physical activity recommendations. There is a knowledge gap with regard to what specific motivations and barriers patients with HF experience and possible gender differences. Also, no studies have specifically explored the relation between motivation and physical activity and the influence of self-efficacy on this relation in patients with HF.

To improve and increase physical activity in patients with HF, alternative approaches to motivate and increase self-efficacy to physical activity are needed. One new approach in physical activity interventions is exergames (games to improve physical exercise).

Playing exergames could increase heart rate, oxygen uptake and EE from resting, and may facilitate the promotion of light to moderate physical activity. The use of these exergames might be an opportunity for patients with HF to increase physical activity at home and could increase motivation (since it is fun to exergame with the family) and remove barriers (no sports facilities nearby, bad weather), and therefore increase self-efficacy. No research has been done on potential clinical benefits.

AIMS

The overall aim of this thesis was to describe physical activity in patients with HF, with special focus on motivations and self-efficacy in physical activity, and to describe the potential of exergaming to improve exercise capacity.

The specific aims were:

Study I: To evaluate physical activity in patients with HF and describe the factors related to physical activity. An additional aim was to examine potential barriers and motivations to physical activity, and possible sex differences related to them.

Study II: To examine what kind of role exercise self-efficacy plays in the relationship between exercise motivation and physical activity in patients with HF.

Study III: To assess the influence of the exergame platform Nintendo Wii on exercise capacity and daily physical activity in patients with HF, and to study factors related to exercise capacity and daily physical activity, and to assess patients' adherence to exergaming.

Study IV: To explore the experiences of patients with HF using an exergame platform at home.

METHODS

Design

The thesis includes three quantitative studies and one qualitative study. An overview of the design, participants, data collection, data analyses and time of data collection is shown below (Table 3).

Table 3 Overview of designs and methods study I - IV

	Study I	Study II	Study III	Study IV
Design	Cross-sectional	Cross-sectional	Pilot intervention study	Qualitative study
Participants	154 patients with HF	101 patients with HF	32 patients with HF	14 patients with HF
Data collection[1]	Questionnaires	Questionnaires	6MWT, Activity monitor, questionnaires, daily diary	Interviews
Data analyses	Kruskal-Wallis test, student's t-test, one-way ANOVA, paired sample t-test	Spearman's correlation, logistic regression	Kruskal-Wallis test, student's t-test, one-way ANOVA, paired sample t-test	Inductive content analysis
Time of data collected	May 2014 – July 2014	Jan 2015 – March 2016	May 2012 – August 2013	June 2014 – April 2016

HF, Heart Failure; 6MWT, 6-Minute Walking West; ANOVA, ANalysis Of VAriance

[1] The measures are presented in table 4

Sampling and participants

All patients included in this thesis had been diagnosed with HF by a cardiologist according to the European Society of Cardiology guidelines[97] and were living in their own homes. Additional inclusion criteria were: (i) being 18 years or older (no upper age limit); (ii) being able to speak and understand Swedish; (iii) being able to fill in the data collection material; (iv) having a life expectancy longer than six months. In studies III and IV, additional exclusion criteria were: (i) being unable to use the exergame due to visual impairments (see a TV screen at a distance of 3 m); (ii) having a hearing impairment (the patient was not able to communicate by telephone); (iii) having a cognitive impairment (assessed by a nurse or cardiologist) and/or (iv) motor impairment (the patient should be able to swing his/her arm at least 10 times in a row).

Setting and procedure

In study I, 300 patients with HF (diagnosis codes I50.0 and I50.9) from an HF clinic at a county hospital in Sweden were invited to fill in questionnaires on physical activity The patients received the invitation letter and questionnaires by post and were asked to return a signed informed consent and the questionnaires in a prepaid envelope.

In studies II & IV, patients were enrolled at the four Swedish study sites of the HF-Wii study (ClinicalTrial.gov, identifier: NCT01785121).

In study III, patients were recruited from an HF clinic in a county hospital in Sweden and data were collected.

Data collection

Data in studies I, II, and III were systematically collected using questionnaires. In study III, the 6-minute walking test (6MWT), an activity monitor and a daily diary were used additionally (Table 4). Data were collected by interviews in the qualitative study (IV).

Background variables and participants' characteristics such as age, gender, education, marital state, were collected by a questionnaire. Study nurses collected data on clinical variables such as NYHA-class, comorbidity, and medication from the patients' medical charts. Additional data was collected using self-reported questionnaires (I, II, III), activity monitoring (III), 6-minute walking tests (III), daily diaries (III) and interviews (IV).

Table 4 Variables and measures used in studies I, II and III

Variable	**Objective measures**	**I**	**II**	**III**
Exercise capacity	6 minute walking test[98]			X
Physical activity	Activity monitor[99]			X
	Subjective self-reported measures			
Physical activity	s-IPAQ[100]	X		
	One self-reported question[101,102]		X	X
Exercise motivation	Exercise Motivation Index[103]	X	X	X
Exercise self-Efficacy	Exercise Self-efficacy Scale[104]	X	X	X
Anxiety and depression	HADS[105]			X
Time spent exergaming	One self-reported question			X
Perceived Physical Effort	Borg's scale[106]			X
Heart failure symptoms	Visual Analogue Scale			X
Global well-being	Cantril's ladder of life[107]			X

s-IPAQ, short form International Physical Activity Questionnaire; HADS, Hospital Anxiety and Depression Scale.

Objective measures

Daily physical activity was monitored with an activity monitor (III); the DirectLife Triaxial Accelerometer for Movement Registration (TracmorD) (Philips New Wellness Solutions, Lifestyle Incubator, the Netherlands)[99], which measures daily physical activity by registering body acceleration in three directions: up and down, side to side and front to back. These registered body accelerations were translated into kilojoules (kJ), taking age, gender, height and weight into account. This instrument has been found valid and reliable.[99]

Exercise Capacity (III) was assessed the 6MWT[108] at baseline and 12 weeks after having access to an exergame platform. The 6MWT is a simple, low-cost method for estimating exercise capacity; only a pre-measured level surface and a timing device are needed. The mode of exercise (walking) is familiar to patients, although it may represent a maximal test for some. The test has appeared to be useful for assessing other interventions, such as cardiac resynchronization, and has strong predictive power for both mortality and morbidity. A 30-meter difference in the 6-MWT (based on self-rated physical function) between baseline and 12 weeks was considered clinically relevant.[109] A recent study stated that the minimal difference of importance for 6MWT distances among patients with chronic HF is around 36 meters.[110]

Subjective measures

Physical activity was measured with the short form International Physical Activity Questionnaire (s-IPAQ) (I), with a self-reported question (II).

The s-IPAQ[100,111] contain seven items for identifying the frequency and duration of light, moderate, and vigorous physical activity as well as inactivity during the past week. The questions focus on four activity types: 'vigorous activity' periods for at least 10 min; 'moderate activity' periods for at least 10 min, 'walking' periods for at least 10 min, and time spent 'sitting' on weekdays. Frequency of activity is measured in days, and duration in hours and minutes. The answers to the questions were transformed into Metabolic Equivalent of Tasks (METs), or simply metabolic equivalents, a physiological measure expressing the energy cost of physical activities defined as the ratio of metabolic rate and therefore the rate of energy consumption. The total physical activity score is the sum of vigorous, moderate, and walking physical activity scores. The patients were classified into three physical activity categories: low, moderate, and high. Typical s-IPAQ correlations with an accelerometer were 0.80 for reliability[100,111]. The s-IPAQ is validated for people in the 18–69 age range, and an additional analysis was performed in study I to see whether there were significant differences in the total score of the scale between patients with HF younger than 69 and those older than 69. No differences were found in the total METs (*P*-value = .71).

The self-reported question to measure *physical activity* was: Over the past week (even if it was not a typical week), how much time did you exercise or were you physically active (e.g., strength training, walking, wimming, gardening, or other type of training)? The answer possibilities were (1) None; (2) Less than 30 minutes/week; (3) 30-60 minutes/week; (4) More than one up to three hours/week; (5) More than three hours a week. More than 60 minutes a week was defined as being physically active, less than 60 minutes was defined as not being physically active. The single-item question that was used was easy to complete and construct, face and content validity have previously been established and have been used in several previous studies.[101,102]

Exercise Motivation was assessed with the Exercise Motivation Index (EMI) (I, II, III)[103]. The index consists of 15 statements followed by a five-point rating scale for each statement, ranging from 0 (not important) to 4 (extremely important). Summing the scores for physical, psychological, and social motivation, and dividing them by the number of statements for each area calculated three sub scores. The Swedish version of the index is valid and reliable[103] and the Cronbach's alpha of the EMI in this thesis was between 0.89-0.92. For presentation reasons, in study I the response alternatives in the EMI were dichotomized. Response alternatives 0 (not at all important) – 2 (important) were combined as indicating no or little motivation, and response alternatives 3 (very important) and 4 (enormously important) were combined as a motivation.

Exercise Self-efficacy was measured with the Exercise Self-Efficacy Scale (I, II, III).[104,112] The questionnaire assessed self-efficacy beliefs towards potential barriers to exercise. These barriers were work schedule, physical fatigue, boredom related to exercise, minor injuries, other time demands, and family and home responsibilities, and consisted of nine situations that might affect participation in exercise. For each situation, the patient used a scale ranging from 1 (Not Confident) to 10 (Very Confident) to describe their current confidence in being able to exercise for 20 minutes, three times a week. The instrument is reliable and valid[104,112], Cronbach's alpha of the Exercise Self-Efficacy Questionnaire in this thesis was between 0.89-0.93. For presentation reasons, in study I, the response alternatives in the Exercise Self-Efficacy Scale were dichotomized. The response alternatives 1 (not confident) – 5 were combined to indicate a potential barrier, whereas the response alternatives 6–10 (very confident) were combined to indicate no potential barrier. Based on the literature, four additional potential HF-specific barriers were added in study I; in spite of poor weather, in spite of experiencing HF symptoms, in spite of experiencing side effects of the medications, afraid of getting hurt through exercise.

Anxiety and Depression were assessed with the Hospital Anxiety and Depression Scale (HADS)(III).[105] The HADS is a valid and reliable instrument used to assess the prevalence of emotional distress among patients with HF. The scale consists of 14 items in two sections, where seven items measure anxiety (HADS-A), and the remaining seven items measure depression (HADS-D). These are rated on a four-point scale with different response options for each question, and with a theoretical range of 0 to 21 in each group. This test can validate the existence of symptoms and evaluates their severity.[113] The item-to-subscale reliability correlations are reported as ranging from 0.41 to 0.76 for the anxiety items and 0.30 to 0.60 for the depression items.[105]

A daily diary (III) used for 12 weeks assessed the *time spent exergaming, the perceived physical effort, HF symptoms (fatigue, shortness of breath) during exergaming, and global well-being.*

Time spent exergaming per day was measured with a daily diary where the patients were asked to report the number of minutes they played every day for 12 weeks.

Perceived physical effort in relation to playing Wii was measured with the Borg's Rating of Perceived Exertion (RPE)(III).[106] The RPE is a valid and reliable instrument based on a subjective feeling of exertion and fatigue during exercise, and it is used to assess and regulate exercise intensity. The patients were asked to give a numerical value on a scale from 6 (no exertion at all), to 20 (maximum effort). This instrument had a significant association between heart rate and exergaming[114] and was found to be valid and reliable in patients with HF.[55]

Heart failure symptoms (fatigue, shortness of breath) when playing Wii were measured with a numeric rating scale ranging from 10 (worst experienced fatigue, shortness of breath), to 0 (no experienced fatigue or shortness of breath whatsoever). This measure is valid and has been used in previous studies.[115]

Global Well-being was assessed with Cantril's ladder of life.[107] Patients rated their sense of well-being on a ladder, with 10 reflecting the best possible life imaginable and 0 reflecting the worst possible life imaginable. A higher score indicated better well-being. This instrument had been used in various cardiovascular studies and is considered to be a valid measurement of global well-being.[116]

Interviews

Interviews (IV) were performed by two research assistants, who were not part of the HF- Wii study team. The interviews were performed in the patients' homes or in a quiet room at the hospital, depending on the preference of the patient. With permission, the interviews were tape-recorded and transcribed verbatim for data analyses.

To explore the *experiences of patients with HF in exergaming*, initially, a question was asked: 'Tell me about your experiences when using the game computer?' Subsequently, questions were asked about exergaming and various aspects of it, exploring preferences, attitudes, use and abilities. Follow-up questions were used in which the patients were asked to develop their descriptions. Methodological rigor in the qualitative study was aimed for by following guidelines outlined for qualitative research.[117] Awareness of preconceptions was emphasized throughout the study, testing rival explanations and being open to variations in coding of the data. Presenting quotations offered insight into what was said and further elucidated the findings. Recording and transcribing interviews verbatim and using open coding initially, based on words, increased trustworthiness. Attempts at confirmability included researcher reflexivity, and a journal was kept in which ideas about relationships between categories were recorded. In addition, a systematic approach to analysis was used which allowed investigators to share and explore together charted data.[118]

Exergaming intervention

The pilot intervention study (III) and the qualitative study (IV) described the use and experiences of an exergame platform: Nintendo Wii (Nintendo Company Ltd., Kyoto, Japan). This is a platform with a wireless controller (the Wii Remote: 148 × 36.2 × 30.8 mm), which connects to the Wii console (159 × 44 × 216 mm) through Bluetooth. The Wii remote enables patients to interact with the Wii console through movements. The patients in the studies used the game-series 'Wii Sports', which includes the following games: bowling, tennis, baseball, golf, and boxing.

The patients learned how to use the Wii during a one-hour instructor-led introduction session at the hospital. The Wii console was installed in the patient's home one week after the introduction, and an instructor demonstrated how to use it once more. After the installation, the patients were encouraged to play exergames for 12 weeks. They could decide for themselves to exergame alone or with others. Safety guidelines were discussed and provided in writing (e.g., use the wrist strap during exergaming). Patients were advised to exergame for 20 minutes per day in the pilot study (III), and they could increase their time playing if they felt good. No problems occurred in the pilot study (III) and most patients were more active than 20 minutes per day. To increase the possible effects of physical activity, patients were advised to exergame for 30 minutes a day, five days a week in the larger RCT (HF-Wii[119]) from which the qualitative data were collected (IV). During the 12 weeks, the instructor was available for questions and telephone guidance for two hours per day during workdays. In case of medical problems, the patient was instructed to call the HF nurse. After finishing the study after 12 weeks, the patients in the pilot study were offered to the choice of buying or returning the Wii. In the HF-Wii study (IV), the patients could keep the exergame platform after the study termination.

Data handling and analysis

Missing data

In general, missing values were not replaced in the analyses unless how to do so was stated in the instructions of the instrument.

With regard to the activity monitoring (III) no specific instructions were available, and if there were more than three missing values per week on the activity monitor data, that week was excluded from the analyses. If there were three days or less of missing values in a week, these values were replaced with the mean kJ/day the patient expended in that specific week.

If data were missing on the 6-minute walking test in the pilot study (III), either due to drop-out or problems performing the test, these patients were treated as 'no increase'.

Data analyses

For analyses of quantitative data SPSS versions 22 or 23 were used. Descriptive statistics were used to characterize samples. In the descriptive analyses, means and standard deviations (or range) were calculated for continuous data, and absolute numbers and percentages were computed for nominal variables.

In studies I and III possible differences were analyzed by Kruskal-Wallis analysis, Student´s t-tests and one-way analysis of variance (ANOVA) for unpaired data, where appropriate. For paired data the paired sample t-test was used. Differences were considered statistically significant at P-value < 0.05.

To examine the mediation and moderation effects (II), Spearman's correlation was initially calculated, and correlations with a significance level lower than 0.10 were included in the regression analyses. Secondly, a simple mediation model was specified (Figure 2). To reveal the mediation effect an analysis was conducted into whether motivation affected physical activity through exercise self-efficacy. Logistic regression analyses were made to examine the moderation and/or mediation effect of exercise self-efficacy on the relation between exercise motivation and the amount of physical activity. For the possible mediation effect, the first equation regressed the mediator exercise self-efficacy on the amount of physical activity (independent variable) (Pathway c Figure 2). The second equation regressed the dependent variable exercise motivation on the amount of physical activity (Pathway a in Figure 2). The third equation regressed the dependent variable on both the independent and the mediator variables (Pathway b/c in Figure 2).

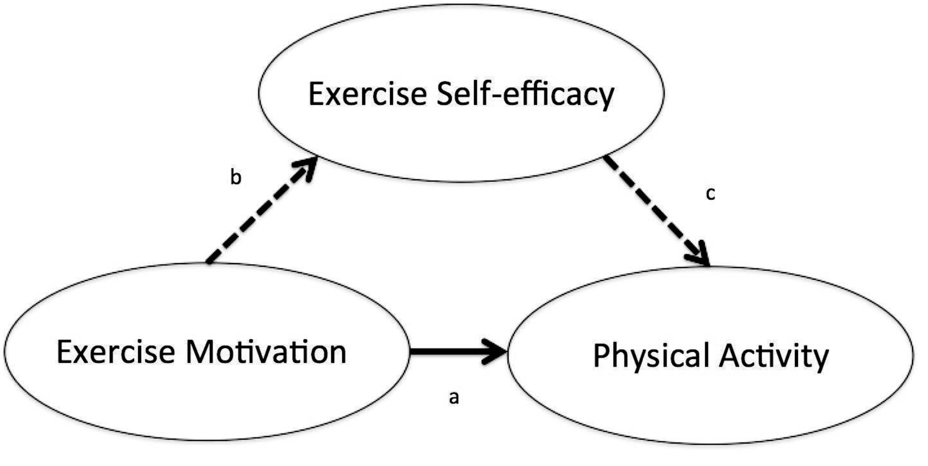

Figure 2 Hypothetical mediation involving physical activity, exercise self-efficacy and exercise motivation

To explore the moderation effect an analysis was conducted into whether the effect of motivation on physical activity was dependent on exercise self-efficacy. For the possible moderation effect, first, an equation regressed the moderator exercise self-efficacy on the amount of physical activity (Pathway a, Figure 3). Subsequently, the dependent variables of exercise motivation and exercise self-efficacy, and the interaction between exercise motivation and exercise self-efficacy (using mean centered variables) were regressed on the amount of physical activity (Pathway d, Figure 3). If mediator and/or moderation effects were found, the regression model was controlled for age, gender and NYHA-class. These variables were included based on former research in older adults and patients with HF.[5,47]

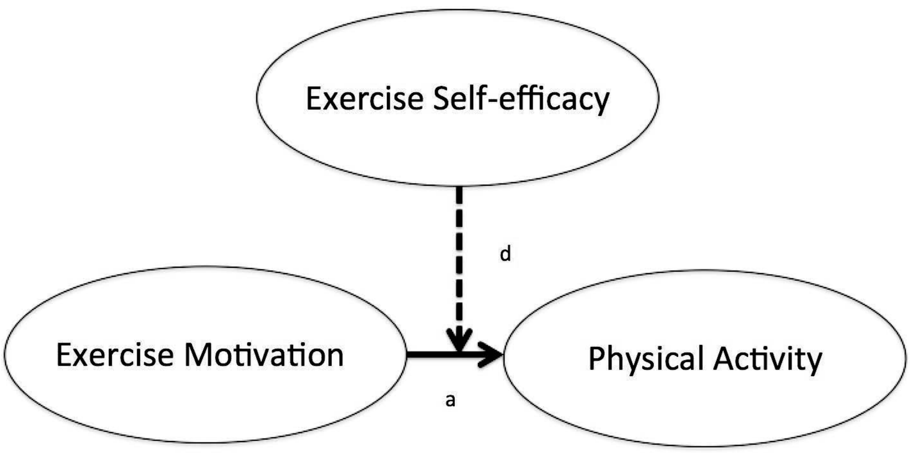

Figure 3 Hypothetical moderation involving physical activity, exercise self-efficacy and exercise motivation

Inductive content analysis was used in the qualitative study (IV) using the steps described by Elo and Kyngäs.[118] First, the interviews were read repeatedly to get an overall understanding of the whole. All of the authors read four of the transcribed interviews separately and extracted meaningful units in the text that described experiences with exergaming. Subcategories and categories were developed inductively. The authors discussed their impressions of the text and the selection of meaningful units in order to establish a mutual basis for the analysis. Throughout the analysis, there was a constant movement between the parts of the analysis to the text of the whole interviews.

Sample sizes

Study I examines the physical activity in patients with HF and their motivations and self-efficacy in physical activity. The relationships between these three factors were analyzed. A good power requires 50 patients for each factor measured, according to Pedhazur's and Schmelkin's[120] rule of thumb. Therefore, 150 patients needed to be included in study I. Previous surveys have shown the response rate of patients with HF in Sweden to be 33%–65%[121-123]; for this reason, 300 patients were approached, and 154 were included (I).

Study II includes the baseline measurements in the on-going HF-Wii study[119]; therefore, this sample was the number of patients included at time of the analyses. Because a full mediation was detected in study I, and therefore a large effect detected in this study, this study has a sufficient number of patients (n = 101).[124]

Literature suggests that a pilot study sample (III) should be 10% of the sample projected for the HF-Wii study[119], while other research has suggested 10-30 patients[125-127]. In the HF-Wii study[119], sample calculation is based on a difference of 30 meters between the control group and the Wii group (which is described to be a clinically significant difference in patients with HF based on 80% power, 5% significance). A total of 250 patients in the intervention group and 250 patients in the control group are needed. To ensure appropriate patient numbers at the end of the study, 2 * 300 patients will be included. For these reasons, 32 patients were chosen to include in the pilot study (III) (10% of 300 patients needed in the Wii group of the HF-Wii study[119]).

A purposive sample of 14 patients was chosen in the qualitative study (IV) in order to include sufficient variation to represent the group of patients with HF with access to an exergame platform in the HF-Wii study.[119]

Ethical approval and considerations

All studies in the thesis were conducted according to the principles of the Declaration of Helsinki and in accordance with the Medical Research Involving Human Subjects Act in Sweden (Regionala etikprövningsnämnden i Linköping; Dnr: 2010/412-31; 2012/247-31; 2014/292-32). Written informed consent was contained from all patients and it was clarified that the patients could terminate their participation at any time, and that this would in no way affect their care. If patients were expected to send any material to the research team, prepaid envelopes were provided. The HF-Wii study, which studies II and IV were part of, is registered in ClinicalTrial.gov, identifier: NCT01785121. Participation was free of charge.

Data collection was carried out through questionnaires and the patients in the studies were guaranteed confidentiality. A potential risk was that data collection via questionnaires and interviews could be perceived as burdensome. The number of measures was carefully considered in order to limit the number of questions as much as possible. Respect was paid to the patients' privacy and serious health conditions.

Shortness of breath and fatigue can occur during physical activity in patients with HF, and therefore also during exergaming (III & IV).

However, since shortness of breath and fatigue can occur at any time in patients with HF and was therefore not a direct risk of this study.

There is a minor risk of falling during exergaming (III & IV). To minimize this risk, patients with balance problems were excluded, the research team looked at the safety in the patients' homes and if necessary secured the home environment (e.g., no loose rugs or furniture in the way). Additionally, safety guidelines were provided verbally and in written form.

To avoid patients were feeling obliged to participate in the interviews, the people who interviewed them had not been previously involved in the study and were not their health care providers. The risk of identification of participants in study IV was considered. For this reason, patients were selected from three different centers in Sweden included in the HF-Wii study.[119]

RESULTS

Research population

All patients in this study were diagnosed with HF and their mean age ranged between 67 and 70 years and there were slightly more men than women. All patients in the studies lived in their own home, between 66-90% were married or in a relationship and most patients were in NYHA-class II and III (between 88% - 100%) (Table 5).

Table 5 Background characteristics of the patients in the studies

	Study I N = 154	Study II N = 101	Study III N = 32	Study IV N = 14
Age (years)	70 (±10)	67 (±13)	63 (±14)	70 (±8)
Female gender	41 (27%)	14 (39%)	10 (31%)	6 (43%)
Marital status				
Married/in a relationship	25 (66%)	68 (67%)	27 (90%)	11 (79%)
Children	-	81 (80%)	29 (97%)	-
Grandchildren	-	-	23 (82%)	11 (79%)
Education				
Higher than secondary school	30 (20%)	21 (21%)	18 (57%)	4 (29%)
NYHA-class				
- I	-	4 (4%)	-	-
- II	22 (71%)	55 (55%)	22 (71%)	12 (86%)
- III	9 (29%)	33 (33%)	9 (29%)	2 (14%)
- IV	-		-	-

NYHA-class, New York Heart Association functional classification

Physical activity and related factors

In total 34% of the patients had low physical activity (<600 METS; less than 30 minutes of moderate intensity physical activity on most days of the week) (I) and 42% of the patients reported that they were physically active less than 60 minutes per week (II).

Table 6 Differences between patients with heart failure with low and high weekly physical activity levels, and high physical activity level.

	Low physical activity[1] N = 53	High physical activity[2] N = 35
Age (years)	71 (±9)	72 (±11)
Female gender	30 (38%)	11 (31%)
Marital status		
Married/in a relationship	25 (66%)	25 (71%)
Education		*
Higher than secondary school	6 (11%)	8 (23%)
NYHA-class[3]		
- I	5 (9%)	2 (6%)
- II	9 (17%)	12 (34%)
- III	17 (32%)	6 (17%)
- IV	1 (2%)	2 (6%)
Comorbidity[4]	37 (79%)	23 (70%)

* *P*-value < .05

[1] Low Physical Activity: <600 METS (less than 30 minutes of moderate intensity physical activity on most days)

[2] High Physical Activity: (≥3000 METS) (at least one hour per day of moderate-intensity activity or half an hour of vigorous-intensity activity)

[3] For patients not represented, the NYHA-class was missing

[4] Comorbidity was defined as having two or more diseases

NYHA-class, New York Heart Association functional Classification

Physical activity was significantly associated with the level of education (I). Patients with a high physical activity level (n = 29, 55%) had significantly higher education, compared to patients who only completed primary school (n = 9, 26%; *P*-value = .04) (Table 6).

The amount of physical activity was also significantly related to motivation (r = .21, *P*-value = .04) (II) and exercise self-efficacy (r = .30, *P*-value < .01) (I). Patients with a high physical activity level had higher exercise self-efficacy (mean 2±1) and higher exercise motivation (mean 4±2) compared to patients with a low physical activity level (mean 3±2 and mean 1±1, *P*-value = .01).

No differences were found between patients with a high physical activity level and patients with a low physical activity level with regard to sex (*P*-value = .54), NYHA-class (*P*-value = .13), or comorbidity (2 or more diseases) (*P*-value = .26) (Table 6) (I).

Self-efficacy and motivations for physical activity

With regard to self-efficacy, most of the patients (68% - 85%) had no confidence in overcoming all the potential barriers (I). The potential barriers that were most difficult to overcome in 80% or more of the patients were: “Suffering from minor injuries”, “Need to spend time on other things”, “Need to spend time on family responsibilities” “Feeling physically tired”, and “Working long hours” (I).

The potential barriers that were seen as easiest to overcome were: “Family is not interested in exercise” and “Being afraid of getting hurt through exercise”. No differences were found in potential barriers between men and women (I).

With regard to motivations, two out of the 15 motivations for physical activity were experienced by more than 50% of the patients with HF: "I want to be healthier and perhaps live longer" and "I want a slower aging process and to feel younger" (I). The motivations that were experienced by less than 20% of the patients were: "People who are fit are admired, I want to be admired too", "I want to look good", "Everyone else exercises, I want to do that too". Social motivations for exercise were rated in 22% of the patients as important, the physical motivations were expressed to be important by 33%, and the psychological motivations were rated as the most frequent ones for being physically active (41%).

Men and women differed significantly in the total amount of motivation and the subscales of motivation (social motivation, physical motivation, and psychological motivation) (I). Women had higher total motivation than men (mean 2.1 ± 2.4 vs. mean 1.7 ± 2.0, *P*-value = .01), higher social motivation than men (mean 1.7 ± 1.0 vs. mean 1.2 ± 0.9, *P*-value = .02), higher physical motivation than men (mean 2.5 ± 1.0 vs. 2.1 ± 1.0, *P*-value = .04), and higher psychological motivation than men (mean 2.2 ± 1.0 vs. 1.8 ± 1.1, *P*-value = .02). Women significantly more often expressed two motivations compared to men: "I am proud of myself when I take regular exercise" (53% vs. 31%, *P*-value = 0.01) and "I feel more successful when I am in good shape" (39% vs. 24%, *P*-value = .05).

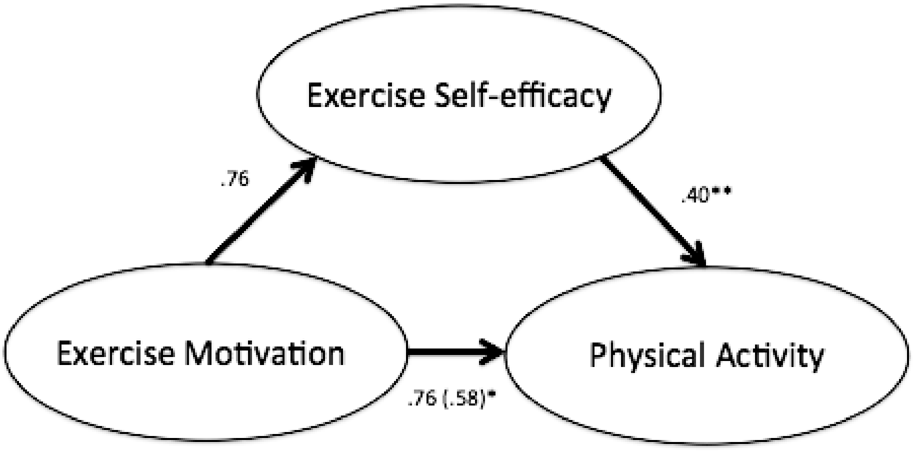

Figure 5 Simple mediation model in 101 heart failure patients. *P-value < .05, **P-value <.01; Direct effect in parentheses.

When studying the relationship between motivation and physical activity and the potential role of self-efficacy on this relation, it was found that motivation predicted physical activity (b = .58, P-value = .02) (II). After controlling for exercise self-efficacy, the relation between motivation and physical activity did not remain significant (b = .76, P-value = .06), indicating full mediation (Figure 5). Full mediation means that with the inclusion of self-efficacy the relationship between motivation and physical activity dropped to zero. Rather than a direct causal relationship between motivation and physical activity, motivation influences self-efficacy, which in turn influences physical activity. Thus, self-efficacy serves to clarify the nature of the relationship between motivation and physical activity.

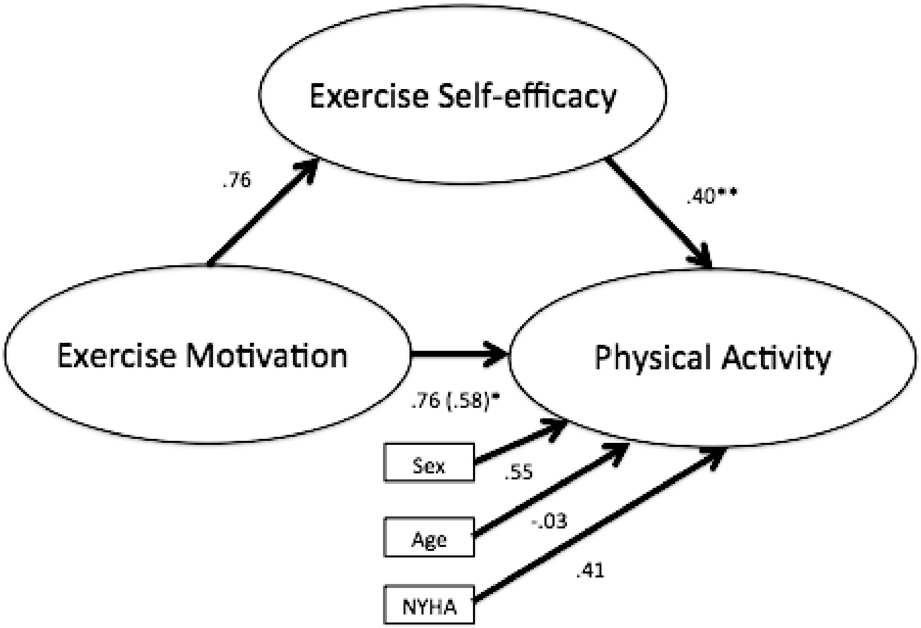

Figure 6 Simple mediation model in 101 heart failure patients. **P*-value < .05, ** *P*-value < .01; Direct effect in parentheses. Control variables were sex, (men = 1, women = 2), age and New York Heart Association functional classification

This mediation effect was controlled for age, sex and NYHA-class (Figure 6) (II). Sex (b = .55, *P*-value = .36), age (b = -.03, *P*-value = .22) and NYHA-class (b = -.41, *P*-value = .46) did not have a significant association with the amount of physical activity, but adding them to the model increased the explanatory value (R-square) of the model (Figure 6). Together, 24% of the variance in the amount of physical activity was explained (R^2 = .17 if sex, age and NYHA-class were not included as covariates).

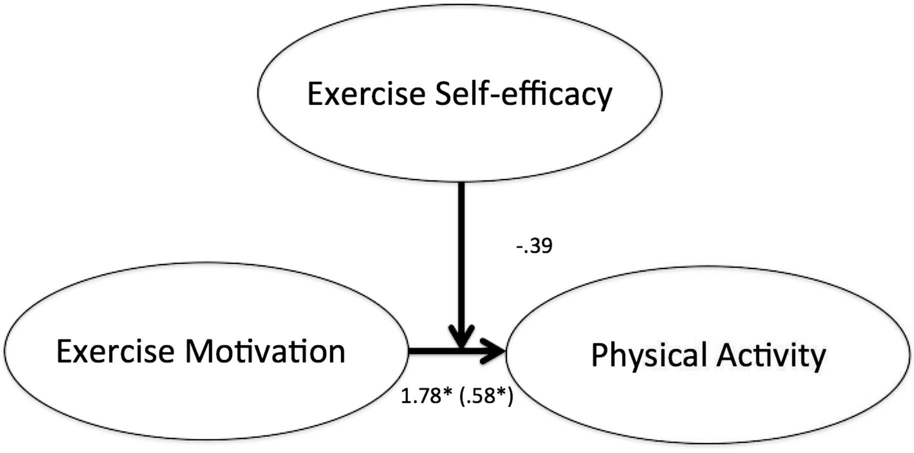

Figure 7 Simple moderation model in 101 heart failure patients. **P*-value < .05, ***P*-value < .01; Direct effect in parentheses.

When studying whether self-efficacy was a moderator in the relation between motivation and physical activity, self-efficacy did not significantly interact with motivation in explaining physical activity (Figure 7) (II). After including the interaction term (motivation * self-efficacy), the relation between motivation and physical activity changed from b = .58 (*P*-value = .02) to b = 1.78 (*P*-value = .02), but the interaction between self-efficacy and motivation was not significant (b = -.39, *P*-value = .10) (II, figure 7). This means that the relation between motivation and physical activity does not depend on self-efficacy. Because there was no moderation effect, the model was not further explored by adding the covariates sex, age and gender.

Exergaming

Exercise capacity

A clinically significant difference of 30 meters difference in the 6MWT was found in 53% of the 32 patients (n = 17) between baseline and three months. In total, nine patients (28%) decreased the distance walked (−69 m ± 28 m) on the 6MWT (III). Furthermore, five patients could not perform the 6MWT at three months due to medical problems; one had developed lung cancer, one was too tired to walk, one experienced pain in the hip, and two had pain in the legs. Only comorbidity was significantly (*P*-value= .01) related to the number of meters walked in the 6MWT at baseline (427 ± 102), compared to patients without comorbidity (524 ± 82) (III).

When studying the factors related to exercise capacity it was found that patients who increased their walking distance in the 6MWT were in a significantly lower NYHA-class (78% NYHA-class II), and had been diagnosed for a significantly shorter period of time (56% had been diagnosed within the last year), compared to the patients who decreased their walking distance in the 6MWT (44% NYHA-class II, *P*-value = .02); 22% diagnosed within the last year, *P*-value = .04). No other factors related to change in 6MWT were found (Table 7).

Table 7 Comparisons between patients who decreased or increased on the 6MWT after an exergame intervention, and between patients who exergamed less than the median exergaming time or more than the median time.

	↓6MWT N = 9	↑6MWT N = 18	↓Exergaming N = 15	↑Exergaming N = 15
Age (years)	67 (±17)	61 (±13)	63 (±15)	65 (±14)
Female gender	3 (33%)	7 (39%)	7 (47%)	3(20%)
Marital status				
Married/in a relation-ship	9 (100%)	16 (89%)	12 (80%)	6 (40%)
Children	9 (100%	16 (89%)	14 (93%)	14 (93%)
Grandchildren	7 (78%)	14 (78%)	10 (67%)	13 (87%)*
Education				
Higher than Secondary school	4 (44%)	13 (72%)	12 (80%)	6 (40%)
NYHA-class		*		
- I	-	-	-	-
- II	4 (44%)	14 (78%)	11 (73%)	9 (60%)
- III	5 (56%)	4 (22%)	4 (27%)	5 (33%)
- IV	-	-	-	-
Time after diagnosis (months)		*		
Less than a year	2 (22%)	10 (56%)	8 (53%)	6 (40%)
Comorbidity	3 (33%)	4 (22%)	3 (20%)	5 (33%)

* *P*-value < .05

NYHA-class, New York Heart Association functional Classification

6MWT, 6-Minute Walking Test

Daily physical activity

At baseline, the patients in the pilot study expended 2368 ± 847 kJ/day, and at three months they expended 2807 ± 1807 kJ/day, with no significant difference between those weeks (*P*-value = .29) (Figure 8) (III).

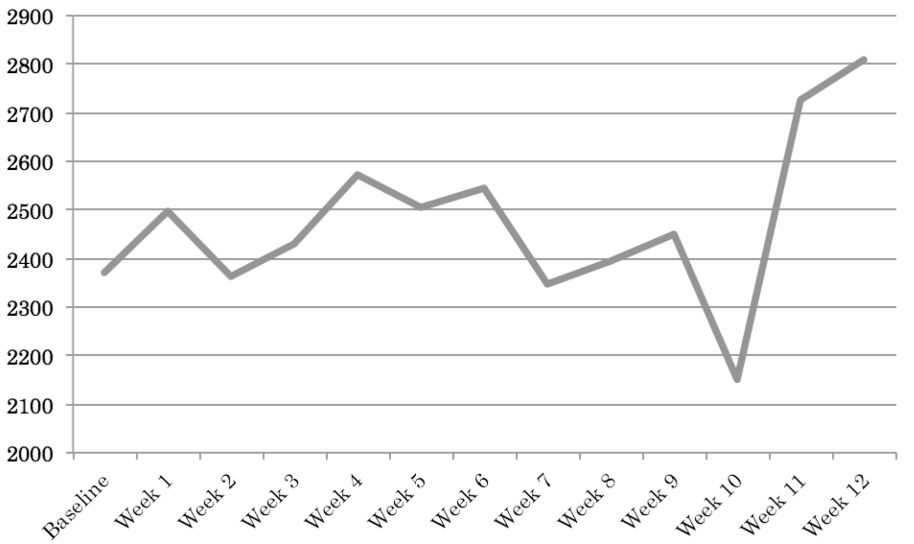

Figure 8 The amount of kilo joules expended in 32 patients with heart failure at baseline and after 12 weeks of having an exergame platform at home.

A trend is shown towards a gradual increase in EE, with the amount of EE fluctuating over the 12-week study period. No factors (age, gender, marital status, education eve, NYHA-class or comorbidity) were found to be related to the number of kJ the patients expended per day, or the change in kJ expended over the 12-week study period.

The time spent exergaming

The time patients spent exergaming was on average 28 ± 13 minutes per day, with a median of 27 minutes (Figure 9) (III).

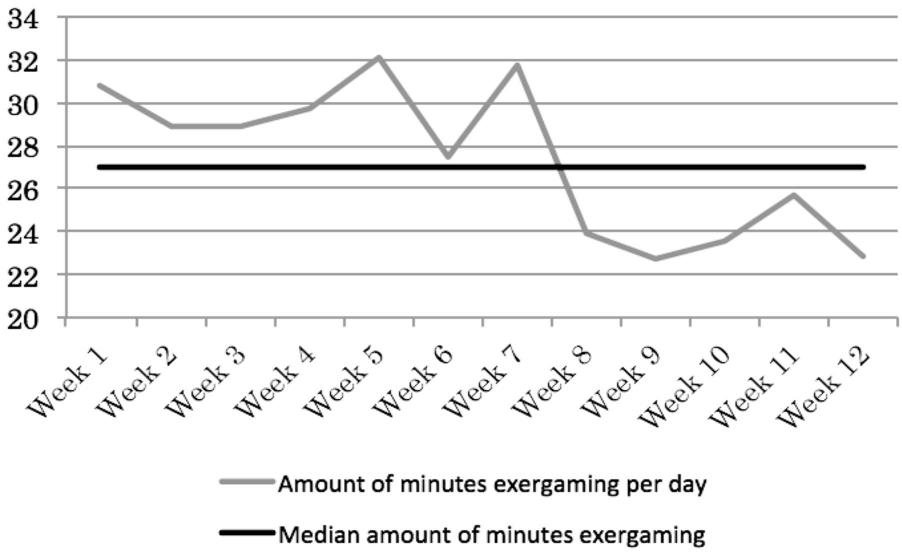

Figure 9 The number of minutes spent exergaming in 32 patients with heart failure for 12 weeks using an exergame platform at home

The number of minutes spent exergaming per week fluctuated over time, and patients gradually decreased this number. Two patients stopped exergaming during the study, without giving a reason (both female, 63 and 57 years old).

On average, male patients exergamed for more minutes per day (32 ± 12 minutes) than female patients (19 ± 11, *P*-value = .03), while there was no significant difference in age between the men (68 ± 14) and the women (58 ± 14, *P*-value = .09). When the first six weeks of access to the exergame platform were compared to the last six weeks, we found that both male and female patients had decreased the time spent exergaming. However, no sex differences were found regarding the decrease in number of minutes spent exergaming (−5 ± 9).

The data also showed a trend that patients who exergamed longer than the median time were more often married or in a relationship (*P*-value = .08), and had a lower educational background (*P*-value = .07) than patients who exergamed less than the median time (Table 7). Patients who exergamed longer than the median time, more often had grandchildren compared to patients who exergamed less than the median time (P-value = .02) (Table 7).

The experiences of exergaming

In the analysis of the experiences of exergaming the categories found were (IV): (i) making exergaming work, (ii) added value of exergaming, (iii) less appeal of exergaming (Figure 10) (IV).

Making exergaming work	Added value of exergaming	Less appeal of exergaming
• Exergaming was easy due to the introduction • Exergaming due to feeling obligated towards research team • Setting goals in exergaming • Finding routines in exergaming • Difference in intensity between the exergames • Knowing the sport in real life helped • Virtual environment in exergaming was realistic	• Feeling enjoyment during exergaming • Exergaming is convenient to use at home • Exergaming increase physical fitness • Exergaming allowed the involvement of others • Mastering exergames better over time • Challenged to improve when exergaming	• Feeling too tired to exergame • Exergaming is boring • Exergaming gives too little fitness • Want to be active in groups instead of exergaming alone • Exergame less over time • Other things take time away from exergaming

Figure 10 Categories and subcategories describing the experiences of patients with heart failure in exergaming

Making exergaming work

The introduction session and installation of the exergame platform at home was experienced as helpful to start exergaming. A reason for exergaming was a feeling of obligation to the research team to exergame for 12 weeks (intervention period). Patients said that after receiving the exergame platform at home, they found a routine and exergamed for 30 minutes a day, five days a week. Furthermore patients with HF described the challenges in finding routines to include exergaming in their daily life.

"Sometimes I thought it was good to do it (exergaming) right away in the morning. Later it went well any other time of the day ... it was to put it (exergaming) in my daily routine somewhere. It was important to determine a time." (Male, 70 years old)

Setting goals in exergaming, such as trying to get a higher score every time playing, helped patients in continuing exergaming.

Experiences concerning why the patients with HF were interested in playing specific games in the platform and how they chose the games that suited them best were described. Also, a difference in the intensity between the five different games that were available in Wii Sports was experienced. Bowling was the least physically intensive game in the exergame platform, whereas tennis and boxing were experienced as physically intensive.

"Bowling was not particularly difficult when you started. Golf on the other hand could be a little troublesome. It was more difficult. In boxing you try to not get hit... You had to move your arms very much. So it was pretty tough actually." (Male, 71 years old)

Mental and/or physical effort was needed in order to be successful in exergaming and therefore exergaming tested the abilities of patients with HF in many different ways. Familiarity with the sports in the exergame in real life helped when selecting a specific game to play. Sometimes they fantasized that they were playing this game for real outdoors.

"I fantasied I was out on the tennis track. When I lived in Spain for a while... I lived near a tennis court. And I heard people playing tennis ... So I went there in my thoughts (during exergaming)". (Male, 70 years old)

Exergaming adding value

Patients enjoyed exergaming and said it enabled them to be more active. They experienced an increase of physical fitness, which could increase the patients' physical condition and help them to stay healthy. Exergaming improved their physical and/or mental state and they enjoyed exergaming, especially when they were recovering from deterioration in their health and could receive this exercise mode in their home.

"It was probably useful at the beginning when I was at home using the game instead of going out for a walk alone. Because then I was a bit worried to go out and walk alone... with my heart in the beginning. But I have come to realize that it is not dangerous. Gaming is now a great addition to some other activities." (Male, 71 years old)

They experienced that exergaming enabled them to be more active with others. Some patients in the interviews exergamed with their grandchildren, children, spouses, neighbors and friends, and this was seen as an added value.

"They thought (the grandchildren) it was fun to beat the grandmother of course... I have always liked to play different stuff. We have always been a family that liked to play games. Of course it's fun, better than to play alone." (Female, 82 years old)

Other added values that were experienced by the patients were being able to be active inside the house when the weather was bad.

Patients got more skilled and experienced in exergaming over time. They were excited to learn and felt competitive and described how they challenged themselves and constantly wanted to improve their skills.

Practicing in exergaming helped the patients to improve at exergaming and to master exergaming over time. Many patients said that they did not know the rules of baseball and therefore did not play this game.

Less appeal of exergaming

Some patients experienced that exergaming did not suit them. Patients were especially adherent at the beginning of the study, but exergamed less over time. Some patients played more sporadically, and some even stopped exergaming. Other things took time away from exergaming (e.g., family obligations, holidays) and some patients experienced exergaming as boring. The feeling of being too tired was also expressed as a reason for not exergaming. Some patients thought that exergaming gave too little fitness to improve health.

Less appeal of exergaming could also be due to that they wanted to be active in groups instead of exergaming alone.

"I'm probably more a group person than I am an 'alone' person. I do not like it that much to be alone. I'm alone almost all the time and physical things are more fun to do with someone. It is much more fun if you have someone to talk to". (Male, 73 years old)

DISCUSSION

The general aim of this dissertation was to describe the physical activity in patients with HF, with special focus on self-efficacy and motivations, and to describe the experiences and the potential of exergaming to improve exercise capacity in patients with HF.

Physical activity: motivation and self-efficacy

One-third of patients with HF had a low level of physical activity, and 42% of patients were physically active for less than one hour a week. Social motivation was only important for 22% of the patients, and physical motivation was only important for one-third of the patients. Psychological motivation was viewed as the most important motivation and was described as such by 41% of the patients. By far the most important single item to motivate patients was "I want to be healthier and perhaps live longer", which motivated two-thirds of the patients. Looking at these results combined with the perspective of the self-determination theory[65], intrinsic motivations (engaging in an activity for the pleasure and inherent satisfaction) were more often expressed in this thesis as motivators for physical activity than extrinsic motivations (engaging in an activity for instrumental reasons). In a literature review, a trend was shown towards identified regulation predicting short-term adoption of physical activity more strongly than intrinsic motivations, and intrinsic motivation being more predictive of long-term physical activity adherence.[65] The studies in this literature review[66] also showed that competence satisfaction and intrinsic motives positively predicted physical activity participation. For these reasons it is important for patients with HF to have a high intrinsic motivation and it is a good result that the patients with HF feel a high intrinsic motivation towards physical activity by having access to an exergame platform at home.

Women had higher total motivation to engage in physical activity and also scored higher on all the subscales of motivation (physical, social, and psychological), but they had a similar physical activity level compared to men. An explanation for this result could be that women have more difficulties in dealing with their barriers, and barriers could differ between men and women.[7] In research, women described physical activity as tiring and painful, and they disliked public or mixed-gender physical activity programmes.[7] Women are more likely to show non-adherence to physical activity because of medical problems and family obligations, whereas men more often report that they are 'too lazy', find physical activity boring, and find that rehabilitation 'interferes with work'.[7,128,129]

The majority of the patients had a low self-efficacy for physical activity and experienced all the potential barriers as obstacles in becoming physically active. Furthermore, this thesis shows that exercise self-efficacy has a role in explaining the relationship between motivation and physical activity. Motivation lowers the barriers to becoming more physically active, meaning that motivation leads to a higher self-efficacy towards physical activity (mediation effect). An issue to take into account is that there are barriers experienced by patients with HF that are difficult to remove with motivation. These barriers include lack of knowledge, environmental considerations (e.g., no facilities nearby), safety, cost, friends/partner not interested, and barriers related to the weather.[7,10,15]

It should be recognized that physical activity in patients with HF is also influenced at macro system dimensions (e.g., societal values about physical activity, safe neighborhoods), exosystem dimensions (e.g., mass media), meso system dimensions (e.g., involvement of physical activity in the rehabilitation program at the hospital), and micro system dimensions (e.g., walking paths near home).[130] To motivate and increase self-efficacy in patients, it is important to consider not only the patient-related factors (e.g., age, low level of education), but also other factors, for example lack of resources and support. Examples of resources and support are lack of reimbursement, transportation issues, lack of education on the importance of physical activity, and lack of expertise with HF in the healthcare team.[7]

To increase motivation and self-efficacy in physical activity it is important to offer more than only cardiac rehabilitation at the hospital[7] and also to offer cardiac rehabilitation programs at home. Offering physical activity possibilities at home could remove some of the barriers that patients with HF feel with regard to physical activity (e.g., no facilities nearby, transportation).[14]

Looking at the literature, new physical activity programs could be useful in patients with HF, such as dancing[131], yoga[132,133], tai chi[134,135] and exergaming.[119,136] These innovative physical activity programs could remove some of the barriers patients with HF face. For example, many patients with HF have danced at some point in their lives. Formal experience with exercise could increase the amount of exercise and decrease the feeling that they cannot perform this exercise. Also, dancing could encourage social interaction and support from the dance partner. Group lessons in yoga and tai chi could also increase social facilitation, and new interventions such as exergaming at home could decrease the transportation issues.[7] In order to tailor physical activity to patients with HF, there should be a broader offering of different kinds of physical activity than only rehabilitation in the hospital.

Exergaming

Experiences of patients with HF using an exergame platform at home were presented (III & IV). The results confirm the conclusion of an earlier scoping literature review[74] and case study[72] , that exergaming might be a possibility for patients with HF to become more physically active. The studies in this thesis show that exergaming is feasible (no adverse events, no problems with learning the technology, most patients continued exergaming) and might be effective for a larger group of patients with HF, independent of age, gender and comorbidity. Exergaming could increase exercise capacity and EE. Patients did not perceive exergaming as strenuous and it did not increase their HF symptoms. The results provide insight into the challenges of exergaming and its added value. They also provide important information on aspects to discuss when initiating and supporting long-term maintenance for patients who want to use exergaming to increase their exercise capacity and physical activity.

Because the increase in physical activity was not significant, this suggests that the increase of exercise capacity did not generate more daily physical activity. The largest increase in physical activity occurred in the 11th and 12th weeks of access to the exergame platform at home. A reason for this could be the telephone conversation the patients had with the study team, where the patients were invited to visit the hospital for the follow-up measurements. In the interviews, patients said that they felt obligated to the research team, because they said yes to the study. This strengthens the assumption that the telephone conversations that patients had with the research team in weeks 11 and 12 prompted them to be more active in the last two weeks of the exergame intervention.

Previous studies have also shown that there is a difference in the amount of energy expended for the different exergames, where bowling involved the least and boxing the highest amount of energy EE.[73] Therefore, patients had the option to decrease or increase their physical activity by changing the exergame. From the interviews it became clear that the kind of exergames patients played also depended on the popularity of these games in Sweden. Baseball is not a national sport in Sweden and therefore patients did not know the rules and, as a result, did not prefer to play baseball. It should be noted that the sports exergames offered to a patient group should be adapted to the specific country where the intervention takes place. An additional option could be to provide education about the sports that are not popular or well known in these countries.

Notably, but not surprisingly, there was a difference between men and women with regard to the time spent exergaming. This result is supported by the literature, where men generally favor exergaming more than women.[73] This might imply that in the future, men and women's preferences should be examined. However, this should not be overstated, as both men and women played longer than the time advised by the nurses. In addition, women were the same as men as regards the decrease in the time spent exergaming during the 12 weeks they had access to Wii. As the number of minutes spent exergaming fluctuates in the study, and as there was a small decrease at the end, it is advisable for future interventions to have more follow-up points in order to keep the time spent exergaming the same.[137] Patients said that making routines in exergaming was important for the adherence to exergaming over time. From research in adapting physical activity in daily living it seems that peer teaching, skills mastery, reinterpretation of symptoms, goal setting, graphic feedback, problem-solving support, social persuasion and motivational interviewing can help patients to be active.[56,138-142] In the interviews, patients said that goal setting and graphic feedback (which you receive with exergaming) specifically helped them in staying active with the exergame platform.

Another interesting finding was that the patients with grandchildren exergamed more than the patients without grandchildren. This finding suggests that social facilitation could increase the time spent exergaming. A social environment that is not interested in physical activity is known to be a barrier for physical activity in patients with HF.[7] Exergaming could facilitate a greater connectedness with family, especially grandchildren, and remove some of the barriers to becoming physically active. These results have also been confirmed with the interviews, where the patients said that exergaming with others was an added value and brought joy and adherence for the ones who wanted to be active with others. Similar results have also been reported in previous studies about exergaming in older adults.[137,143]

Even though exergaming was experienced as fun and having added value, other activities such as family obligations or travel were prioritized and took time away from exergaming. These competing activities were also described in previous research.[9,14] It is important to realize that patients have a lot more to do in their life than being physically active and the things that take time away from being physically active should be discussed before rehabilitation. Also, the longer patients had been diagnosed with HF and the higher the NYHA-class were factors related to smaller change in exercise capacity when patients had access to the exergame platform for 12 weeks. The longer a patient had been diagnosed with HF, the more symptoms the patient experienced, and the more difficult it was for them to increase exercise capacity using exergaming.

An interesting reflection can be made concerning the weather and exergaming. In general, the weather is seen as a barrier to physical activity: rain, snow, wind and hot weather make it difficult to be physically active and in some cases even dangerous.[9] The patients said that bad weather was a motivator to exergame.

It should be noted that familiarization with the Wii (an introdusction session in the hospital, repeated instructions on the exergames during the installation of the Wii at home, and the opportunities for further guidance in the first 12 weeks) was very important. This familiarization helped patients to get started with the exergaming, remove barriers, increase motivation and maintain exergaming over time. These assumptions were also expressed in the interviews, where the patients explicitly stated that the familiarization with the exergame platform in the study helped them start exergaming. These assumptions were also found in former research that included exergaming.[87,91,143]

It is important to state that exergaming was not suited to all the patients. Some patients said that exergaming was not appealing and did not help in increasing their physical activity, which confirms that physical activity for patients with HF should be tailored to individual preferences and capabilities. This is also seen in research on multiple sclerosis and exergaming. The exergame platform used in this study was limited in its customizability to accommodate various fitness and functional levels.[96]

Methodological considerations

Collecting data from different sources could be considered as methodological strength of the results in this thesis. However, there are some methodological limitations.

Design

The cross-sectional designs (I & II) were a limitation to establishing causal relationships between physical activity and health indicators. The pilot study (III) examined the feasibility of an approach that intended to be used in a larger scale study: the HF-Wii study.[119] Although not essential for many aspects of the pilot study, inclusion of a control group would have allowed for a more realistic examination of recruitment, randomization, implementation of interventions, blinded assessment procedures, and retention in blinded interventions.[144]

Sample

Heart failure nurses selected the patients in study III. Therefore, there is a possibility that the research team only recruited patients who they thought could interact with the exergame platform. It is possible that this group was therefore younger than the general HF population and was more motivated to learn a "new" technology and participate in a physical activity intervention.

In studies II and IV, participants were enrolled in a physical activity interventional study, and therefore they also might have been more motivated to become more physically active than the general population of patients with HF.

Most patients were in NYHA-class II or III. To ensure variation in patients in the interviews (IV), an effort was made to vary age, gender, NYHA-class (Table 1), but patients with NYHA-class I and NYHA-class VI were still missing.

Data collection

Valid and reliable questionnaires (I, II, III), an activity monitor and 6MWT (III) were used in this thesis. The scores of these questionnaires, the activity monitor and 6MWT were handled in accordance with the given instructions. However, additional questions were developed for the exercise self-efficacy scale (I), based on HF-specific barriers for physical activity. These questions were only used in a descriptive way.

Data collection in studies I and II was limited because the assessment of physical activity levels was based on self-reports. In study II a single-item question was used to assess physical activity. This item was easy to complete and construct, face and content validity had previously been established and it had been used in several previous studies [101,102] However, it would have been a strength if convergent validity had been established correlating the self-assessed item with objective measures of physical activity, like a valid activity monitor or double labelled water testing.[145]

The mechanism underlying the patients' increase in the amount of meters in the 6-minute walking test needs to be carefully interpreted (III). In this small group we found no difference in time spent exergaming between the group who increased in exercise capacity and the group who decreased in exercise capacity. However, other mechanisms (increased confidence, increased performance of other activities) might be hypothesized to result in better outcomes. Patients might have played different games with different EEs. If these data were missing in the 6-minute walking test, the patients were treated as 'no increase'. These patients could have decreased in exercise capacity and, therefore, overestimation of the effect was possible. Another methodological consideration in the pilot study (III) is the placement of the activity monitor on the patients. In the validation study of the activity monitor, the device was placed on the lower back, using an electric belt. In this study, the patients wore the device as a necklace or in their pocket, as advised by the manufacturer. This means that the device was not tightly fixed to the body and there is a possibility that some of the movements registered did not reflect body movement.

Generalizability, confirmability & transferability

The generalizability of the findings in all studies included in this thesis may be limited to relatively healthy patients with HF living at home. Although carried out in Sweden (I, II, III & IV), issues raised are likely to apply to other countries and further work is being planned to collect data on exercise capacity, physical activity, motivations, self-efficacy and the experiences of exergaming in international sites included in the HF-Wii Study.[119]

In the qualitative study (IV), the confirmability and transferability was strengthened by the fact that some of our findings were confirmed by previous studies concerning experiences of physical activity.[9,14] The detailed documentation of the data handling and the coding (IV) makes it easier for future researchers to judge the transferability of the criteria to other user populations or other situational contexts.

Recommendations for future research

It is particularly important to identify and promote those factors that lead to sustained physical activity in the long term. From this thesis it has been learned that self-efficacy and motivation are important factors affecting how patients with HF become physically active, and that self-efficacy has a mediation effect on the relation between motivation and physical activity. Future designs of interventions should keep in mind that these concepts are important to consider when encouraging patients with HF to become more physically active.

In a meta-analysis[146] where the researchers compared the contribution of specific intervention techniques to changes in both self-efficacy and physical activity behavior outcomes in "healthy adults", they found that action planning (specific detailed planning of when, where and how the specific behavior is going to be performed) produced significantly higher self-efficacy and physical activity behavior scores, provided instruction and reinforcing efforts towards behavior were associated with significantly higher levels of both self-efficacy and physical activity. These techniques could be further explored in research on physical activity and exergaming in patients with HF.

Future research is also needed to study the possibilities to include significant others from the beginning of a physical activity intervention, or in this case exergaming, to increase enjoyment and adherence for those who want to play together. For patients who want to be physically active in groups, possibilities should be explored to do exergaming in a group, for example a exergame bowling competition, or other rehabilitation possibilities to be physically active in groups should be offered. To further improve options for tailoring, future exergames should include a wider range of different fitness and functional levels.

Further research, with a higher level of methodological quality and that examines the relative efficacy and costs of intervention programs aimed to enhance daily activity in non-health care settings, such as home settings, is needed. Also, a longer follow-up period is needed to examine the long-term effects of these promising exergame platforms. Therefore, the HF-Wii study which is an RCT study[119], is on-going to assess the influence of exergaming on exercise capacity in patients with HF (clinicaltrial.gov identifier: NCT01785121).

CONCLUSIONS

This thesis shows that it is a challenge to improve physical activity in patients with HF. This challenge goes beyond simply instructing patients to be active. It is important to look at factors that influence physical activity in patients with HF. Level of education, exercise self-efficacy, and motivation were important factors to take into account when advising a patient with HF about physical activity.

Barriers to and motivation for physical activity in patients with HF do not always relate to their disease and sex differences in motivations towards physical activity. Furthermore, the results contribute to the investigation of psychological mechanisms in physical activity in patients with HF. It has been demonstrated that exercise motivations in physical activity as well as self-efficacy beliefs are important when performing physical activity. Stronger motivations lead patients with HF to have higher self-efficacy (and therefore experience fewer barriers), which in turn leads them to have higher physical activity.

Providing patients with HF access to an exergame platform is a promising and safe intervention. Exergaming has the potential to increase exercise capacity in patients with HF. Although the daily physical activity did not change over time, exergaming was feasible for patients with HF and might be a rehabilitation option. Patients experienced challenges to making exergaming work, but good familiar-ization helped in getting started. Over time and with practice, patients found they became more skilled in the exergaming. Also, some patient's experiences added value and increased physical fitness, e.g., exergaming with friends/family/neighbors. The results also showed that this technology is not appealing for all patients and they prefer other kinds of physical activity.

IMPLICATIONS FOR PRACTICE

- Motivating patients with HF to be physically active should include improving their intrinsic motivation
- Men and women need to be motivated in different ways to be physically active
- Barriers to physical activity that are difficult to overcome by motivation need to be addressed
- A variety of formats for physical activity in patients with HF should be considered and physical activity should be tailored to the patient based on level education, motivation and self-efficacy
- Exergaming can be considered as a promising intervention to increase exercise capacity in patients with HF and it could facilitate a greater connectedness with family, especially grandchildren
- Exergaming can be considered for rehabilitation at home since it is feasible and safe for patients with HF, but it needs proper familiarization

SVENSK SAMMANFATTNING

Bakgrund: Följsamhet till rekommendationer för fysisk aktivitet är låg hos patienter med hjärtsvikt. Det är därför viktigt att undersöka i vilken utsträckning och varför patienter med hjärtsvikt är fysiskt aktiva. Begreppet self-efficacy kan definieras som en individs tilltro till den egna förmågan att utföra ett speciellt beteende i en specifik situation. Det finns ingen vedertagen svensk översättning av self-efficacy, i denna avhandling kommer upplevd självförmåga att användas för att översätta begreppet. Upplevd självförmåga och motivation för fysisk aktivitet är betydelsefulla för att en person ska bli mer fysiskt aktiv. Vilken roll den upplevda självförmågan har i relationen mellan motivation och fysisk aktivitet hos patienter med hjärtsvikt är okänd. Det behövs alternativa metoder för att motivera till och öka den upplevda självförmågan för fysisk aktivitet. Ett av dessa alternativ skulle kunna vara exergames (tv- eller datorspel för att förbättra fysisk aktivitet). Det är därför viktigt att få mer kunskap om potentialen hos exergaming för att öka den fysiska aktiviteten hos patienter med hjärtsvikt.

Det övergripande syftet med avhandlingen var att beskriva den fysiska aktiviteten hos patienter med hjärtsvikt, med särskilt fokus på motivation och upplevd självförmåga i fysisk aktivitet, samt att beskriva potentialen av exergaming för att förbättra den fysiska kapaciteten.

Metoder: Studie I (n = 154) och studie II (n = 101) i denna avhandling var designade som tvärstnittsstudier. Studie III (n = 32) var en 12-veckors pilottestning av en interventionsstudie som utvärderade en tv-spels plattform i hemmet, med en före och eftermätning. Studie IV (n = 14) beskrev erfarenheter av exergaming hos patienter som deltog i interventionsgruppen i en randomiserad kontrollerad studie där de hade tillgång till en tv-spelsplattform i hemmet.

Resultat: Totalt hade 34% av patienterna en låg nivå av fysisk aktivitet, 46% av patienterna en måttlig nivå och 23% av patienterna rapporterade en hög nivå. Högre utbildning, högre upplevd självförmåga, och högre motivation var signifikant associerade med mer fysisk aktivitet. Hinder för fysisk aktivitet rapporteras vara svåra att överkomma. Psykologiska motivationer var de mest viktiga motivationerna för att vara fysiskt aktiv. Kvinnor hade en signifikant högre motivation att vara fysiskt aktiva. Upplevd självförmåga medierade förhållandet mellan motion, motivation och fysisk aktivitet genom att motivation leder till en högre upplevd självförmåga till högre fysisk aktivitet.

Mer än hälften av patienterna ökade sin fysiska kapacitet signifikant efter 12 veckor med en tv-spels plattform i hemmet. Lägre NYHA-klass och kortare tid sedan diagnos var faktorer som signifikant hade samband med större ökning av fysisk kapacitet. Den genomsnittliga tiden som tillbringades med tv-spelande var 28 minuter per dag. Att vara man eller att ha barnbarn var relaterat till mer tid spenderat med exergaming. Analyserna av kvalitativa data resulterade i tre kategorier som beskriver patienternas upplevelse av exergaming: (i) få exergaming att fungera, (ii) mervärdet av exergaming, (iii) brist på attraktionskraft till exergaming.

Slutsats: En tredjedel av patienterna hade en låg nivå av fysisk aktivitet i det dagliga livet. Utbildningsnivå, upplevd självförmåga, och motivation är viktiga faktorer att ta hänsyn till när rådgivning skulle ges till patienter om fysisk aktivitet. Förutom en hög nivå av motivation till fysiskt aktiv är det viktigt att patienter har en hög grad av upplevd självförmåga.

Exergaming har potential att öka den fysiska kapaciteten hos patienter med hjärtsvikt. Resultaten visade också att denna teknik kan vara lämplig för vissa patienter, medan andra kan föredrar andra typer av fysisk aktivitet.

Nyckelord: hjärtsvikt, fysisk aktivitet, träning, motivation, upplevd självförmåga, exergame

NEDERLANDSE SAMENVATTING

Achtergrond: Het aantal patiënten met hartfalen (HF) dat zich kan houden aan de aanbevolen lichamelijke activiteit is over het algemeen klein. Het is essentieel om te onderzoeken in hoeverre en waarom patiënten met HF lichamelijk actief zijn. Het hebben van self-efficacy (een persoonlijke overtuiging dat hij/zij capabel is om te doen wat nodig is om een taak te volbrengen op een bepaald kwaliteitsniveau) en motivatie voor lichamelijke activiteit is belangrijk om meer lichamelijk actief te worden. Het is echter niet duidelijk wat de rol van self-efficacy is in relatie tot motivatie en lichamelijke activiteit bij patiënten met HF. Alternatieve benaderingen zijn nodig om patiënten te motiveren lichamelijk actiever te zijn en de self-efficacy te verhogen. Een van de mogelijke alternatieven om patiënten met HF te helpen lichamelijk actiever te zijn is de inzet van exergames: computerspellen om fysieke activiteit te bevorderen. Er is tot nu toe geen onderzoek is gedaan naar de inzet van exergaming bij patiënten met hartfalen en de mogelijkheden van exergaming om patiënten te stimuleren tot meer lichamelijke activiteit.

Het doel van dit proefschrift is het beschrijven van de lichamelijke activiteit van patiënten met HF met extra aandacht voor de motivatie en self-efficacy ten opzichte van lichamelijke activiteit. Een tweede doel is om inzicht te krijgen in de mogelijkheid om exergaming te gebruiken om de lichamelijke activiteit van patiënten met HF te verhogen.

Methode: In dit proefschrift worden gegevens van 4 studies beschreven (studie I-IV). Studie I (n = 154) en II (n = 101) hebben een cross-sectioneel survey design. Studie III (n = 32) is een 12 weken durende pilot-interventie studie met een pretest-posttest design waarbij patiënten 12 weken lang een exergame platform thuis konden gebruiken. Studie IV (n = 14) beschrijft de ervaringen van patiënten die deelnamen aan de interventiegroep van een gerandomiseerde studie waarin zij een exergame platform thuis kregen.

Resultaten: In totaal hebben 34% van alle patiënten met hartfalen een laag niveau van lichamelijke activiteit, 46% had een matig niveau, en 23% een hoog niveau. Een hoger opleidingsniveau, self-efficacy en motivatie significant werd geassocieerd met een hogere hoeveelheid lichamelijke activiteit. Het bleek dat barrières voor fysieke activiteit moeilijk te overbruggen waren. Met betrekking tot motivatie, bleek dat psychologische motivatie de belangrijkste drijfveer was om fysiek actief te zijn. Verder bleek dat vrouwen een significant hogere motivatie voor fysieke activiteit hebben dan mannen.

Een ander belangrijk resultaat was dat self-efficacy de relatie tussen motivatie en lichamelijke activiteit beïnvloedt; motivatie leidt tot een hogere self-efficacy wat leidt tot hogere fysieke activiteit.

Met betrekking tot de resultaten van exergaming bleek dat de inspanningscapaciteit van meer dan de helft van de patiënten aanzienlijk was toegenomen na 12 weken gebruik gemaakt te hebben van een exergame platform thuis. Patiënten met een lager NYHA-klasse en een kortere tijd na de diagnose verhogen significant meer hun inspanningscapaciteit. Ook bleek dat het hebben van een partner en kleinkinderen gerelateerd is aan meer tijd besteden aan exergaming.

De analyse van de ervaringen van patiënten in de kwalitatieve studie resulteerde in drie categorieën: (i) zorgen dat exergaming werkt, (ii) toegevoegde waarde van exergaming, (iii) geen aantrekking tot exergaming.

Conclusie: Een derde van de patiënten met HF heeft een laag niveau van lichamelijke activiteit in hun dagelijks leven. Opleidingsniveau, self-efficacy en motivatie zijn belangrijke factoren om rekening mee te houden bij het geven van advies aan patiënten met HF betreffende fysieke activiteit. Naast een hoge motivatie tot bewegen is het belangrijk dat patiënten met HF een hoog niveau van self-efficacy hebben om fysiek actief te zijn.

Exergaming heeft potentie om inspanningscapaciteit bij patiënten met HF te verhogen. Uit de resultaten blijkt ook dat deze techniek geschikt is voor een deel van de patiënten, terwijl een deel van de patiënten wellicht liever andere vormen van lichamelijke activiteit beoefenen.

Trefwoorden: hartfalen, lichamelijke activiteit, bewegen, motivatie, self-efficacy, exergame

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