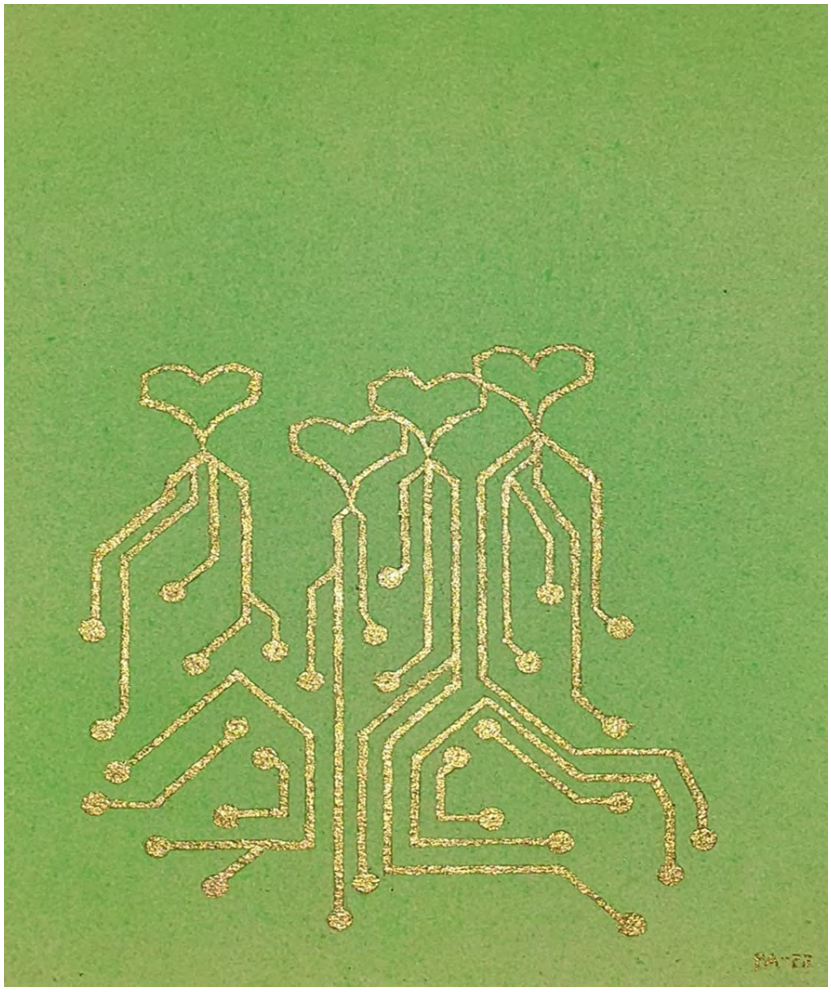
JYU DISSERTATIONS 609

Marjo-Riitta Anttila

Trust-Building and Personalized Life Changes in Digital Cardiac Rehabilitation Process



UNIVERSITY OF JYVÄSKYLÄ
FACULTY OF SPORT AND
HEALTH SCIENCES

JYU DISSERTATIONS 609

Marjo-Riitta Anttila

Trust-Building and Personalized Life Changes in Digital Cardiac Rehabilitation Process

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ABSTRACT

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The purpose of the present dissertation project was to create a conceptual model for the process of digital cardiac rehabilitation (CR) by using the Glaserian grounded theory approach (GT). The project explored technology experience, attitudes, and behavior by creating different groups (Study I) and deepening the understanding of the groups' profiles by comparing them to aspects of biomedical, psychosocial, and environmental lifestyle risk, and health behavior (Study II) as well as the different meanings attached to the rehabilitation process of patients with coronary heart disease (CHD) (Study III).

The analyses were based on 39 patients with CHD who attended CR in 2015–2017. The intervention lasted for 12 months and included three 5-day periods of traditional rehabilitation. Between the rehabilitation periods, the intervention provided patients with web-based coaching via a remote connection and daily physical activity monitoring. The data consisted of focus group interviews, and questionnaires, physical tests and measurements. The data were analyzed using GT, which included open, selective, and theoretical coding. Analysis of variance, Tukey's honestly significant differences test, Student's t-test, the Mann-Whitney U-test, and the Kruskal-Wallis test were used to analyze the data.

The study showed the diverse behaviors of patients as technology users and how cardiac patients reflected various lifestyle risk behaviors during the rehabilitation process. Trust-building was part of the life change process and involved interactions between emotion, cognition, acceptance, and support processes. The processes go on forward to the identification of new meaning of life towards trust and hope in life. During rehabilitation process personalized encounters will enhance the patient's trust and promote life change. The result of the project was creating a model for the trust-building process enabling personalized life changes. These results provide a new kind of theoretical perspective to tailor actions that promote and support behavioral and life changes.

The CR program featured various personalized trust-building methods that are valuable tools for life change management, which seeks self-awareness of thoughts and emotions. This study's findings can help clinicians develop tailored digital health solutions for patients in CR.

Keywords: digital cardiac rehabilitation, grounded theory, trust-building

TIIVISTELMÄ (ABSTRACT IN FINNISH)

Anttila, Marjo-Riitta
Luottamuksen rakentuminen ja yksilöllinen elämänmuutos osana digitaalista sydänkuntoutusprosessia
Jyväskylä: Jyväskylän yliopisto, 2023, 84 s.
(JYU Dissertations
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Tämän väitöskirjaprojektin tarkoituksena oli käsitteellistää digitaalinen sydänkuntoutumisprosessi glaserialaisen grounded teorian lähestymistavan avulla. Tutkimuksen tarkasteltiin kokemuksia ja asenteita teknologian käytöstä luomalla erilaisia käyttäytymisen kokemusryhmiä (Tutkimus I), syvennettiin ymmärrystä näiden ryhmien profiileista vertaamalla niitä biolääketieteellisiin, psykososiaalisiin ja ympäristöön liittyviin riskitekijöihin ja terveyskäyttäytymisen osa-alueisiin (Tutkimus II) sekä tutkittiin sydänkuntoutujien antamia eri merkityksiä kuntoutusprosessille (Tutkimus III).

Tutkimukseen osallistui 39 sepelvaltimotautia sairastavaa potilasta, jotka olivat sydänkuntoutuksessa vuosina 2015–2017. Kuntoutus sisälsi kolme viiden päivän pituista jaksoa vuoden aikana. Kuntoutujat osallistuivat verkkopohjaiseen valmennukseen ja päivittäiseen fyysisen aktiivisuuden seurantaan kuntoutusjaksojen välissä. Aineisto koostui sekä fokusryhmähaastatteluista että kyselylomakkeista ja vyötärönympäryksen ja fyysisen kunnon mittauksista. Analyysin vaiheet olivat avoin, selektiivinen ja teoreettinen koodaus. Tilastollisia analyysimenetelmiä olivat varianssianalyysi, Tukeyn testi, t-testi, Mann-Whitney- ja Kruskal-Wallis-testit.

Tulokset nostivat esille uudenlaisen näkökulman yksilöllisestä elämänmuutosprosessista ja luottamuksen rakentumisesta digitaalisessa sydänkuntoutuksessa. Luottamuksen rakentuminen osana kuntoutumista oli osa kognitiivisen, emotionaalisen, hyväksymisen ja sosiaalisen tuen prosessia. Luottamuksen rakentuminen edellytti omien tunteiden ymmärtämistä ja sairauden tuomien ajatusten tunnistamista sekä uuden elämäntilanteen hyväksymistä. Luottamus omaan itseensä, toisiin ja omaan elämään rakentui yksilöllisen kohtaamisen kautta. Tämän pohjalta muodostui käsitteellinen malli luottamuksen rakentumisesta elämänmuutoksessa osana sydänkuntoutusta.

Digitaalisten ratkaisujen avulla voidaan räätälöidä kuntoutusta vastaamaan kuntoutujien yksilöllisiä kohtaamisen ja tuen tarpeita. Tutkimustulokset haastavat kehittämään ja räätälöimään kuntoutuksessa käytettäviä ohjausmenetelmiä ja teknologioita.

Avainsanat: digitaalinen sydänkuntoutus, grounded teoria, luottamuksen rakentuminen

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Jyväskylä, January 2023
Marjo-Riitta Anttila

ORIGINAL PUBLICATIONS AND AUTHOR CONTRIBUTION

This dissertation is based on the following publications, which will be referred to by their Roman numerals. The dissertation also includes unpublished results to create a conceptual model.

I Anttila, M.-R., Kivistö, H., Piirainen, A., Kokko, K., Malinen, A., Pekkonen, M., & Sjögren, T. (2019). Cardiac rehabilitees' technology experiences before remote rehabilitation: qualitative study using a grounded theory approach. *Journal of Medical Internet Research, 21*(2), e10985. https://doi.org/10.2196/10985

II Anttila, M.-R., Soderlund, A., Paajanen, T., Kivistö, H., Kokko, K., & Sjögren, T. (2021). Biopsychosocial profiles of patients with cardiac disease in remote rehabilitation processes: mixed methods grounded theory approach. *JMIR Rehabilitation and Assistive Technologies, 8*(4), e16864. https://doi.org/10.2196/16864

III Anttila, M.-R., Söderlund, A., & Sjögren, T. (2021). Patients' experiences of the complex trust-building process within digital cardiac rehabilitation. *PloS ONE, 16*(3), e0247982. https://doi.org/10.1371/journal.pone.0247982

As the first author of the original publications and considering the comments of the co-authors, the author of this dissertation formulated the research questions and designs for publication. The author actively participated in the data collection, raw data analyses, statistical analyses with a statistician, and manuscript writing. In all studies, the author had the consent and authority to use the data from the research project, Digital health technology in CR (Etäteknologia Sydänkuntoutuksessa [EtSy]).

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ABBREVIATIONS

BREQ-3	Behavioral Regulation in Exercise Questionnaire-3
BSP	Basic social process
CABG	Coronary artery bypass grafting
CHD	Coronary heart disease
CR	Cardiac rehabilitation
CVDs	Cardiovascular diseases
DEPS	Depression Scale
E-usage	Use of information and communication technologies
HSD	Honestly significant difference
GT	Glaserian grounded theory
IPAQ	International Physical Activity Questionnaire
Kela	The Social Insurance Institution of Finland
MD	Mean difference
OSF	Official Statistics of Finland
6MWT	Six-minute walk test
NSTEMI	Non-ST-elevation myocardial infarction
PTCA	Percutaneous transluminal coronary angioplasty
PCI	Percutaneous coronary intervention
SERES	Self-Efficacy to Regulate Exercise Scale
STEMI	ST-elevation myocardial infarction
TPB	Theory of planned behavior
TTM	Transtheoretical model
WHOQOL-BREF	World Health Organization Quality of Life-BREF

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ORIGINAL PAPERS

1 INTRODUCTION

The secondary prevention and existing treatment of coronary heart disease (CHD) plays a pivotal role and is a significant research topic for identifying needs that require health action (Visseren et al., 2021). Additionally, CHD is generally known type of cardiovascular disease and caused by atherosclerotic changes in the coronary artery (Virani et al., 2021; Visseren et al., 2021). Cardiac rehabilitation (CR) using digital educational interventions that follow a cardiac event is playing an increasingly important role in the management of CHD (Sankaran et al., 2016). The main target for self-management education is to increase patients' knowledge, promote life changes, improve quality of life, and reduce CHD lifestyle-related risk factors (Anderson et al., 2017; Kotseva et al., 2019). The present dissertation aimed to create a conceptual model for the process of digital cardiac rehabilitation (CR) by using a grounded theory approach. The methodological approach taken in this study was ground theory (GT), which allowed the discovery of new perspectives to conceptualize the digital cardiac rehabilitation process.

CR is among the most effective secondary prevention interventions; it uses a multidisciplinary behavioral medicine approach from a biopsychosocial paradigm perspective (Ahmadvand et al., 2018; Borrell-Carrio, 2004; Leon et al., 2005). Behavioral medicine is based on the integrated knowledge of human behavior, biomedical and psychosocial aspects of health, and illness; it integrates all of this information to improve our understanding of health and health-related behavior changes (Engel, 1977; Schwartz & Weiss, 1978). This study is also founded on the biopsychosocial paradigm; thus, it is characterized by the view that the biomedical, psychosocial, and environmental lifestyle risk factors all contribute to behavioral changes (Ahmadvand et al., 2018; Borrell-Carrio, 2004).

CR consists of three core modalities: patient education, physical activity training, and psychological support, all of which ultimately increase the chances of a life change and enhance psychosocial leadership management (Anderson et al., 2017; Goff et al., 2014; Kotseva et al., 2019; Leon et al., 2005). The CR process is focused on cardiac patients' reorganization in a changed psychosocial and lifestyle situation (Ambrosetti et al., 2021; Leon et al., 2005). The process aims to

support cardiac patients in resuming their daily life activities and maintain a good quality of life (Richards et al., 2018). This is important because a cardiac event changes a patient's life and daily activities, which then require a process of psychosocial adaptation (Albus, 2010; Livneh & Antonak, 2005). Therefore, the purpose of patient education is to improve the patient's self-care and self-management abilities, which include psychosocial control and the ability to adapt cognitively to the disease (Kabboul et al., 2018; Livneh & Antonak, 2005). It is also important that patients receive sufficient psychosocial support after a cardiac event and become able to manage their health behaviors and risk factors (Hare et al., 2014; Li et al., 2019).

Recent developments in digitalization have increased the need to implement technology as a part of the CR process (Falter et al, 2020; Scherrenberg et al., 2021). Increased digitalization has enabled a growing number of cardiac patients to participate in CR. Previous research demonstrated that few CHD patients participated in traditional CR that required their physical presence in a rehabilitation center (Neubeck et al., 2012). Digital CR is of interest because it has created new opportunities to address the growing need for digital services (Neubeck et al., 2012). It has created new physical activity opportunities for patients requiring CR as well as other opportunities for group activities and social interaction (Ghisi et al., 2021; Thomas et al., 2021). This development is also supported by cardiac patients' increasing interest in using healthcare technology (Beatty et al., 2013; Buys et al., 2016).

My vast experience working in CR ultimately drove this research. When I started my research training, I had worked as a nurse for almost twenty years and as a research coordinator at a rehabilitation center. During this time, I developed an interest in behavior changes experienced by cardiac patients and the techniques used to achieve them. I wondered how the process of changing patients' behavior could be support CR. At the beginning of digitalization, I was interested in how behavioral change techniques could be implemented via digital platforms. These experiences piqued my curiosity to explore the possibilities and challenges of digitalization in CR. The purpose of the present doctoral dissertation was to create a model that integrated technology use and lifestyle risk behavior in digital CR for cardiac patients.

2

The target group of this dissertation was patients with CHD who had experienced digital CR. The current dissertation explored the following main relevant areas: CR and secondary prevention of CHD, which are connected through digital CR (Figure 1). The term digital CR refers to the multi-professional implementation with secondary preventive guidance and time goals that uses time-independent methods alone or in combination with face-to-face rehabilitation (Falter et al., 2020;Wongvibulsin et al., 2021). The literature review takes place in the background chapter to create a context for the study. A model related to concepts will be introduced only later in the results and discussion section.

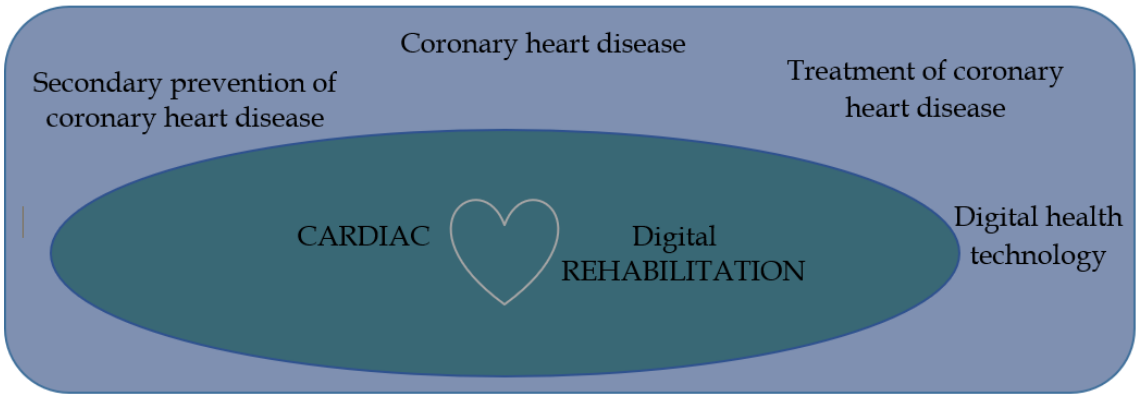

FIGURE 1 The background of the dissertation project.

2.1 Coronary heart disease

Despite tremendous progress in primary and secondary prevention measures, cardiovascular diseases (CVDs) remain generally known cause of mortality globally. In the European Union, they account for approximately 1.8 million deaths in 2019, which represents 36% of total deaths from all causes (Timmis et al., 2020).

Coronary atherosclerotic heart disease, also well-known as CHD, is also a public health problem, which is caused by buildup of atherosclerosis develops in the vessel walls (Virani et al., 2021; Visseren et al., 2021). A total of 8,600 people died of CHD in Finland in 2020 (Official Statistics of Finland [OSF], 2021). The incidence of CHD increases with age and is more common in men than in women. In 2020, CHD caused nearly one in five deaths in men and nearly one in eight deaths in women (OSF, 2021). This implies that secondary prevention is an important treatment globally (Ambrosetti et al., 2021; Kabboul et al., 2018).

2.1.1 Risk factors for coronary heart disease

The main modifiable risk factors for CHD lie in the biopsychosocial field, which include biomedical, psychosocial, and social risk factors (Goff et al., 2014; Visseren et al., 2021). These can be divisions into modifiable and non-modifiable risk factors (Ambrosetti et al., 2021). Non-modifiable risk factors are those that cannot be controlled. They include a person's age, sex, family history of heart disease, and ethnicity (Ambrosetti et al., 2021; McMahon et al., 2017; Visseren et al., 2021). Modifiable cardiac risk factors include high blood pressure and high cholesterol, obesity, uncontrolled diabetes, and other lifestyle risk factors, such as smoking, inappropriate diet, psychosocial stress, and sedentary behavior (Goff et al., 2014). Further, alleviating psychosocial problems such as loneliness, depression, and isolation, can reduce the risk of CHD (Albus, 2010). The rate of CHD mortality has steadily decreased, mainly due to secondary prevention interventions, improved treatment options, and the addressing of modifiable CHD risk factors (Kabboul et al., 2018). For instance, educational interventions together with regular physical activity and exercise training including physiologic adaptions (Sanchis-Gomar et al., 2021) and psychological therapy benefit cardiac health (Anderson et al., 2017).

2.1.2 Secondary prevention through patient education

Despite a decreased mortality rate, CHD remains a public health problem and has reduced many patients' quality of life (Anderson et al., 2017). Therefore, much attention should be given to the fact that each cardiac event is an individual experience and requires support to control patients symptoms and improve their prognosis (Al Hamarneh et al., 2011; Anderson et al., 2017). Secondary prevention of CHD is administered through a multidisciplinary CR program and patient education (Ambrosetti et al., 2021). Patient education within the realms of secondary prevention plays an asset part in improving cardiac patients' quality of life (Anderson et al., 2017) and preventing behavior risk factors (Kabboul et al., 2018; Leon et al., 2005).

Secondary prevention's main objective is to reduce the risk of coronary events and death in patients with clinically diagnosed heart disease (Kotseva et al., 2019). It focuses on decreasing patients' biomedical and lifestyle risk factors and increasing psychosocial and physical activity through patient education and exercise training (Goff et al., 2014; Leon et al., 2005). There are also suggestion

that education-based interventions may enhance health-related quality of life (Anderson et al., 2017). Thus, educating patients includes efforts to reduce behavioral risks, such as smoking/tobacco consumption, poor nutritional behavior, obesity, physical inactivity, the harmful use of alcohol, and psychosocial problems as social isolation, low social support, depression, stress, anxiety (Ambrosetti et al., 2021; Visseren et al., 2021).

Patient education can broadly be defined as the process of self-management. It aims to promote patients' health behaviors and ability to enhance their health and increase understanding about risk factors and their assessments (Al Hamarneh et al., 2011;Anderson et al., 2017). Patients with heart disease also receive educational rehabilitation, which increases their knowledge and understanding of CHD and its various symptoms (Al Hamarneh et al., 2011; Anderson et al., 2017). Health professionals provide information to patients that promote or improve their health behaviors (Kotseva et al., 2019;Virani et al., 2021; Visseren et al., 2021). The goal is that patients learn to understand the benefits of a well-balanced diet, exercise, and adherence to medication and the appropriate metrics or measurements, and thus, are more likely to change their behaviors sustainably (Kotseva et al., 2019). In this dissertation, the term "healthy behavior" refers to lifestyle behaviors that consider the person's actions about how to balance their everyday lives and maintain their physical, mental, and social health (Trovato, 2012; World Health Organization Regional Office for Europe, 1999). The concept of "lifestyle behavior change" is used to describe actions and responses, which may be spontaneous and involuntary and can promote or detract health (Trovato, 2012; World Health Organization. Regional Office for Europe, 1999).

To be effective, the education of the lifestyle risk factors must be based on a theoretical understanding of what happens in the patients' lives and how they and their families can provide support (Winter et al., 2016). The most commonly used behavioral change theories or models in technology-based risk factor interventions are social cognitive theory, transtheoretical model (TTM) (Prochaska et al 1992), theory of planned behavior (TPB) (Ajzen, 1985), and the Technology Acceptance Model (TAM) (Davis, 1989). Theories provide the framework for understanding how patient's health behavior advance after cardiac event as part of the rehabilitation process (Rahman et al., 2015). Social Cognitive Theory (SCT) focuses on the impact of patient experience, interaction of environmental, and individual health behavioral factors (Bandura, 1989; Bandura, 2005). The changes observed in the patients can be identified at the different stages of behavior change process by using change theories such as TTM (Prochaska et al 1992). The theories of behavior change, such as TPB (Ajzen, 2011) and TAM (Davis, 1989), have been used to research the objectives of and behaviors associated with using such technologies (Walsh, 2014).

2.1.3 Treatment of cardiac heart disease

CHD is branched into chronic coronary artery disease (stable angina) and acute coronary syndrome. The atherosclerotic process causes cardiovascular stenosis and/or obstruction. CHD develops from a chronic inflammatory condition of the

coronary arterial wall (Li et al., 2019). Coronary arteries of the heart cannot supply enough oxygen and blood to the heart muscle (Leon et al., 2005), often resulting from plaque buildup in the arteries (Munger & Hawkins, 2004). When this buildup occurs in the heart's arteries over many years, the arteries become cramped and eventually harden, decreasing the flow of oxygenated blood the heart (Munger & Hawkins, 2004). If one or more of the three large coronary arteries are more than 50% blocked, an unstable angina pectoris or myocardial infarction, non-ST-elevation myocardial infarction (NSTEMI), or ST-elevation myocardial infarction (STEMI) may result (Li et al., 2019). Symptoms of CHD may vary among individuals, even if they have the same type of CHD (Fihn et al., 2014). However, known or suspected symptoms in adults include angina pectoris symptoms as chest or arm pain, or a heart attack (Kotseva et al., 2019). Treatments for CHD involve heart-healthy life changes (Goff et al., 2014). Sometimes, treatments involve medications (Li et al., 2019) and/or procedures, such as coronary artery bypass grafting (CABG) or percutaneous coronary intervention (PCI)/ percutaneous transluminal coronary angioplasty (PTCA); PTCA/PCI is frequently used in patients with CHD (Fihn et al., 2014).

2.2 Multicomponent cardiac rehabilitation

Multicomponent CR is a secondary prevention strategy for cardiac patients and it promotes biological, psychological, and social wellbeing (Leon et al., 2005). CR is part of a large and complex concept. Historically, the term rehabilitation has been described as "the return of a person disabled by accident or disease to his/her greater physical, psychological, emotional, social, vocational and economic status" (Benton & Rusk, 1953, p. 417). The World Health Organization (WHO) has provided similar definition, "a set of interventions designed to optimize functioning and reduce disability in individuals with health conditions in interaction with their environment" (World Health Organization, 2020, p. 10).

2.2.1 Cardiac rehabilitation

In literature, the term CR is mostly defined as "coordinated, multifaceted interventions designed to optimize a cardiac patients' physical, psychological, and social function with the additional goals of stabilizing, slowing, or even reversing the progression of the underlying atherosclerotic processes, thereby reducing morbidity and mortality" (Leon et al., 2005, p. 369). This definition has been broadened to include secondary prevention interventions that use a multidisciplinary behavioral medicine approach from a biopsychosocial paradigm perspective including core components (Ahmadvand et al., 2018; Borrell-Carrio, 2004; Leon et al., 2005). Behavioral medicine tackles knowledge on how behavioral, biomedical, psychosocial, and environmental factors interact in health and illness (Schwartz & Weiss, 1978). The focus is on understanding individual behaviors and living conditions (Schwartz & Weiss, 1978). The biopsychosocial

model reflects the development of illness through complex interactions, not only involving biological factors, but also psychological and social factors (Engel, 1977). Core components of CR include assessment of patients perceptions, needs and goals, management and control of risk factors, psychosocial management, educational and vocational guidance, and physical activity and exercise training (Ambrosetti et al., 2021; Goff et al., 2014; Kotseva et al., 2019; Leon et al., 2005; Sanchis-Gomar et al., 2021).

The paradigm shift in rehabilitation within CR is linked to the launch of the WHO International Classification of Activities, Disability, and Health (ICF), which presents rehabilitation as a key health strategy in the 21st century (Stucki, 2016). To achieve full participations commitment, many different intervention frameworks may be needed, depending on the individual's type of disability (Stucki, 2016). In its call for action rehabilitation 2030, the WHO proclaimed rehabilitation as the "health strategy of the 21st century" based on the main goals of WHO, which are to promote healthy lives, well-being in all ages, and a long life expectancy (Briggs & Dreinhöfer, 2017; World Health Organization 2020, p. 10). On the other hand, numerous paradigms and approaches to rehabilitation models support the concept of rehabilitation. The concept of person-centered rehabilitation refers to a situation where a person with a heart disease has the opportunity to be actively involved and engaged in his own rehabilitation and decision-making (Morgan & Yoder, 2012; Walsh et al., 2012). Furthermore, the person-centered rehabilitation takes into account an individual's needs, values, preferences, and experiences in the management of his disease (Dancet et al., 2011; Esmaeili et al., 2016).

This definition of CR is also understood as an adjustment process that removes or reduces barriers to independent functioning and participation (Livneh & Antonak, 2005). The process of adaption in cardiac disease refers to the process by which patients continues to search for new state of perspective and understanding of life and the world (Park & Folkman, 1997). Patients' own emotion-focused coping strategies include cognitive and behavioral efforts to adapt to the disease (Lazarus & Folkman, 1984; Lundgren et al., 2018). The enhance of an individual's meaningful thoughts alleviates emotional anxiety and strengthens self-esteem (Livneh & Antonak, 2005) Social support also plays an important part of this process (Embuldeniya et al., 2013). According to Roy´s adaption model, a person is in constant interaction with the changing environment and all conditions surrounding his behavior (Andrews & Roy, 1994, pp. 18-19). Throughout this dissertation, the term CR also refers to a psychosocial adaption process.

2.2.2 Cardiac rehabilitation in Finland

In Finland, the organization of secondary prevention and CR are based on public healthcare by legislation. The Social Insurance Institution of Finland (Kela) also offers services for CR (Kela, n.d). Other providers include The Finnish Heart Association and its local branches, which supplement the public services by rehabilitation courses to support the follow-up health care of cardiac patients. One example is the TULPPA program (the name describes the Finnish word for

"thrombus") (The Finnish Heart Association, n.d.). Among the rehabilitation services that are offered to cardiac patients, health education is an important component. It includes advice on cardiovascular risk reduction, physical activity (Hautala et al., 2017), social support and stress management (Hämäläinen et al., 2000). The aim of the administrators of CR is to take into account individual needs and goals to ensure the best possible physical, psychological, and social conditions that allow the patient to return to his normal, active life (Ministry of Social Affairs and Health, 2020).

CR is recommended for patients with acute coronary syndrome, CABG, and PCI, to name a few. CR consists of three phases: Inpatient rehabilitation during a short hospital stay (phase 1), limited-time outpatient rehabilitation (phase 2), and, within comprehensive secondary prevention, modifications of risk factors and lifetime maintenance (phase 3) (Simon et al., 2018). In this dissertation, the context was the secondary prevention of CR that was delivered during phase 2 of CR (Simon et al., 2018). Traditionally CR is offered in group programs, which are offered on fixed days and at fixed hours. In recent times, rehabilitation may also be provided as digital rehabilitation. The latter enables, for example, those patients who live far away from the place where rehabilitation is physically delivered to participate (Kela, n.d).

CR is also designed to help patients understand the risk factors of CHD and thereby understand the importance of self-care (Al Hamarneh et al., 2011; Anderson et al., 2017; Visseren et al., 2021). This is important because many cardiac patients experience decreased physical activity or fear of exercise after a cardiac event (Bäck et al., 2020; Hautala et al., 2017; Sanchis-Gomar et al., 2021), as well as reduced psychological and social functioning (Albus 2010; Gallo et al., 2005; Schaufel, et al., 2011; Thomas et al., 2021). After a heart event, a cardiac patient's distress, anxiety, and depression can increase, their cognitive function can worsen, and their social support can decrease (Hare et al., 2014; Hämäläinen et al., 2000). Therefore, the psychological and social aspects of patient self-management should be considered in patient education about CHD (Al Hamarneh et al., 2011; Anderson et al., 2017; Hämäläinen et al., 2000; Gallo et al., 2005; Yates et al., 2018).

2.2.3 Digital health technology

The development of digital health technology is becoming more and more essential in preventing global CVDs and individual challenges. The concept of digital health is understood to mean "the field of knowledge and practice associated with any aspect of adopting digital technologies to improve health, from inception to operation" (World Health Organization, 2021, p. 2). The term digital health interventions encompasses technology that enables the delivery of care through, for example, computing platforms, connectivity, software, and sensors for self-care for cardiac patients and can combine measurement, monitoring, storage and analysis of personal data, including monitoring data for physical activity the heart`s function curve, blood sugar levels, heart rate and blood pressure (Falter et al 2020; Wongvibulsin et al., 2021). In addition to mobile phones, examples

of health information technologies include wearable sensors, telehealth applications, interactive voice response (IVR), robotic, gaming consoles, and virtual reality (Odone et al., 2019; Wongvibulsin et al., 2021).

Digital CR, for example telerehabilitation, is possible through rehabilitation that is accessible through communications technologies as smart phones, the internet, web portal, monitoring devices, and other utilities (Wongvibulsin et al., 2021). Wide-ranging technology enables new kinds of hybrid rehabilitation and enables the participation of different heart patients that are less dependent on time and place and increases their ability to seek, find, understand, and appraise personalized health information (Beatty et al 2013; Melholt et al., 2018). All this will require learning new ways of thinking, coping, and setting goals, which have been studied in the context of common digital interventions (Partridge et al., 2017; Richards et al., 2018; Schaufel et al., 2011; Thomas et al., 2021). Technology-intensive interventions should be used in effective behavior change techniques to encourage and support behavior changes, such as goalsetting, social support, prompts, self-monitoring, and feedback on healthy behavior (Davis et al., 2015; Michie & Abraham, 2004; Winter et al., 2016).

2.2.4 Digital cardiac rehabilitation

The digitalization of CR offers a new solution for promoting patient participation, engagement, and quality in life of cardiac patients (Falter et al., 2020; Odone et al., 2019). The term digitalization or digital CR including hybrid cardiac rehabilitation (using both in person and digital rehabilitation strategies) is used here to refer to multi-professional implementation with secondary preventive guidance and goal setting (Ambrosetti et al., 2021; Goff et al., 2014; Kotseva et al., 2019; Leon et al., 2005). The meaning of digitalization is not an aim in itself, but is a relevant tool for providing a solution to many patients who do not engage in traditional rehabilitation (Maddison et al., 2015; Odone et al., 2019).

Rehabilitation services have been developed in such a way that they can be available flexibly in real-time, either with time independent methods or in combination with personal rehabilitation techniques (Neubeck et al., 2012; Rawstorn et al., 2018). The technology in CR is professionally coached and monitored; it is a form of rehabilitation with a clearly defined beginning and end, which enables the treatment of patients in their own homes with real-time and personalized support (Falter et al 2020; Wongvibulsin et al., 2021). Cardiac patients have also shown growing interest in using technology (Buys et al., 2016; Melholt et al., 2018), and participating in digital rehabilitation due to increasing digitalization (Rawstorn et al., 2018). This dissertation project used the concept of digital rehabilitation, which refers to a combination of rehabilitation that combines face-to-face traditional CR with the use of digital technology between face-to-face rehabilitation periods.

The use of digital technology in CR has mainly been studied from the effectiveness and usability or functionality viewpoints. Various technology-intensive interventions for CR deal with studies that have assessed the efficacy and usability of the platforms aimed at increasing physical activity (Pfaeffli et al., 2012;

Maddison et al., 2015; Rawstorn et al., 2016). Others have highlighted the relevance of patient education (Melholt et al., 2018). Much of the available literature on digital rehabilitation focuses on life changes (Winter et al., 2016) and self-management (Antypas & Wangberg, 2012).

2.2.5 Experiences from digital cardiac interventions

There are few qualitative studies, which have focused on the experiences of cardiac patients who have participated in technology-based interventions. The majority of the existing research in the field of internet-based programs have explored a life change (Jarvis-Selinger et al., 2011; Pfaeffli et al., 2013; O'Shea et al., 2020). The most widely investigated area has been the promotion of physical activity (Jarvis-Selinger et al., 2011; O'Shea et al., 2020; Pfaeffli et al., 2013; Smith et al., 2015) and digital tools for education and motivation in CR (Baek, et al., 2018; Beatty, et al 2013; Salvi, et al., 2018). In additional, research has been focused on the patient-perception of a virtual world-based rehabilitation (Banner et al., 2015), wearable activity (Andersen et al., 2020), web-based programs (Melholt et al., 2018; Nordin, 2017), teleconsultation (Demirci et al., 2019), and gamification as part of CR (Dithmer, 2016).

The results have shown that the web-based intervention part of rehabilitation was largely accepted, and beneficial for patients' education (Melholt et al., 2018; Nordin, 2017). The mHealth tool encouraged participants in sharing data with providers (Beatty et al 2013) and increased participants' access to healthcare professionals, improving health education (Baek et al., 2018; Smith et al., 2015). Virtual CR supported them to make healthy choices, and enabled self-assessment and communication with healthcare providers (Banner et al., 2015). Gamification could be a new way to motivate cardiac patients by using technology as a social and active approach to telerehabilitation (Dithmer, 2016). Timely access to a health-care professional and the interactive tools, like real-time video, seemed particularly important to the users (Baek et al., 2018; Beatty et al., 2013). The acceptance to use and usefulness of technologies in promoting health in general, and in the rehabilitation of cardiac patients in particular, depend on the patients' attitudes toward the technological use means (Nabutovsky et al., 2020). The mHealth tool encouraged participants in sharing data with providers (Beatty et al., 2013) and increased participants' access to healthcare professionals, improving health education (Baek et al., 2018; Smith et al., 2015).

2.3 Rationale

Based on literature cited in this section, it can be concluded that it is important to expand the understanding of cardiac patients' experiences, attitudes, and perceptions, toward the technological methods as part of their health care; however, there is also still very little scientific understanding on this (Falter et al., 2020; Wongvibulsin et al., 2021). However, most of the research done so far has used

the framework and usability of technology in rehabilitation (Pfaeffli et al., 2012; Maddison et al., 2015; Melholt et al., 2018). While some research has been carried out on digital rehabilitation, there is a need for more knowledge and understanding on the complexity of what is going on in the digital CR area (Walsh, 2015). Additionally, more research is needed about various behavioral change management educational methods for digital rehabilitation and their adaptation to the needs of the patient (Nabutovsky et al., 2020). For instance, Winter et al (2016) argues that behavior change theories and techniques require consideration in technology-intensive interventions as risk factors for self-management. This could be met by a model or framework that describes the integration of the digital CR process to support secondary prevention guidance for behavior change in patients to tailor digital tools to patient needs. Currently, no such conceptual theory or model exists. Consequently, there is a need to develop a model to embrace a patient perspective and support patients' rehabilitation process. The model allows to create a systematic theoretical structure within key concepts and their connections. This dissertation follows Barney Glaser's GT approach, and can be defined as the discovery of theory from a systematic theoretical structure consisting of concepts and their connections which are analyzed using a comparative analysis (Glaser & Strauss, 1967, p. 2).

3 AIMS OF THE INDIVIDUAL STUDIES

However, despite the growing knowledge base on the digital development of CR, it has rarely been studied from the point of view of the cardiac patients themselves, nor has it been studied for model development. The purpose of the present dissertation project was to create a conceptual model based on three published articles to conceptualize the process of digital CR related to technology use, lifestyle risks, and health behaviors. The conceptualization of the digital CR process was conducted using a GT approach. This dissertation project sought to create a conceptual model in responding to the following specific research questions:

Q1 What kind of groups can be found on the basis of the cardiac patients' experiences with technology and their attitudes toward technology before the completion of 12 months of digital CR (Study I)?

Q2 What kind of differences can be identified in these groups' profiles when comparing them in terms of biomedical, psychosocial and environmental factors and how do these deepen the understanding of these profiles in CR (Study II)?

Q3 What kind of different meanings do patients give to the rehabilitation process after CR (Study III)?

Q4 After publishing the three articles, I focused on the conceptual model development. What kind of conceptual model emerges and how does it resolve cardiac patients' main concern on the digital CR?

4 METHODOLOGY AND METHODS

The aims, methods, and analysis options of the present dissertation project were linked to GT methodology with a Glaserian approach. I chose to apply GT as a method, due to my interest in understanding how cardiac patients' behavior change could be supported in the process of digital CR. The choice of GT was also a personal decision, as my view of the substantive area was that CR is a multiple process, with digitalization bringing a change to the existing process. However, the methodology principles of the GT helped provide a conceptual overview of the phenomenon through the participants' views to generate a conceptual model of substantive area. The essential methodological principles that comprise GT methodology are as follows: Constant comparative methods, theoretical sensitivity, theoretical sampling, and theoretical saturation (Glaser, 1978, p. 101; Holton, 2008; Levers, 2013).

4.1 Grounded theory methodology selected

Glaserian grounded theory is appropriate when the goal of the research is to generate a conceptual theory or model based on inductively research data, that is, "the discovery of theory from data" for describing and explaining using the constant comparative method (CCM) (Glaser & Strauss, 1967). The GT method is not just about describing a research object using concepts, but also about discovering a theory (Glaser, 1978, p. 32) or a model (Andersen et al., 2013; Jacobsson et al., 2004). The model also assists in having an understanding of the causes related to the main structure of the process (Andersen et al., 2013; Glaser 1978, pp. 74-75).

The dissertation project was guided by a CCM, which is a strategic method for coding and conceptual category development with theoretical sampling (Glaser, 1978, p. 2; Glaser & Strauss 1967, pp. 21-23). The data generation was guided by a process of ongoing analysis through coding and memoing, a procedure known as theoretical sampling. Theoretical sampling is a purposeful sampling strategy that allows the researcher to decide which data will be used as the

current data and/or the collection of data that will be used during the succeeding analysis (Glaser, 1978, p. 36).

While preparing for a GT study, it was important to have theoretical sensitivity that covered the entire data collection and analysis process without any preformed hypothesis or preconceptions about the results (Glaser, 1978, pp. 3, 36; Holton & Walsh, 2017, p. 25). Theoretical sensitivity also involves the researcher's professional and educational background, personal practical experiences, and knowledge about CR. Through this theoretical sensitivity integrating practice and grounded theory, I develop the ability to manage and modify theoretical knowledge about CR. Considering my background in being nurse for CR, as well as being an advocate for health education, I felt that I wanted to increase my understanding of the lived experiences of cardiac patients in the context of digital CR. My goal was to discover and articulate the voice, experience, thought process, and emotions of the cardiac patients about digitalization on rehabilitation, while understanding their insights on behavior change. Because the present aim was to explore the participants' main concerns and the basic social processes related to it (Glaser, 1978; Glaser & Holton, 2005), the GT approach was the most appropriate choice and was used with a variety of methods for data collection and conceptualizing the complex phenomenon.

This dissertation study sought to conceptualize the process of the digital CR for the development of a model through the use of mixed methods GT (Glaser, 2008, p. 11; Holton & Walsh, 2017, p. 3; Johnson & Walsh, 2019; Walsh, 2015). Mixed methods refers to the mixing or interplay of various aspects, such as perspectives, qualitative and/or quantitative methods, methodologies, and paradigms (Creswell & Clark, 2018; Walsh & Johnson, 2019). This definition highlights that this is an approach that offers a broad form of looking at research objects in multiple ways to better respond to the research question (Glaser et al., 2010, p. 30; Walsh, 2015; Walsh & Johnson, 2019). Considering that the purpose of this dissertation was widely rooted in my interest in the secondary prevention of CR and the related management of risk factors, a qualitative and quantitative combination of the GT approach proved to be the best choice. These foundational pillars of GT are a good fit for this dissertation, since it seeks to better understand the main concerns of cardiac patients and create a model for the conceptualization of the processes involved in digital CR.

4.2 Study design

This dissertation project was a part of a wider registered research project on digital health technology in CR as hybridi CR (EtSy); more detailed information about design is found in the ISRCTN Registry (ISRCTN61225589). The study is conducted in cooperation with the University of Jyväskylä, Kela and a rehabilitation center in Middle Finland.

The participants of the wider research project were recruited by the officers of Kela; they also scheduled the periods for rehabilitation for each group between

September 2015 and May 2016. CR courses were conducted in groups of 10 and the 15-day total duration was divided into three 5-day periods over one year. The participants were recruited from adult patients (18 years or older) with CHD, who had cardiovascular risk factors or angina pectoris with a marked physical capacity limitation, myocardial infarction episode, or have undergone CABG or PTCA. Participants (n=70) had been allocated into the experimental groups, namely the pilot group (n=40) and control groups (n=30); one patient left the experimental group at the beginning of study.

Patients from the experimental and control groups participated in a traditional rehabilitation course (Kela, Cardiac rehabilitation course for adults, n.d). The traditional rehabilitation course supports the patients' physical, psychological, and social ability to work or study, to perform life changes and daily activities, and to understand their own illness and how it changed their situations. In traditional group rehabilitation, peer support and sharing of experiences promote the individual rehabilitation process (Kela, Cardiac rehabilitation course for adults, n.d). The experimental groups (n=3 group) and pilot group (n=1 group) in which a total of 39 cardiac patients, who also used digital health tools in their traditional CR. Between the rehabilitation periods, the intervention provided patients with web-based coaching via an electronic software (m-Coach Movendos, Finland) related to the patient's own goals and aspects of secondary prevention, such as physical activity, stress management, sleep quality, and diet. Web-based coaching consisted of social and professional support, such as peer group connection and monthly feedback from physiotherapists. Patients monitored daily physical activity with an activity tracker accelerometer (Fitbit Charge HR®, USA). The web-based coaching was based on several behavioral change techniques, such as individual goalsetting, educational materials and patient information, social support, peer discussion, prompts, self-monitoring in a diary, and feedback about healthy behaviors.

4.3 Participants

The dissertation project used a purposive sampling method that included three experimental groups and one pilot group with a total of 39 cardiac patients who used digital health rehabilitation technology. Participants were 26% female (10/39) and 74% male (29/39); of them, 32 (82%) underwent coronary angioplasty, while 4 (10%) had undergone PTCA 3−12 months prior to rehabilitation. The mean patient age was 54.8 (range, 34–77) years. Of the study background, 71% (27/38) had completed lower professional education. The study participants had no musculoskeletal disorders or cognitive/memory impairments, were able to use a computer and mobile application, and could access the internet at home or with family members or friends. An overview of the participants' characteristics is presented in Table 1.

TABLE 1 Demographic baseline characteristics of the participating cardiac patients.

Characteristics	n/total
Sex	
Male	29/39
Female	10/39
Age	
<55 years	20/39
55+ years	19/39
Marital status	
Married	20/38
Unmarried	6/38
Cohabiting	4/38
Divorced/separated	8/38
Education	
Vocational or trade	27/38
College	6/38
University of applied sciences	5/38
Operation	
Coronary artery bypass graft	3/39
Coronary angioplasty	31/39
Coronary artery bypass graft and coronary angioplasty	1/39
Surgical timing	
0-12 months before rehabilitation	25/39
>12 months before rehabilitation	10/39
None	4/39

4.4 Data generation methods

The choice of methods and generation of data were linked to the GT methodology using a Glaserian approach. The main data used in the dissertation project was already gathered from the wide EtSy project, where I worked as a nurse on the cardiac courses. As part of the research group, I actively participated in quantitative data collection and participated in the formation of interview questions, and the planned interview questions were also modified during data collection process. The dissertation project consisted of the three studies. The qualitative data generation consisted of face-to-face focus group interviews conducted by another researcher at a rehabilitation center. The focus group interview was chosen as a data collection method to gather a more diverse understanding of the participants' experiences, attitudes, and perspectives (Wengraf, 2001). The quantitative data generation process was performed using a variety of methods, including measurements of waist circumference, physical fitness the 6-min walk test (6MWT), and light-intensity physical activity (LPA). The WHO Quality of Life-BREF (WHOQOL-BREF), International Physical Activity Questionnaires (IPAQ), Self-Efficacy to Regulate Exercise Scale (SERES), the Behavior Regulation

in Exercise Questionnaire-3 (BREQ-3) and 10-item Depression Scale (DEPS). Table 2 presents a methodological overview of the three studies.

TABLE 2 Methodological descriptions of the analyzed studies.

Study	Design	Participants	Data Generation
I	Qualitative	39 patients	Face-to-face semi-structured and focus group interviews
II	Quantitative	39 patients	Measurements: waist circumference, LPA, 6MWT. Questionnaires: WHOQOL-BREF, SERES, DEPS, BREQ-3 Web-based participation (number of tasks and messages)
III	Qualitative	30 patients	Face-to-face semi-structured and focus group interviews

6MWT, 6-min walk test; BREQ-3, the Behavioral Regulation in Exercise Questionnaire-3; DEPS, 10-item Depression Scale; IPAQ, International Physical Activity Questionnaire; LPA, light-intensity physical activity; SERES, Self-Efficacy to Regulate Exercise Scale; WHOQOL-BREF, World Health Organization Quality of Life BREF

4.4.1 Technology experience and attitude groups (Study I)

First, due to my interest in understanding patient technology use behaviors and attitudes, I selected a semi-structured focus group interview as the method of generating the qualitative data (n=39); the interviews were conducted of 10 female and 29 male cardiac patients. The questions were presented to the group face-to-face. The other interviewer performed the interviews, which consisted of four focus group discussions at the beginning of the CR. The interviewer encouraged the participants to speak openly about their experiences and attitudes toward technology prior to using digital technology. The questions were mostly the same series of open-ended questions that were posed to all subjects. They were asked questions like, "Tell me about your experience of modern technology in the past," "What are your expectations for technology in rehabilitation?" and "What would you like to see from the use of technology in the future?" The interviews were audio-recorded digitally; each lasted 30–60 min—overall, a total of 156 min. The transcripts were imported into ATLAS.TI computer software.

4.4.2 Group biopsychosocial profiles (Study II)

Second, this dissertation study sought to identify the groups' profiles by comparing their biomedical, psychosocial, and environmental, lifestyle risk, and health behavior factors. Study II's purpose was to further understand the previous qualitative results. The qualitative results addressed the behavioral diversity in the four previously defined technology usage groups. In the study II

measurements that were conducted in 39 patients, quantitative data were gathered during a 12-month rehabilitation period.

This analysis contained 13 biopsychosocial variables related to CHD biomedical, psychological, social, environmental, lifestyle risk, and health behavior factors. The biomedical risk factors for CHD refer to things like physical inactivity and obesity (Goff et al., 2014). Thus, the biomedical variables that were selected included waist circumference and physical fitness (6-min walk test 6MWT) (Steffen et al., 2002). In additional, physical activity was measured using LPA (Bull et al., 2020) using a Fitbit tracker. Physical activity was also monitored through a self-reported IPAQ (Craig et al., 2003). The quality of life questionnaire on physical health (Domain 1) used as The World Health Organization Quality of Life-BREF (Skevington & O'Connell, 2004).

Psychological risk factors, such as depression, low psychological quality of life, poor self-efficacy and behavioral control are associated with increased CHD (Ambrosetti et al., 2021; Visseren et al., 2021). These risk factors were measured with three questionnaires: SERES (Bandura, 2006), the BREQ-3 (Ingledew et al., 2004) and Quality of Life-BREF include psychological health (Domain 2) (Skevington & O'Connell, 2004).

Social risk determinants, such as lack social support, social isolation, and low participation are also well-known risk factors for CHD (Albus, 2010). This also included a quality of life questionnaire, Quality of Life-BREF with social relationships (Domain 3), and environment (Domain 4) domains (Skevington & O'Connell, 2004).Thus, activity to use digital platform (Movendos) was measured by individuals' visits to the site, including how many pages they visited, how many tasks they had completed, and how many conversations they had participated in during the 12 months of intervention.

4.4.3 Meanings of rehabilitation process (Study III)

Third, semi-structured focus groups interviews were selected to explore what kind of different meanings patients assign their rehabilitation process, where behavior changes play an important role. The semi-structured interviews were conducted in cardiac patients *(*n = 30), which included 8 women and 22 men, with each focus group including 5-9 patients who were at the end of their rehabilitation process. Participation in the interview was voluntary and five patients did not participate in the interview during the end of rehabilitation period. The other interviewer than the researcher conducted the interviews in a rehabilitation center and lasted approximately 30-90 minutes. The interviewer was free to deal with the themes during interviews included these key steps: "What were your meaningful experiences during the rehabilitation process?"; "How was the peer group meaningful for you?"; "What are your experiences of how technology has been a help to you in coping with daily life and life changes?"; "What are your experiences of cooperation in the last 6 months in the web-based platform?"; "What are your experiences of web-based coaching via a computer?"; and "What are your experiences of feedback on the results of the group during rehabilitation?" The interviewer asked additional questions as needed.

4.5 The analysis phases of the project

The dissertation project analysis was based on a data-driven approach that uses CCM with the principles of GT (Glaser, 1998, p. 3; Glaser & Strauss, 1967, p. 3). During CCM, data generation was guided by the ongoing analysis, which included a coding process, a procedure known as theoretical sampling. In phase I, the researcher began the analysis of study I before study II, and study III continued after study II.

The first data analysis phase of GT began with open coding of the data. The open coding analysis consisted of interviews and a statistical analysis. This analysis was undertaken to conceptualize the data by coding them to form subcategories and emergences categories and core categories into which they fit (Glaser, 1978, p. 2).

In the second phase, the researcher developed a model. This phase of the analysis includes both selective and theoretical coding (Glaser, 1978, p. 3; Holton, 2007). The selective coding process was used to determine the more dense and saturated core category. Finally, theoretical coding conceptualization was used to create a model. The conceptual model that emerged integrates all categories (substantive codes) with the core category during the sorting and memoing phases of GT (Glaser, 1978, pp. 73-74, 81, 93). These phases are summarized in Figure 2.

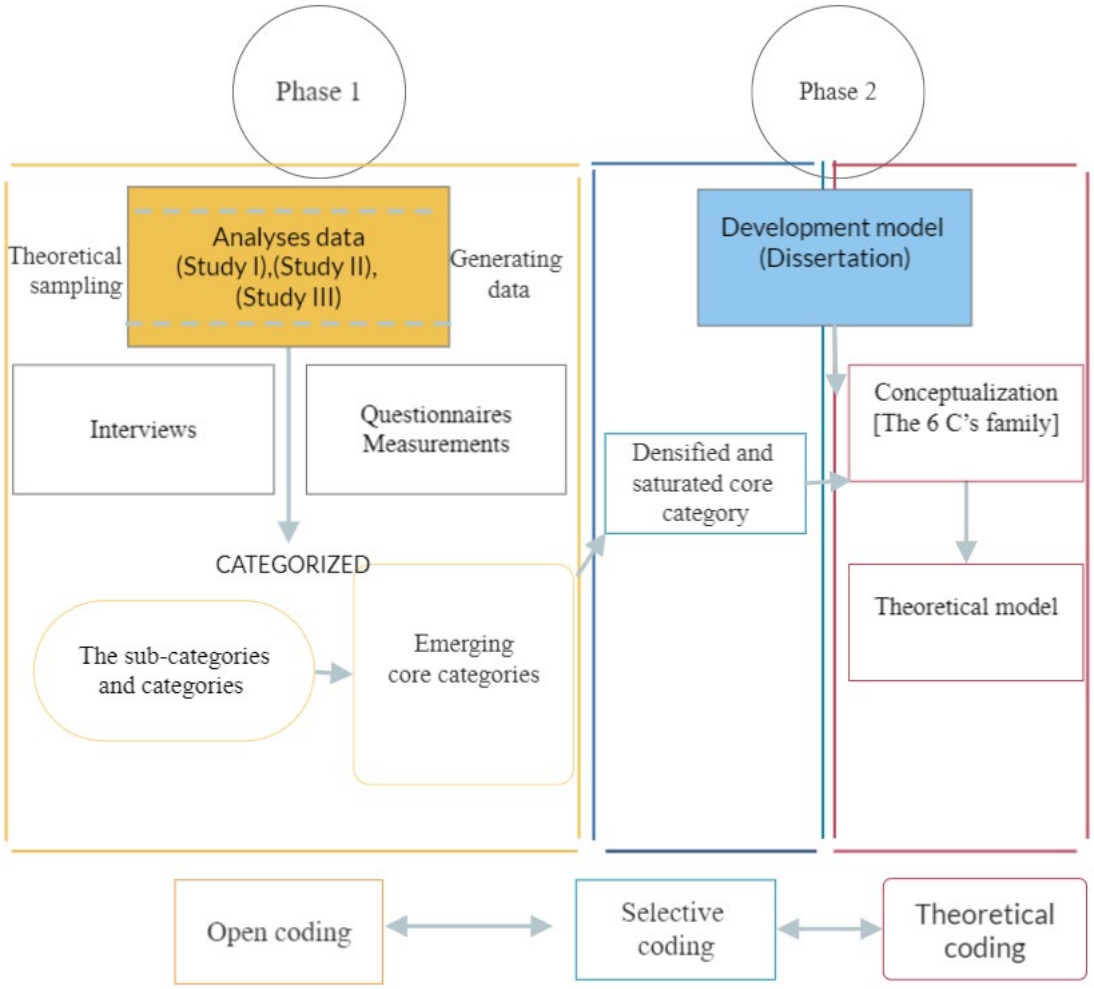

FIGURE 2 Constant comparative analysis process and writing free-form memos. Categorization with open coding

In the first phase, the interview data (Studies I and III) and the statistical data (Study II) were coded and categorized for the identification of core categories and related concepts (Glaser, 1978, p. 2). The coding of the interview data started with open coding substantively, meaning that each incident was compared with other incidents in the dataset (Glaser, 1998, p. 140; Holton, 2007). Beginning with systematically reading the open coding of the data line by line and asking a series of the questions: "What's going on?", "What category does this incident indicate?', "What is actually happening in the data?" (Glaser, 1978, p. 57). As a researcher, coding and writing analytic notes (memos) of ideas about codes during the open coding process plays an important role (Glaser, 1978, p. 83). Next, the researcher coded the different incidences into as many categories as possible.

The coding of statistical data (Study II) also included the categorization process. Statistical analyses examined differences in biomedical, psychological, social, environmental, lifestyle risk, and health behavior factors among the four groups of patients with cardiac disease; these groups (Study I) were based on e-usage. In the first study, two researchers independently read the interview responses and divided them into four e-usage groups (more design details are

found in original publication II). In Study II, statistical analysis examined the intergroup differences in biopsychosocial variables. The researcher and a statistician used the following statistical tools: mean, analysis of variance, and t-test or a non-parametric test, i.e., Mann-Whitney and Kruskal-Wallis tests. The tests were used to measure the significance of the intergroup differences using Tukey's honestly significant differences test or the Kruskal-Wallis test (both with Bonferroni correction) using the SPSS statistical package (version 24; SPSS, Chicago, IL, USA). After the quantitative analyses, the researcher compared the groups' results in terms of recommended and reference values.

4.5.1 Core category formed by selective coding

In the second phase, the researcher continued the dissertation project to develop a model. This phase of the analysis included selective and theoretical coding. During the selective coding process, the researcher focused on categories related to the core categories (Glaser, 1978, p. 61; Holton, 2007). The data were carefully coded to theoretically saturate the core and its related concepts and avoid missing an important category (Holton, 2007; Glaser,1978, p. 93). The analysis progressed once a potential core category had been densified and saturated (Glaser, 1978, p. 61; Holton, 2007).

During the analysis, there was an ongoing dialogue about the data, which was an important part of writing memos to ensure theoretical sensitivity. Memo writing was a constant process that theocratized a write-up of ideas about the codes and their relationships and then sorted them (Glaser, 1978, pp. 16, 83; Holton & Walsh, 2017, p. 78). I either wrote or drew my reflections (text, pictures, mapping, recordings of the conversations, and feedback from my researcher group) about my thoughts, ideas, and questions during the data gathering, coding, and analysis processes. Documenting memos was an important part of the decisions made at each study phase. It also provided key tools for decision-making in the model creation process. Other individuals also helped me remember the pertinent details for decision-making.

4.5.2 Conceptualization of the process in the 6 C's family

The second phase progressed to theoretical coding. The term "theoretical coding" used by Glaser (1978) referred to "the theoretical codes that conceptualize how the substantive codes may relate to each other as a hypothesis to be integrated into theory" (Glaser 1978, p. 72). The researcher sorted free-form memos during the process that reflect hypotheses about the connections between theoretical memos, categories, and the final core category (Glaser, 1978, pp. 116, 133). Therefore, only on those concepts chosen that are related to the core category as a fully integrated theory (Glaser, 1978, pp. 55, 93).

Conceptualization of the process helps "coding families." Glaser (1978) identified the general uses of coding families to help researchers integrate and write about their substantive theories or models. These two uses specified by Glaser (1978) were: 1) promoting the researcher's ability to maintain a conceptual

level in writing, especially when it is about concepts and the relationships between them, and theoretical codes can be observed for usefulness and fit; and 2) preventing researchers from overlooking other aspects of the family and indeed other related coding families (Glaser, 1978, pp. 73-74, 81, 93). Glaser (1978) listed 18 "coding families," one of which is the 6 C's (Figure 3), which stands for causes, contexts, contingencies, consequences, covariances, and conditions (Glaser 1978, pp. 74-75).

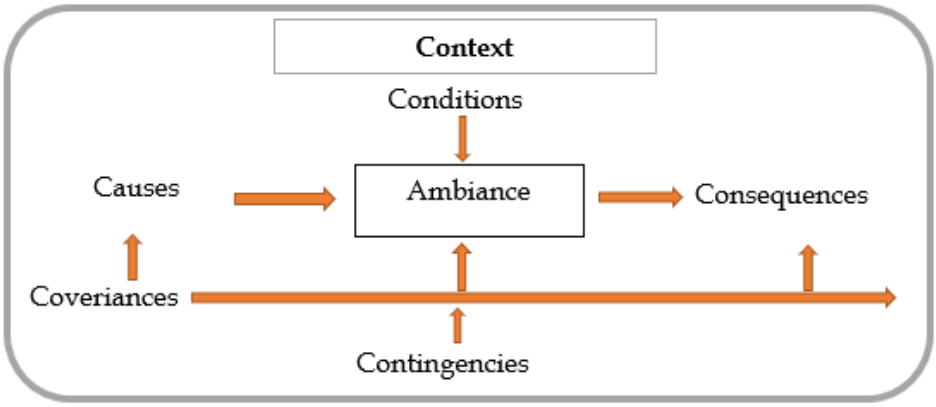

FIGURE 3 Glaser's (1978) 6 C's family includes causes, contexts, contingencies, consequences, covariances, and conditions.

In this dissertation project, the 6 C's coding framework facilitated the development of a more detailed coding structure by helping integrate concepts into processes and document the results. The 6 C's helped the researcher confirm the main core category and related categories and the properties and dimensions as the basic social structural processes that unite them. Thus, the theoretical code for the model represents the best fit with the basic social process (Glaser, 1978; Glaser & Holton, 2005).

4.5.3 Development of a conceptual model

In the theoretical coding, the researcher continued to integrate concepts into the hypothesis when resolving the main concern (Glaser, 1978, p. 93). Additionally, the prime function was to create a dense and saturated model (Glaser, 1978, p. 93; Holton, 2007). The researcher was able to discover that, by using criteria for fit, work, relevance, and modifiability, a theory must fit the data and be relevant to the field under study. Moreover, it must work; in other words, it must be able to explain the behavior under study (Glaser, 1978, pp. 4-5; Glaser & Strauss, 1967, p. 3). Finally, the researcher searched the literature for various parts of the theory to compare properties and provide a broader view of their similarities and differences. The core category was theorized and synthesized with extensive literature references. In this dissertation, a conceptual model was developed that included a main core category, which provides a model in the context of CR.

4.6 Ethical considerations

The study contributes to the body of knowledge on health digital technology in CR studies. The Ethics Committee of the Central Finland Health Care District (6.10.2015) and Kela (10.9.2016) approved this study. During this study, the researcher explored the role of a cardiac nurse and a researcher when patients completed rehabilitation. The researcher also participated in the study without compromising participant identities. The participants were informed in writing about the study prior to rehabilitation; when they arrived at the rehabilitation center, they were given information orally before their written permission was obtained. Their participation in the study was voluntary, and each had right to refuse to participate without affecting their own rehabilitation program if they so wished. Participants were also asked for their permission to record the interview on a recording device that could be turned off at any time during the interview. Only the research group had access to the data collected from the interviews, questionaries, and measurements. The participants were identified by personal number codes, and the details about the password-secured login were provided only to the research group. Only the principal investigator had access to which code referred to which study participant. The study results did not contain any identifiable information about the individual participants. The individual quotes have been described in the dissertation, but all possible precautions were taken to disguise the study participants' identities.

The researchers strictly adhered to the research ethics guidelines for data processing in terms of fairness, equality, and honesty. The research adhered to all of the ethical principles stated, therefore, its results are reliable. In terms of theoretical sensitivity, it was necessary that the researcher made observations with an open mind throughout the data collection and analysis process. Having an open mind allowed the researcher to analyze the research findings without any preconceptions and by genuinely asking what is happening and what is central to patient concerns. It also supported the writing of sections on the data analysis and conclusions without overinterpreting the results or forcing the data to reach a particular conclusion. The researcher of this dissertation had the main responsibility of conducting the quantitative data analysis with the assistance of a statistician. The researcher wrote the original article, reviewed it, and made the necessary changes after discussion with other authors.

5 TRUST-BUILDING ENABLING PERSONALIZED LIFE CHANGES MODEL

The purpose of this dissertation was to create a model conceptualizing the phenomenon of interest, that is, technology use and lifestyle risk behavior in the digital CR process. The conceptual model emerged based on three study results. In this section, the researcher presents the main results and generates the model around the analytical phases.

5.1 Results of three studies

The main results of the three studies showed that the core category was *enabling personalized and trusting in life change* based on three study results: *cardiac patients' identification of e-usage in the behavior change process* as *identifying e-usage in the behavior change process* (Study I), *reflecting lifestyle management* (Study II), and *complex trust-building process* (Study III) (Figure 4).

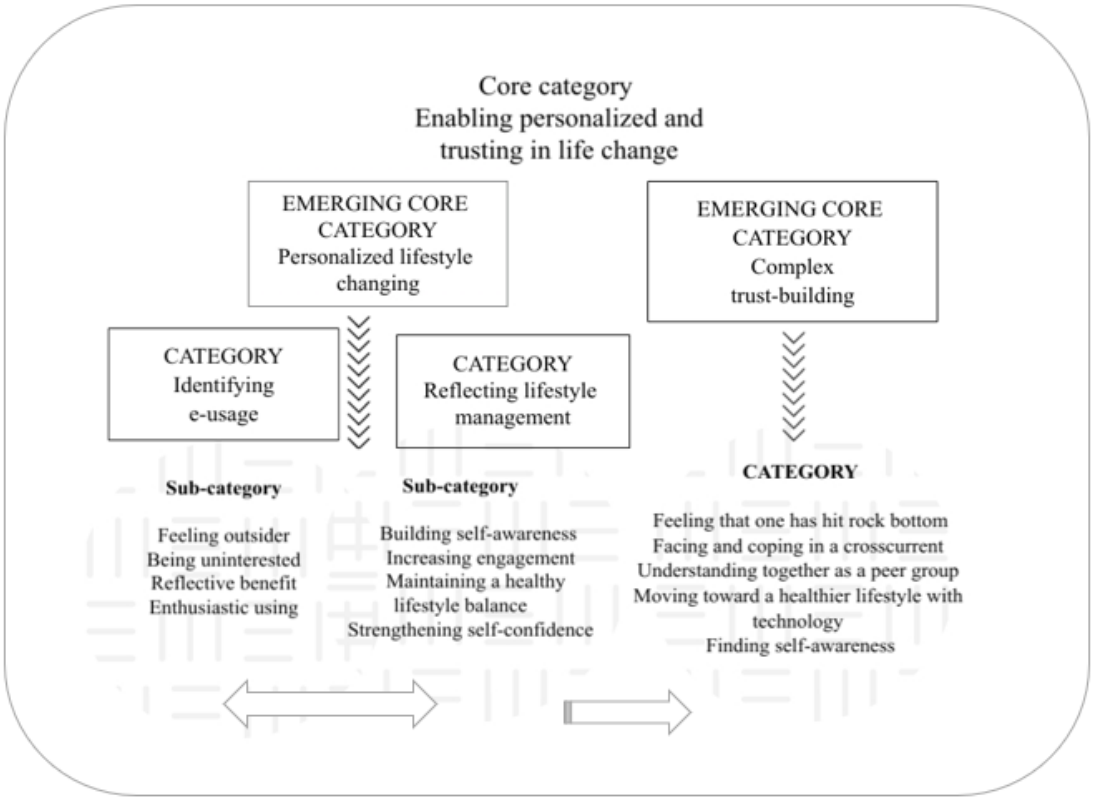

FIGURE 4 The main results of the three studies results indicated a saturated core category containing two core categories as well as sub-categories.

5.1.1 Identifying the e-usage groups (Study I)

Study I was based on the qualitative analysis of technology use based on the associated behaviors and attitudes of patients with cardiac disease that were assessed before digital rehabilitation. The research question of the first qualitative sub-study was to determine the experiences and attitudes patients had toward technology in general. The results of *identifying e-usage in the behavior change process* described the experiences of 39 patients. The descriptors of the patients' prior technology use behaviors and attitudes included *feeling like an outsider*, *being uninterested*, *reflecting on the benefits*, and *enthusiastic use*. The *feeling like an outsider* and *being uninterested* groups required more face-to-face counseling, while counseling was sufficient in the *reflecting on the benefits* and *enthusiastic use* groups. Concerns regarding technology usability were more widespread, indicating that technology should be simple, flexible, and easy to use and learn. The *identifying e-usage in the behavior change process* category, which was created based on subcategories and four dimensions of the patients' e-role and e-usage, enabled participation in e-process and behavior change counseling and coaching (Figure 5).

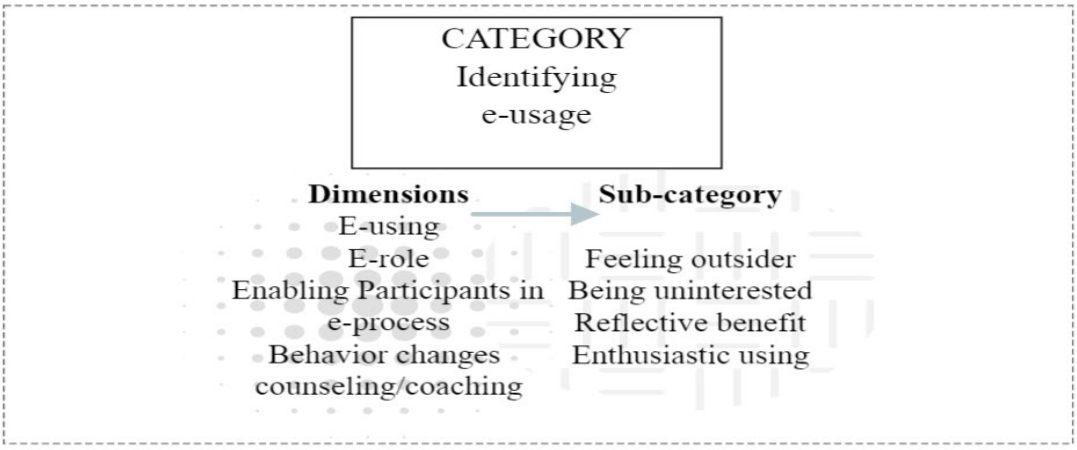

FIGURE 5 The identifying e-usage in the behavior change process category and its sub-categories and the dimensions of e-using.

The first group, *feeling like an outsider*, reflected patients' concerns about the experience of feeling like an outsider while using technology. These participants found the technology fearsome and were disappointed about the lack or absence of encouraging technology and adequate positive support. The second group, *being uninterested*, reflected the experiences of patients who are conversant and have experimented extensively with technology. Their opinions differed about the need for and occasional use of health technology outside of work, as they were not interested in using the solutions in their spare time. Patients felt that empowering digital support that generates a positive spark interest in change includes feedback on the progress of weekly tasks. One concern regarding motivation in using technology was whether technology could support behavior change by employing simple methods, such as regular reminders and prompts. Most participants agreed with the statement that health technology should be problem-free. The subjects in the third group, *reflecting on the benefits*, maintained an interest in technology only when they had a use and need for it in everyday life. There were some suggestions about technology being an easy-to-use interactive tracking tool with personalized information. These views surfaced mainly in relation to the subjects in the fourth group, *enthusiastic use*, who use smoothly functioning technology diversely, like for self-tracking with a personalized lifestyle feedback. The category *identifying e-usage in the behavior change process* describes the diversity of patients' technology usage behavior. Their different needs for technology use should be considered in web-based guidance and coaching planning to encourage participation in the digital process.

5.1.2 Reflections of lifestyle management (Study II)

Study II used quantitative data and examined the differences in biomedical, psychological, social, environmental, lifestyle risk, and health behavior factors of CHD components among these four groups based on their different experiences and attitudes about technology: *feeling like an outsider*, *being uninterested*, *reflecting on the benefits*, and *enthusiastic use* (Study I).

The category of *the reflecting lifestyle changing as part of the rehabilitation process* is associated with different biopsychosocial narrative descriptions (profile) in digital rehabilitation. The *feeling like an outsider* and *being uninterested* groups had high-risk lifestyle behaviors. The *being uninterested* group had a larger mean waist circumference than the *enthusiastic use* group. The *feeling like an outsider* and *being uninterested* groups had lower physical fitness (6-min walk test) levels than the *enthusiastic use* group. These views surfaced mainly in relation to the self-management of lifestyle risk factors, such as daily physical activity and weight. These groups' adherence to the web-based program was low. The group with the profile *feeling like an outsider* showed that they felt fearsome to use technology and so they need positive support for using technology and increasing their self-awareness. The *being uninterested* group had a lower self-efficacy, and they might have quickly given up when they ran into difficulties. They may need increasing engagement and motivation in activity empowerment and patient education, including self-monitoring with reminders and prompts, as they are externally motivated. Based on the profiles, the study identified profiles related to the rehabilitation process. Based on these results, the profile for the *feeling like an outsider* group was renamed *developing self-awareness* (Table 3) and the profile for the *being uninterested* group was renamed *increasing engagement* (Table 4).

TABLE 3 Differences in biopsychosocial factors among *feeling outsider* (n=8) group between *being uninterested, reflecting on the benefits*, and *enthusiastic use* groups.

Qualitative data	Proposition	Variables	RV	Mean	Statistically significant differences (*P*<.05) between groups	Group 1, the *feeling like an outsider* group, profile descriptions
"That technology hasn't really come...My wife taught the computer...supported, well, taught—so I went to the courses. And the kids did. I thought that if I'm still starting to tinker, there won't be enough hours in the day to learn." (Participant 25, 60-year-old man, focus group 1, study I).	**Proposition 1.** The *feeling like an outsider* group might benefit from developing self-efficacy in physical activity and adequate positive support as individuals in this group consider themselves outsiders and find technology fearsome.	Waist circumference (cm)	<94	107.1	The *feeling like an outsider* group had lower physical fitness than the *enthusiastic use* group (MD - 55.8, 95% - 110.7 to -0.92, p =.047 in a t-test). Performing guided tasks in the program in the Kruskal Wallis test (p =.038). Communicating via messages were lower in the *feeling like an outsider* group than in the *enthusiastic use* group (p =.034) in the Mann-Whitney test.	The *feeling like an outsider* group, *developing self-awareness* profile **Psychological:** A high self-efficacy to regulate exercise according to their own estimate. **Biological**: High-risk behavior related to being inactive and overweight. Self-reported weekly physical activity differed from accelerometer-measured physical activity. **Social**: Engagement in technological solutions was low.
		6MWT (m)	>623	575.5		
		LPA (min/per week)	>150	134.9		
		IPAQ (min/per week)	>150	421.4		
		WHOQOL-BREF Physical health	>16.5	13.6		
		WHOQOL-BREF Psychological health	>16.5	14.3		
		WHOQOL-BREF Social relationship	>16.5	14.3		
		WHOQOL-BREF Environment	>16.5	14.9		
		DEPS	<8	6.8		
		SERES	>50	67.0		
		BREQ-3	>0	12.0		
		Completed task mark	>87	45.0		
		Discussions mark	>6.6	4.3		

RV, recommended value; 6MWT, 6-min walk test; BREQ-3, the Behavioral Regulation in Exercise Questionnaire-3; DEPS, 10-item Depression Scale; IPAQ, International Physical Activity Questionnaire; LPA, light-intensity physical activity; SERES, Self-Efficacy to Regulate Exercise Scale; WHOQOL-BREF, World Health Organization Quality of Life BREF

TABLE 4 Differences in biopsychosocial factors among *being uninterested* (n=10) group between *feeling outsider, reflecting on the benefits*, and *enthusiastic use* groups.

Qualitative data	Proposition	Variables	RV	Mean	Statistically significant differences (P<.05) between groups	Group 2, the *being uninterested* group, profile descriptions
"I'm waiting for it and I'm truly interested, as if I were waiting for something like a spark. That it is something, something like, motivating, and...well...I can't say, but it like maybe not now for sure every week. If once a month, certainly something could come...a reminder." (Participant 56, 45-year-old man, focus group 3, study I). "When I could enter inputs in there, and if my own activities could be there, then I would be like a response: Is this the right or wrong direction, and... And that's when it's really some-body, something and someone monitoring what you're doing." (Participant 41, 49-year-old woman, focus group 2, study I).	**Proposition 2.** The *being uninterested* group might benefit from weight management and physical activity self-monitoring with reminders and prompts as they feel externally motivated.	Waist circumference (cm)	<94	112.7	The *being uninterested* group had a larger mean waist circumference than the *enthusiastic use* group (MD 14.2, 95% 1.0 to 27.5, p=.031 in the Tukey HSD test).	The *being uninterested* group, *increasing engagement* profile **Psychological**: Low self-determination scores (externally regulated). **Biological**: Low levels of physical fitness, poor self-assessed physiological quality of life and a high waist circumference. Interested in self-monitoring their physical activity. **Social**: Uninterested in participation in web-based coaching.
		6MWT (m)	>623	558.9		
		LPA (min/per week)	>150	174.6		
		IPAQ (min/per week)	>150	461.3	The *being uninterested* group had lower physical fitness than the *enthusiastic use* (MD -0.72, 95% CI -1.4 to -0.06, p =.029 in the Tukey HSD test).	
		WHOQOL-BREF				
		WHOQOL-BREF Physical health	>16.5	13.7		
		WHOQOL-BREF Psychological health	>16.5	14.2	The degree of self-determination in exercise (BREQ-3) scores were significantly different between the *being uninterested* and *enthusiastic use* groups in a t-test (MD -7.3, 95% CI -13.5 to -1.1, p =.023), *being uninterested* group had lower values than the *enthusiastic use* group.	
		WHOQOL-BREF Social relationship	>16.5	15.9		
		WHOQOL-BREF Environment	>16.5	14.3		
		DEPS	<8	6.7		
		SERES	>50	56.6		
		BREQ-3	>0	5.7		
		Completed task mark	>87	31.4		
		Discussions mark	>6.6	6.1		

RV, recommended value; 6MWT, 6-min walk test; BREQ-3, the Behavioral Regulation in Exercise Questionnaire-3; DEPS, 10-item Depression Scale; IPAQ, International Physical Activity Questionnaire; LPA, light-intensity physical activity; SERES, Self-Efficacy to Regulate Exercise Scale; WHOQOL-BREF, World Health Organization Quality of Life BREF

In contrast, a comparison of the profiles' results revealed that the subjects in the group, *reflecting on the benefits* and *enthusiastic use* showed healthy lifestyle choices. Among these participants was a description of a healthy lifestyle behavior balance and low-risk behavior. This is a rather expected result; these groups had good adherence to technology use, especially towards interactive technology with personalized information and feedback. Patients in the *reflecting on the benefits* group showed a fair amount of intrinsic motivation for maintaining healthy lifestyle choices, high self-efficacy in exercise, and were interested in using health technology. This group has a *maintaining a healthy lifestyle balance* profile, such as healthy eating and exercising. A surprising result is that the *enthusiastic use* group had the lowest self-efficacy in physical activity compared with the other group profiles, even though they had the minor risk behavior. Based on the profiles, the study identified profiles related to the rehabilitation process. The *reflecting on the benefits* group was renamed *maintaining a healthy lifestyle balance* (Table 5). The profile for the *enthusiastic use* group was renamed *strengthening self-confidence* (Table 6).

TABLE 5 Differences in biopsychosocial factors among *reflecting on the benefits* (n=6) group between *feeling outsider, being uninterested*, and *enthusiastic use* groups.

Qualitative data	Proposition	Variables	RV	Mean	Statistically significant differences (P<.05) between groups	Group 3 the *reflecting on the benefits*, profile descriptions
"Let's put it in this way: I'm not actually now that way from being pushed, yeah. Yes, it comes from my own desire. The main purpose is monitoring: it's for that. It's interesting to follow what happens if you change some exercise habits, and you can see from this, what changes have happened in the background. Very okay."(Participant 17, 57-year-old man, focus group 2, study I).	**Proposition 3.** The *reflecting on the benefits* group might benefit from easy-to-use and interactive technology as their interest is maintained by technology with personalized information and interactive tracking tools.	Waist circumference (cm)	<94	102.3	No statistically significant differences (P<.05) between *reflecting on the benefits* and *feeling outsider, being uninterested*, and *enthusiastic use* groups.	The *reflecting on the benefits* group, *maintaining a healthy lifestyle balance* profile **Psychological**: Intrinsic motivation for exercise and high self-determination, including a positive balance in life. A higher score indicates higher self-efficacy for exercise. **Biological**: Showed healthy lifestyle choices related to eating behavior and exercise. **Social:** Health technology interests them.
		6MWT (m)	>623	624.3		
		LPA (min/per week)	>150	137.2		
		IPAQ (min/per week)	>150	320.8		
		WHOQOL-BREF				
		WHOQOL-BREF Physical health	>16.5	14.4		
		WHOQOL-BREF Psychological health	>16.5	14.4		
		WHOQOL-BREF Social relationship	>16.5	15.7		
		WHOQOL-BREF Environment	>16.5	15.3		
		SERES	>50	62.0		
		BREQ-3	>0	11.8		
		DEPS	<8	2.0		
		Completed task mark	>87	116.8		
		Discussions mark	>6.6	7.8		

RV, recommended value; 6MWT, 6-min walk test; BREQ-3, the Behavioral Regulation in Exercise Questionnaire-3; DEPS, 10-item Depression Scale; IPAQ, International Physical Activity Questionnaire; LPA, light-intensity physical activity; SERES, Self-Efficacy to Regulate Exercise Scale; WHOQOL-BREF, World Health Organization Quality of Life BREF

TABLE 6 Differences in biopsychosocial factors among *enthusiastic use* (n=15*)* group between *feeling outsider, being uninterested*, and *reflecting on the benefits* groups.

Qualitative data	Proposition	Variables	RV	Mean	Statistically significant differences (*P*<.05) between groups	Group 4, The *enthusiastic user* group profile descriptions
"I'm waiting and I'm interested. Yes, of course, this here now gives a little push in the pants. I'm already moving pretty well, that's what this thing around my arm tells me...Yeah...and then yes, I have the Sport Tracker on my phone, also. When I go somewhere, I tell it to draw a map, and I see the time and all that."(Participant 66, 34-year-old man, focus group 3, study I). "Modern opportunities. And if now, of course...from where soon could come a little spark, and that spark continues than exercise could begin. And it's really the same benefit. And then, of course, if nothing's heard from there. It sounds real good, and then reminders. Something like you can write comments, and..." (Participant 26, 61-year-old woman, focus group 2, study I).	**Proposition 4.** The *enthusiastic user* group might benefit from empowering their self-efficacy and personalized lifestyle feedback as they have a positive technology mastery experience.	Waist circumference (cm) 6MWT (m) LPA (min/per week) IPAQ (min/per week) WHOQOL-BREF WHOQOL-BREF Physical health WHOQOL-BREF Psychological health WHOQOL-BREF Social relationship WHOQOL-BREF Environment SERES BREQ-3 DEPS Completed task mark Discussions mark	<94 >623 >150 >150 >16.5 >16.5 >16.5 >16.5 >50 >0 <8 >87 >6.6	98.4 631.3 148.3 291.0 14.2 15.5 16.3 15.0 54.2 13.1 4.2 156.0 8.1	The *enthusiastic use* group had higher physical fitness than the *feeling like an outsider* group (MD -55.8, 95% -110.7 to -0.92, p =.047 in a t-test). Task marks in the program in the Kruskal Wallis test (p =.038) and communicating via messages were higher in the *enthusiastic use* group than *feeling like an outsider* group (p =.034) in the Mann-Whitney test. The *enthusiastic use* group had higher than the *being uninterested* group the degree of self-determination in exercise scores in a t-test (MD -7.3, 95% CI -13.5 to -1.1, p =.023).	The *enthusiastic user* group, *strengthening self-confidence* profile **Psychological**: High self-determination in relation to exercise behavior but had a lack of self-efficacy in physical activity. **Biological**: A waist circumference and a physical fitness level that represented a low behavior risk level. **Social**: Highly interested in technological health solutions.

RV, recommended value; 6MWT, 6-min walk test; BREQ-3, the Behavioral Regulation in Exercise Questionnaire-3; DEPS, 10-item Depression Scale; IPAQ, International Physical Activity Questionnaire; LPA, light-intensity physical activity; SERES, Self-Efficacy to Regulate Exercise Scale; WHOQOL-BREF, World Health Organization Quality of Life BREF

The reflections of patients on their lifestyle risk factor management differed during the process of digital rehabilitation as *developing self-awareness, increasing engagement, maintaining a healthy lifestyle balance,* and *strengthening self-confidence.* The main results of the analysis are shown in Figure 6.

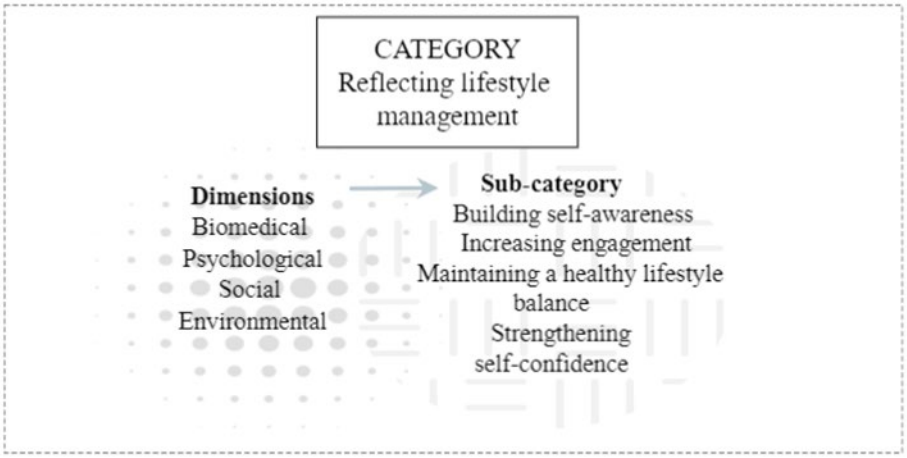

FIGURE 6 The category that reflecting the lifestyle and its sub-categories as well as biological, psychological, social, and environmental factors dimensions.

5.1.3 Complex trust-building process (Study III)

In Study III, we continued to analyze the experiences of cardiac patients in rehabilitation. Study III aimed to quantitatively explore the different meanings that patients had given to the process at the end of rehabilitation. The core category was *complex trust-building process,* which included feeling that one has hit rock bottom, facing and coping with a crosscurrent, understanding their concerns as a peer group, moving toward a healthier lifestyle by using technology, and finding self-awareness. The complex process of trust-building involved interactions between emotion, cognition, acceptance, and support processes (Figure 7).

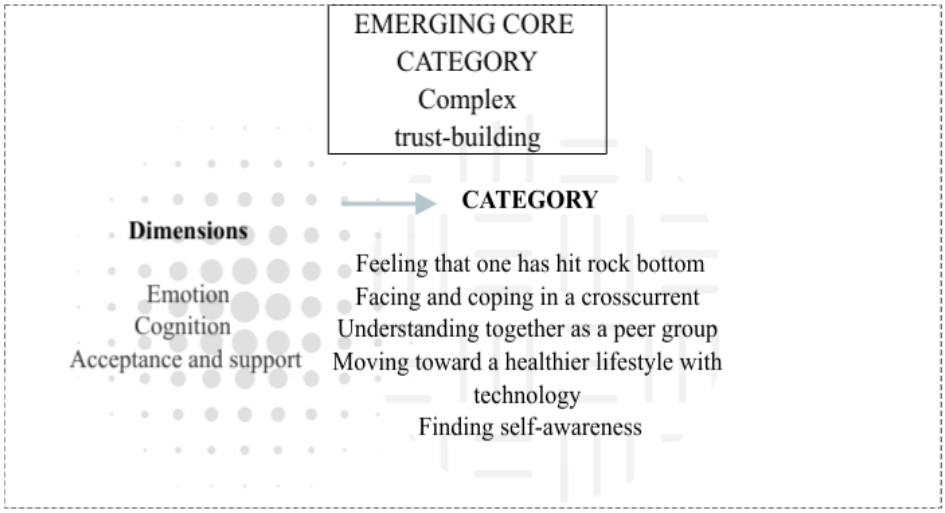

FIGURE 7 Core category of cardiac patients in complex trust-building and its categories and dimensions including emotion, cognition, acceptance, and support processes.

Patients expressed their concerns about cardiac disease. Some patients described their feelings of distress after a cardiac event as the feeling of having hit rock bottom. Moreover, this life situation involved feelings of worthlessness, powerlessness, and even despair because of their experience with a sudden cardiac event. One of the concerns expressed about the causes of the illness was how it could have been avoided; the link between daily and work-related stress and cardiac events was also considered. The participants also mentioned their trying to avoid thoughts or feelings about managing their new life situations. In their accounts of the events surrounding effective coping strategies after a cardiac event, they mentioned their struggle with life's difficulties and experiencing both ups and downs. Patients highlighted the importance of receiving support from their loved ones, which ultimately encouraged them to keep progressing. Almost everyone indicated that the most important coping mechanism was the acceptance of the disease and the continued effort to give life new meaning.

Among the patients, the positive view was that face-to-face peer contact had a positive impact; they appreciated being able to give each other feedback. The patients noted that the utilization of technology was able to support their physical and life changes; it also increased their self-awareness. This was particularly true for instances in which they felt that technology helped them recognize their own development. They noted that they appreciated receiving immediate feedback, which helped them seek and utilize information to evaluate their own goals and progress. A recurrent theme among the participants was a sense that the rehabilitation process increased their own awareness of their current situation since it provided a time and place for reframing their own needs and thoughts, re-evaluating their goals, and setting new life goals. Patients argued that the development of their personalized life management (e.g., self-care) skills occurred through their learning, repetition, and application of self-care knowledge. They also found hope in living, self-trust, and satisfaction and

gradually forgot about the burden of their disease as they continued their daily lives.

5.2 Conceptual model emergence

After publishing the first three articles, I continued to explore what kind of conceptual model emerges and how it is able to resolve cardiac patients' main concerns about digital CR. The results were synthetized to create a conceptual model. In the first phase, the data were openly coded by core category. In the second phase, the data were selectively coded to identify a densified and saturated core category as well as theoretically coded to create a model.

5.2.1 Emergence of core categories

The results from the open coding analysis deepened our understanding of technology use (Study I) and lifestyle risk behaviors (Study II) in the process of digital CR from the perspective of cardiac patients. The analysis also assessed the different meanings given by the CHD patients to the rehabilitation process (Study III). The main finding of the first phase of studies I and II was the emergence of one core category: *personalized lifestyle changing,* which is associated with *identifying e-usage in the behavior change process* (Study I) and *reflecting lifestyle management* (Study II). Thereafter, another core category was found for Study III: c*omplex trust-building process.* Table 7 summarizes the relationships between the core categories of the three studies.

TABLE 7 Summary of emerging core categories results (Studies I-III).

Emerging core category: Personalized lifestyle changing (Study I and II)				
Category: Cardiac patients' identifying of e-usage in the process of behavior change (Identifying e-usage) (Study I)				
Dimensions	**Feeling outsider**	**Being uninterested**	**Reflecting benefit**	**Enthusiastic using**
Patient's e-role	Outsider	Occasionally	Usefully	Diversely
Patient's e-using	Fearing to use	Limited to use of technology	Feeling technology useful	Empowering self- tracking
Enabling participation in e-process	Encouraging	Problem-free technology	Easy-to-use technology	Smoothly functioning technology
Behavior changes counseling/ coaching	Technology supporting	Activity empowerment	Interactive tracking tool	Getting feedback
Category: Reflecting on lifestyle management (Study II)				
Dimensions Biomedical Psychosocial Environmental	**Building self-awareness**	**Increasing engagement**	**Maintaining a healthy lifestyle balance**	**Strengthening self-confidence**

Emerging core category: Complex trust-building process (Study III)					
Dimension	**Feeling that one has hit rock bottom**	**Facing and coping in a cross-current**	**Understanding together as a peer group**	**Moving toward a healthier lifestyle with technology**	**Finding self-awareness**
Emotion	Feelings of worthlessness and powerlessness	Struggling the ups and downs	Feeling of being on the "same level"	Moving forward toward self-trust	Finding hope
Cognition	Avoiding thoughts	Noting own thoughts	Giving and receiving feedback	Seeking information about activity	Developing self-care through learning, repetition
Acceptance and support	Recognizing rock bottom of my life	Encouraging support	The positive importance of face-to-face peer group contact	Supporting "a great buddy" tech	A time and place to increase awareness of one's own needs

5.2.2 Densified and saturated core category

In the second phase of analysis, the aim was to develop a densified and saturated core category and create the conceptual model. The results from coding increased our understanding on the cardiac patients' use of technology, along with the associated concerns on lifestyle risks and health behaviors in the digital CR process. In the results of studies, I, II and III the concept of data densified and saturated one core category titled *enabling personalized and trusting in life change*.

5.2.3 Conceptualization of process

The second phase was the conceptualization of a process. The researcher chose the concepts that are related to the core category (Glaser, 1978, pp. 55, 93). These process supplements the six C`s (6 C´s; context, condition, causes, consequences, contingencies, and covariance) (Glaser 1978, pp. 74-75), which will help researchers integrate findings about the *trust-building enables personalized life changes* model. The description of the model that is focused on personalized experiences of life changes that will enhance trust and promote life changes. These main concepts are based on three concepts: personalized life changing, trust-building, and life change (Figure 8).

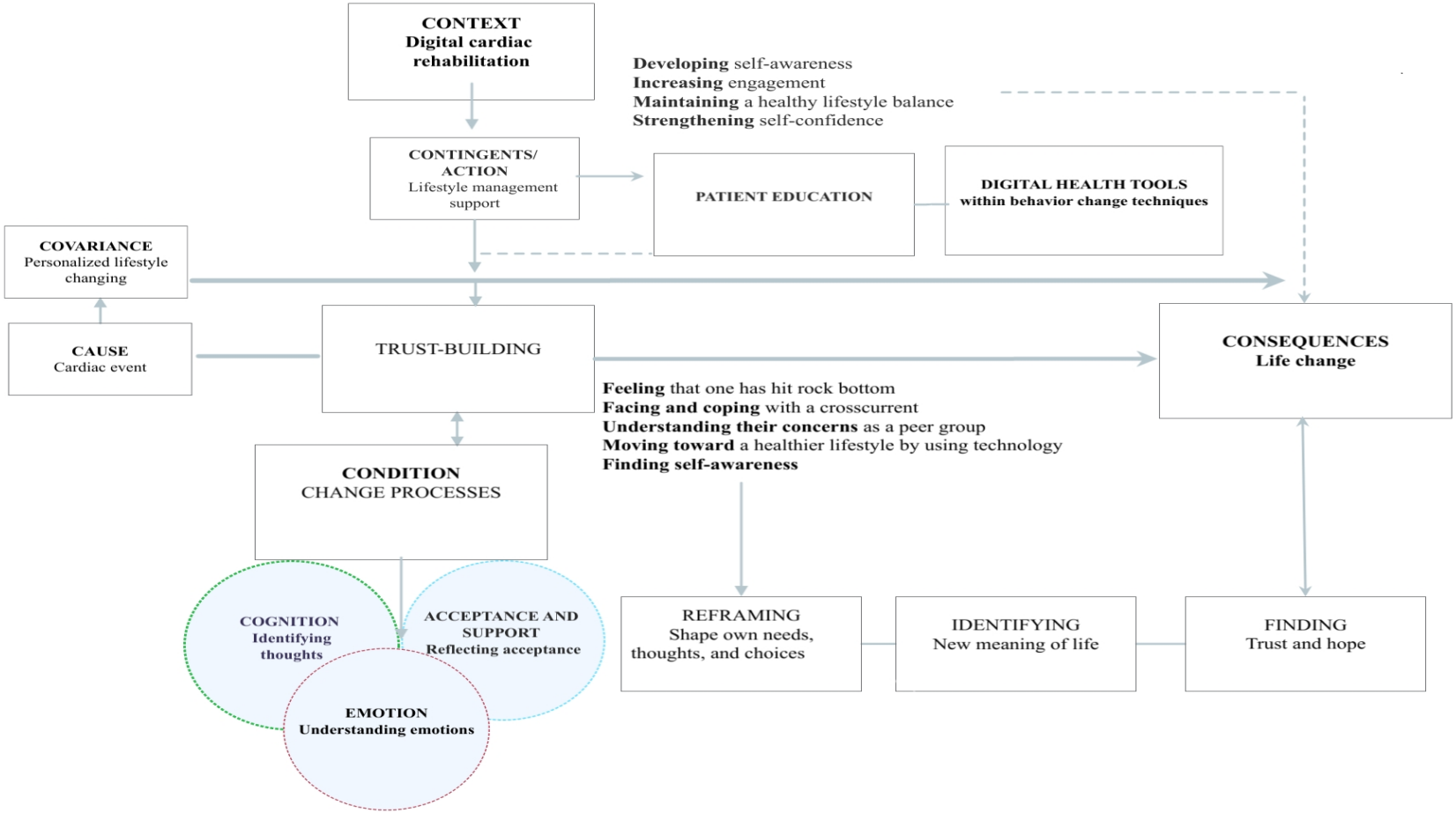

FIGURE 8 The trust-building enables personalized life changes model using the six C's (context, condition, causes, consequences, contingencies, and covariance) (Glaser, 1978, pp. 73-74).

5.2.4 Trust-building enables personalized life changes model

The most essential result of the dissertation project was a conceptual model based on three published articles results: *identifying the e-usage, reflecting lifestyle management,* and *complex trust-building*. The main concern of the patients was how to enable personalized life changes during the digital CR process. The main concepts were based on three concepts: personalized life changing, trust-building, and life change.

First, the finding was a personalized lifestyle changing process. Empowering and enabling patients by using tailored or personalized education and action points were found to promote the trust-building process. The main aims were to build, increase, maintain, and strengthen the personalized life changes in patients. This promotes the various aspects and attitudes that are needed to achieve the individual's goals; and this covers aspects from the biomedical, psychological, social health behavior, and attitudes about digital technology. Digital health tools within behavior change techniques (goalsetting, information, social support, peer discussion, prompts, self-monitoring) may also promote this process. Personalized lifestyle management proves to be encouraging and supportive of coping with life changes.

Second, the basic social process involved was trust-building for life change. As a preliminary suggestion, the phases in the trust-building may be (1) identifying their feelings, (2) facing and coping with a crosscurrent, (3) understanding their concerns as a peer group, (4) moving toward a healthier lifestyle by using technology, and (5) finding and developing self-awareness. Developing self-awareness includes reframing, including the identification of new meanings in life, as well as having increasing trust and hope in life. Having more stability in terms of emotions, cognition, acceptance, and support plays a significant role in recognizing and supporting the trust-building process.

Third, the life change of patients may contribute to a deepened understanding of the complexity of the CR processes. The processes can be viewed as those that consist of conditional descriptions that may affect life change after a cardiac event. The processes are ultimately influenced by the sudden cardiac event and the subsequent need for rehabilitation. These processes slowly develop over time, and they have a beginning and an end. In other words, these phases have a dimension of time (i.e., institutional timing).

6 DISCUSSION

The purpose of the present dissertation project was to create a conceptual model that provides a proposal for a substantive area in CR. Studies I-III have guided the step-by-step process in developing this model. In this dissertation project, the GT approach has been used; it has enabled us to discover new perspectives on digital CR. The emerging model was based on 39 patients with CHD who participated in cardiac digital rehabilitation courses from 2015 to 2017.

6.1 Summary of main results

The result of the dissertation project was based on three main study results. In study I, we identified four different the e-usage groups, which were based on the patients' experiences with and attitudes about technology. The profiles of the groups from study II varied, and this reflects the various management styles of the patients' lifestyle and health behaviors. In study III, we found that complex trust-building followed a life change event, which was a cardiac event in this case. The main concerns of the cardiac patients were how to develop a personalized experience for life change during the digital CR process. The most essential result of the dissertation project was the formation of the conceptual model that encompasses the *trust-building enables personalized life changes* model. The following section discusses in great detail how behavioral change theories and others literature support the findings of the studies (I–III) and the conceptual model developed.

6.1.1 Personalized digital health technology needs (Study I)

The first question in this dissertation project was what the groups experience when using technology and what their attitudes toward technology are. The results presented in study I showed that *identifying the e-usage* category consists of four groups that define the patients' different experiences and behaviors

associated with the use of technology, as well as web-based guidance, in the process of behavior change. These groups were feeling like an outsider, being uninterested, reflecting on the benefits, and enthusiastic use. Patients who felt like outsiders and were not interested in technology needed more face-to-face patient education encounters, whereas patients who reflected on the benefits and were enthusiastic about using technology felt that web-based guidance was sufficient in providing support for the rehabilitation.

The study found that cardiac patients were able to reflect on their own attitudes and needs about technology in the context of a cardiac event or disorder. There was a need for interactive coaching, which gives the patients a little push, constructive feedback, and support for the achievement of life changes goals. These results further support the idea that setting personal goals and altering behavioral factors, such as attitudes and beliefs, may positively impact overall health (Ajzen, 2011). The attitude towards these changes is determined by one's belief that the behavior leads to either a favorable or unfavorable outcome (Ajzen, 2011). The components of behavior techniques within secondary prevention interventions can help patients increase their self-direction, set specific goals, and take action to achieve and sustain health-supporting behaviors (Beatty et al., 2013; Brough et al., 2014; Taylor et al., 2016; Wolever et al., 2013). In this study, important behavior techniques for maintaining a spark of interest and motivation required immediate feedback, weekly assignments, and regular reminders. This technology acceptance broadly supports the work of other studies in this area, which link digital behavior technique components to promote or detract health-promoting choices.

This study showed that technology can be simple and easy to use, which was also illustrated in previous studies (Brough et al., 2014; Davis et al., 2015; Torp et al., 2008). At the beginning of digital rehabilitation, it is important to encourage patients to hone their abilities to use various easy-to-use technology, which also produce positive and successful experiences. Studies have also found that even though the digital skills of senior citizens have improved, they need support to effectively use technology (Arthanat et al., 2016). The minimization of application risks increases their trust in the technological systems (Arthanat et al., 2016; Egea & González, 2011; Pearson et al., 2016). This supports the findings of study I, which found that each individual's attitude was relevant to building his trust in technology.

This study showed that it is important to identify the various types and aspects of technology as well as the user's role in them. The planning process must consider the different roles of the patients, such as the experiences of the outsider for active users. As patient skills develop, the patients gain self-esteem and have the opportunity to develop positive, successful experiences (Arthanat et al., 2016; Brough et al., 2014). In digital rehabilitation, one should not expect to only have the necessary skills, but also the learning that comes with developing these skills, which include cognitive and motor, and perceptual skills (Arthanat et al., 2016; Broady et al., 2010; Rawstorn et al., 2016); this will ultimately give the patient enough time to learn new skills (Broady et al., 2010). Digital health applications

allow users to receive information and receive automated feedback; on top of this, they allow patients to connect with peers and health care professionals. In the future, recognizing the needs and concerns of different technology users should be considered when tailoring a solution that involves technology. This way, the acceptance and utilization of digital health technology may be enhanced for a more meaningful and effective rehabilitation experience.

6.1.2 Biopsychosocial lifestyle management (Study II)

The second question in this dissertation project sought to determine what kind of differences can be identified in the four group profiles by comparing them in terms of the biomedical, psychological, social, and environmental and health behavior aspects. The four groups were classified based on their experiences and attitude toward technology use: feeling like an outsider, being uninterested, reflecting on the benefits, and enthusiastic use (Study I). In Study II, the *reflecting lifestyle management* category illustrated how patients in the four groups also reflect on their lifestyle management differently during the rehabilitation progress. Based on the qualitative and quantitative analyses, the four profiles were renamed to the following: finding and developing self-awareness, increasing engagement, maintaining a healthy lifestyle balance, and strengthening self-confidence.

Study II also showed how the behaviors of cardiac patients consist of not only biomedical, but also psychological and life change dimensions. These results align with the biopsychosocial paradigm that highlights the importance of identifying biopsychosocial needs of patients to aid in tailoring interventions (Ahmadvand et al., 2018; Borrell-Carrio, 2004). This allows patients to be more independent in their choices and stances (Ahmadvand et al., 2018). Aside from being able to promote the fulfillment of individual needs by providing motivational, goal-setting, self-efficacy, and self-regulatory skills, it also improves self-awareness and self-management for life change processes (Andersen et al., 2020; Bandura, 2005; Kashani et al., 2016; Palacios et al., 2017). This biopsychosocial understanding may be extended to behavioral medicine based on the biopsychosocial paradigm (Ahmadvand et al., 2018; Borrell-Carrio, 2004) and behavior theories (e.g., theories of learning) (Bandura, 1989). According to the social cognitive theory, it is necessary to increase both positive self-care and the ability to achieve one's goals (Bandura, 1989); this study has also supported this.

How to personalize life changes was the main concern of patients with cardiac disease; that is, how exactly does one enable personalized life changes during the digital CR process? Personalized life change can be developed when certain specified actions are satisfied; for example, experiencing a positive "spark" for behavior change. These actions for life change are associated with different needs for health technology use and how individuals reflect lifestyle risk factors differently in the rehabilitation process. For example, how personalized individual behavior needs are met (i.e., how support is provided for the acceptance of technology use). Technology has brought new challenges to this significant behavioral process, and this challenge requires different theoretical perspectives

and techniques for the new phenomenon. Digital health technology that is used to tailor solutions may be a useful tool in identifying positive forms of personalized lifestyle support and management. This is supported by the findings from earlier studies (Baek et al., 2018; Partridge et al., 2017; Westland, 2019). Based on the results, it is pertinent to consider various biopsychosocial needs when tailoring web-based behavioral change measures for patients with heart disease.

6.1.3 Cardiac patients' trust-building process (Study III)

The third aim of the dissertation project was to identify the different meanings that patients assign to life after CR (Study III). Furthermore, the findings of study III demonstrated that the main social psychological process was *complex trust-building*. Building trust was pertinent during different phases, such as *feeling that one has hit rock bottom, facing and coping with a crosscurrent, understanding their concerns as a peer group, moving toward a healthier lifestyle by using technology,* and *finding and developing self-awareness.* The trust of the patients was closely intertwined with the processes of change, understanding emotions, identifying thoughts, reflecting on acceptance, and personalizing digital support.

In this study (Study III), the main concept revolved around self-awareness, which includes reframing one's needs, thoughts, and choices, identifying new meanings in life, and finding more trust and hope in life. The results from study III suggest that there is an association between the awareness of life meanings and the building of trust. During the trust-building process, the reactions of cardiac patients also involve the process of making or finding new meaning; this is further supported by the idea of the adaption process (Park & Folkman, 1997). It is important to increase cardiac patients' acceptance and awareness of their current condition, as well as his own engagement and strategies for behavior change, to improve upon the psychological flexibility in the behavior change process (Hayes et al., 2012). This finding is consistent with that of Hayes et. al. (2012), who focused on the psychological flexibility process by outlining six overlapping processes: acceptance; cognitive diffusion, also known as *deliteralization;* being present; self-as-context; value orientation; and committed action.

The results of study III focused on everyday life relating to the patient's trust and individual experience, which may include emotion and cognition (Weber & Carter, 2003). A number of theoretical frameworks explain the process of adapting to change after a cardiac event, such as the models of adaptation to illness (Andrews & Roy, 1994, pp. 18-22). The cardiac event was also a stressful situation that was described as *feeling that one has hit rock bottom* for the patient and his family. This life situation entails being able to adapt to a new life situation that broadly affects life. Comparison of these findings with those of other studies notably confirmed that patients experience anxiety and depression after cardiac events occur (Hare et al., 2014; Hämäläinen, et al., 2000), cognitive function impairments and emotional distress (Gallo et al., 2005), a lack of social support (Hare et al., 2014), and effects on their self-care. Additionally, during the trust-building process, the promotion of employing positive thoughts and beliefs alleviates emotional distress and reinforces self-esteem, which in turn contributes to

external changes in behavior; this is also highlighted by Bandura (1989). Prior studies noted the importance of effective cardiac disease management (Dancet et al., 2011; Esmaeili et al., 2016; Greenfield et al., 2014) as well as the role emotions play in understanding the adaption process (Andrews & Roy, 1994, pp. 18-22). Several studies illustrated how the consideration of psychological and emotional needs, especially after a cardiac event, is crucial in promoting effective cardiac disease management (Ellis et al., 2019; Hellem & Bruusgaard, 2020; Jokar et al., 2017; Peterson, 2010; Yates et al., 2018).

The results of this study show the importance of being able to face and cope with a crosscurrent event in life. This concept involved struggling with difficulties in life and experiencing its ups and downs. Coping is defined as the ability to understand the meaning of one's own thoughts, which was also demonstrated by Park and Folkman (1997). Study III also showed that the emotional and social support received by cardiac patients, whether from their peer groups, spouses, other family members, friends, or health care professionals, positively affect their ability to manage their condition (Embuldeniya et al., 2013; Hämäläinen et al., 2000). Other studies confirmed that emotional support enables patients to effectively manage their own thoughts and feelings (Hayes et al., 2012; Lazarus & Folkman, 1984, pp. 150-152). As mentioned in the previous chapter, the role of technology is important as it supports social participation, such as peer group discussions on web-based programs (Nordin, 2017; Partridge et al., 2017).

6.2 Development of trust-building model

This dissertation project focused on conceptual model development. The fourth question of this dissertation was to resolve cardiac patients' concerns about digital CR. The results from this study were analyzed and compared to the behavioral change models and theories in the literature. The theories aim to evaluate, influence, and identify the targets for behavior change and methods for accomplishing such (Glanz, 2014). The theoretical basis for behavior change as a concept promoting life change describes why individuals do or do not engage in certain health behaviors and lifestyle choices (Davis et al., 2015; Noar et al., 2008). The effects of cardiac patients' experiences on their life changes in the context of digital CR include behavior change aspects (Knudsen et al., 2020; Schweier et al., 2018; Webb et al., 2010), exercise (Pfaeffli et al., 2013), healthy eating (Yates et al., 2018), social support (Partridge et al., 2017; Schweier et al., 2018; Wentzer & Bygholm, 2013), and psychological health (Jbilou et al., 2019; Richards et al., 2018; Schaufel et al., 2011). Researchers have observed that the use of such theories has not yet been systematically integrated into digital health interventions and patient education offerings (Sankaran et al., 2016; Webb et al., 2010). However, previous research reported that interventions that are grounded in an appropriate behavior change theory may be more motivating and effective than those that lack a theoretical basis (Davis et al., 2015). Prior studies and behavior theories support the importance of theories of psychological behavior and life change to

understand such phenomena. Therefore, the main model here will be compared to behavior change theories and will describe the key variables of behavior change models.

6.2.1 Concept of trust-building process

The concept of *trust-building enables personalized life changes* mainly supports individual and causation theories, such as the TPB (Ajzen, 1985) that are at the root of the TAM (Davis, 1989; Davis et al., 2015); these are also examples of expectancy and acceptance-based theories. These behavioral theories refer to factors that affect lifestyle-related behaviors, such as motivation, attitudes, and intentions, which influence the implementation of life changes (Ajzen, 1985; Davis, 1989; Webb et al., 2010). These individual behavior change theories have been widely used as parts of behavior change interventions (Ajzen, 2011; Davis et al., 2015; Hung & Jen, 2012; Egea & González, 2011; Noar et al., 2008).

The TPB of reasoned action by Ajez (1985) proposes that an individual's decision to engage a specific behavior is necessary for its success. According to the TPB, an individual's intentions are determined by three variables: personal attitudes, **s**ubjective norms (beliefs about whether other people approve or disapprove of the target behavior), and perceived behavioral control (perception of how easy or difficult it is to adopt the target behavior). The TAM model proposed by Davis (1989) predicts the attitudes toward technology based on its use and usefulness. Based on the developing concept of the model, the identified key concept in this study is that a *personalized experience*, together with trust-building, supports the achievement of impactful changes in behavior and lifestyle. Figure 9 illustrates the relationship between the concepts of *trust-building enables personalized life changes* and the concepts related to the TAM and TPB.

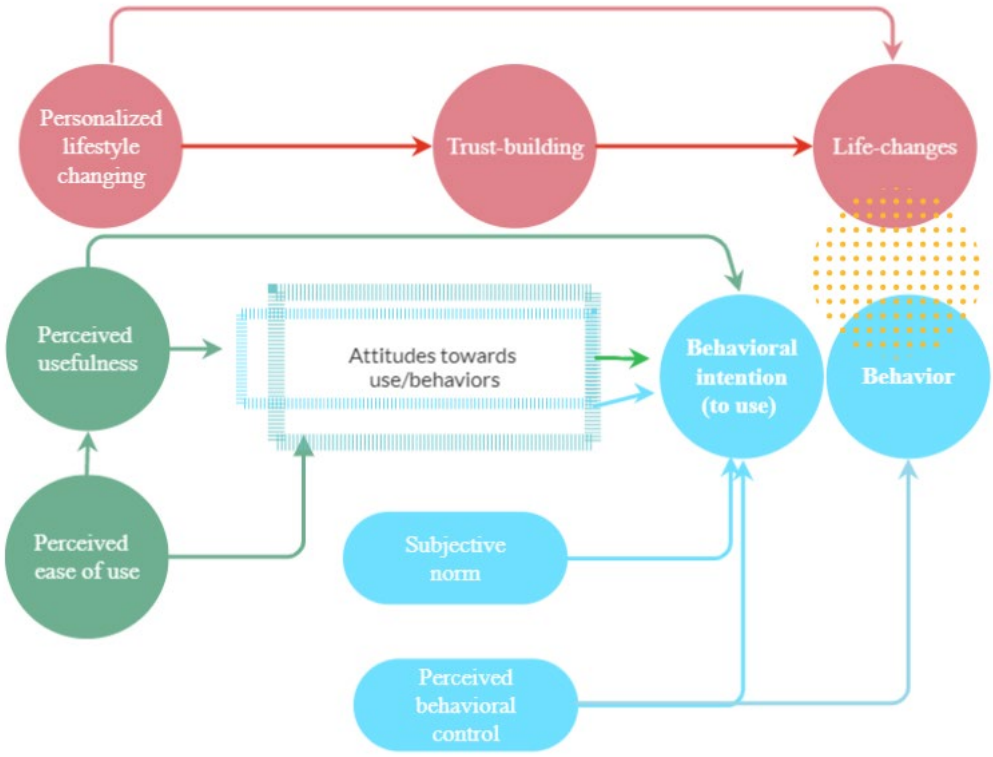

FIGURE 9 Interaction between the *trust-building enables personalized life changes*, the technology acceptance model (TAM), and the theory of planned behavior (TPB). (The technology acceptance model is highlighted in green. The theory of planned behavior is highlighted in blue. The trust-building model is highlighted in red).

6.2.2 Present model versus pre-existing behavior changes models

When compared to TAM and TPB, the model that illustrates *trust-building enables personalized life changes* has some distinct similarities and differences. In this dissertation project, the main concepts included personalized life change, trust-building, and life changes. This implies that the provision of personalized encounters will enhance trust and promote life changes.

Similar constructions were identified in the model and the TAM, which both predicted the acceptance of technology, although the model in question has a broader definition for the concept of personalized life change. The study found that it is important to contact different technology users and identify their biopsychosocial profiles with respect to their own reflections about their lifestyle risk. According to the TAM, technology acceptance is dependent on the perceived: (1) ease of technology use influences; and (2) usefulness. Together, these ultimately improve the individual's attitude and intent to use technology for a real purpose (Davis, 1989). We found that an increase in an individual's perceived usefulness associated with a certain value plays a role in the likeliness of his positive intentions and acceptance to increase. The favorable expectation was that the applications would be easy to use, secure, clear, and feature easily comprehended instructions in their own language.

Second, the model presented here, the TPB (Ajzen, 1985), and the TAM (Davis, 1989) similarly illustrate the link between personal attitude, behavior, and technology use. In this dissertation, trust-building was the central process in the model. Trust-building was the foundation of oneself, one's own life, others, and technology use. The findings of the TAM versus other studies confirms that it is important to deepen the understanding of the diverse roles of patients as technology users and their different attitudes toward technology and coaching (Antypas & Wangberg, 2012; Lupton & Maslen, 2017; O'Reilly & Spruijt-Metz, 2013).

The TPB emphasizes how the subjective norm and perceived behavioral control precede the willingness to attempt to achieve the target behavior (behavioral intention) (Ajzen, 1985). Additionally, the TPB differs from the TAM and current model in that it illustrates how beliefs about how others and their loved ones feel about their behavior also influence the underlying intent of a behavior (Ajzen, 1985). This model revealed that the basis of life changes was an individual's ability to identify his own feelings, face and cope with a crosscurrent, navigate their situation with their peers, utilize technology, and develop self-awareness. In building trust, the awareness and acceptance of one's own feelings, thoughts, and interpretations were particularly emphasized. Therefore, it is important to consider the interaction between an individual's thoughts, feelings, past experiences, behaviors (Hayes et al., 2012), and social environment (Bandura, 1989).

Third, the classical TAM model, like the TPB model, does not fully reflect the relationship intent, actual use or behavior, and motivational content (Walsh, 2015). The TPB model perceived behavioral control as something that refers to an individual's perceptions of their ability to perform a given behavior (Ajzen, 1985). The TPB also includes a direct link between perceived behavioral control and behavioral achievement (Ajzen, 1985). In this model, life changes occurred when the defined actions of lifestyle management were satisfied. In this study, the goal of lifestyle management was to promote actions that would build, increase, maintain, and strengthen personalized life changes. A patient's desired lifestyle management can be supported and achieved when their biopsychosocial needs are met with patient education. Providing a personalized experience through patient education and by tailoring digital health tools may promote trust-building that supports behavior and life changes. Meeting an individual's behavior needs and identifying attitudes about technology are crucial in-patient education, even when provided digitally.

The TAM and TPB models of change support the rehabilitation process by describing how cardiac patients' behaviors develop and change over time. There is also a need to identify strategies for achieving effective behavioral change interventions (e.g., behavior change techniques [BCTs]) (Beatty, 2013; Lundgren et al., 2018; Pearson et al., 2016;). The desired life changes can be supported by the integration of such theories (i.e., TAM/TPB) and BCTs (Banner et al., 2015; Davis et al., 2015; Devi et al., 2014; Peterson, 2010; Schweier et al., 2018). Patient education within secondary prevention that utilizes a variety of BCTs and their components may effectively eradicate behavior risk factors (Goodwin et al., 2016;

Leon et al., 2005). These results corroborate the findings of a great deal of previous work, which highlights the need for individually tailored treatment and actions for CR patients. This study's results further support behavior change theories and behavior change tools, such as self-regulatory techniques, setting individualized behavioral goals, self-management, and prompting (Devi et al., 2014; Westland, 2019); providing individual feedback (Partridge et al., 2017), learning health skills needed for change, providing opportunities for information dissemination and joint problem solving (Melholt et al., 2018); self-monitoring (Partridge et al., 2017; Westland, 2019) and experimenting with action (Michie & Abraham, 2004). Based on the identification of factors influencing lifestyle, it is theoretically possible to find out what to focus alone, but information on the direction of change and the actions affecting it also prove to be significant factors to consider (Michien et al., 2008). The model primarily aims to tailor patient education that guides patients toward resumed activity while considering the necessary physical, cognitive, emotional, and behavioral skills that will achieve the attained individual behavioral and life change goals.

6.3 Conceptual model evaluation

This *trust-building enables personalized life changes* model utilized Glaser and Strauss' criteria for evaluating a purposive substantive underlying theory: Fit, workability, relevance, and adaptability (Glaser & Strauss, 1967, p. 3). Throughout the research and analysis process, the researcher has been aware of these four criteria, which relate to the GT (Glaser, 1978, p. 7). Following the methods outlined was paramount in evaluating the substantive underlying theory using the four aforementioned criteria (Glaser, 1978, pp. 4-5; Glaser & Strauss, 1967, p. 3).

6.3.1 Fit

Fit as suggested by Glaser (Glaser, 1978, p. 7) refers to whether the conceptual model fits into the data and whether the subjects recognize it as reality. Each of the concepts identified in the *trust-building enables personalized life changes* model emerged from the data and was traceable through the entries specified in the interview with the participants. The model was developed using a thorough process, which included many different steps and constantly rechecking with the raw data. The analytical work has required the researcher to set aside time to help find deeper meanings and effectively build a model. Careful review of the documentation process and contents shows that there has been no coercion or overinterpretation of the data.

6.3.2 Work

According to Glaser (1978), the work of the study refers to the ability of the theory to explain most of the phenomenon—the concerns of the participants—in the

substantive area (Glaser, 1978, pp. 7-8). The *trust-building enables personalized life changes* model explains the main concern of the cardiac patients in the digital rehabilitation process. The results can also be applied more widely to different contexts of social and healthcare planning and training for digital rehabilitation education. The results of this study provide guidance on how healthcare providers and professionals can support patients psychosocially and behaviorally in a digital context. The substantive conceptual model also works (Glaser, 1978, p. 7), which means that the model is able to explain, predict, and interpret what happens when digitalization increases in the rehabilitation process. The "suitability" and "work" of the model is defined as the ability of the model to understand the main concern of cardiac patients and their personal rehabilitation processes, which involve how to build trust (Glaser, 1978, pp. 7-8). The relevance and usefulness of the published articles are very relevant and useful for implementing digital rehabilitation. They have also been used in comparative rehabilitation groups, musculoskeletal system reconditioning, and work ability rehabilitation. The results can be used to design digital rehabilitation programs, and include aspects of awareness, emotion, acceptance, and support counseling.

6.3.3 Relevance

Relevance refers to the importance of the research according to Glaser (1978). This suggests that the experiences of cardiac patients in relation to their major concern is represented in the theory; additionally, the concepts stemmed from their main concern (Glaser, 1978, p. 8). With this, the main concern of cardiac patients was well reflected in the data and identified the process of building trust. The new conceptual model, *trust-building enables personalized life changes,* emerged from mixing data and patient experience that were collected from the interviews with participants who described their digital rehabilitation process. Quantitative data supported these qualitative findings and deepened the understanding for the phenomenon. The theory is relevant as it deals with the results of the current topic and contributes to the resolution of cardiac patients' main concern.

6.3.4 Modification

Modifiability is the ability of the research to adapt and change as new data emerges or is introduced; this is an important criterion for a well-founded theory (Glaser, 1978, p. 8; Holton, 2008). Based on the results of this model, there is a need to design or tailor a simple, relevant, easy-to-understand, and easy-to-use technology application that will also produce positive and successful experiences. This development process must be constantly modified to respond to new information brought by digitalization. This constant openness is a powerful feature of GT. The model developed here is not yet fully ready for implementation, but it builds the foundation to re-examine concepts and properties for new data collection and analysis.

6.4 Model strengths and limitations

There are identified weaknesses and strengths that require consideration when interpreting the findings of this dissertation's results. The participants discussed their experiences of the digital rehabilitation process at the beginning and end of rehabilitation; everyone was given the opportunity to share his or her experiences during group discussion. Group interviews have strengths and weaknesses when compared to one-on-one interviews. The interviewer was the same during the process and created an accepting atmosphere and encouraged silent participants. Despite this, few participants were still trying to provide answers that will please the group and/or interviewer. Nonetheless, the participants spoke freely within their familiar peer group.

Another limitation stemmed from our using biopsychosocial variables, which were only collected at two different points in time; this gave a snapshot of the group at two different points in time: pre- and post-intervention (e.g., collected data from the BREQ-3 and SERE questionnaires was taken only at the end of the rehabilitation). However, despite this shortcoming, the BREQ-3 and SERE questionnaires provided valuable information about the patients' own assessment of their behavioral exercises and physical activity. The strength of this dissertation project was being able to create a model using both qualitative and quantitative data. Although the quantitative data were included in the analysis, their main purpose was inductive of the phenomenon under study and not to be interpreted as a statistical generalization or non-testing of the hypothesis. Another strength of the study includes the thorough discussions on the study setting, participants, and processes.

Furthermore, the researcher's own position and prejudices might have also presented as both a limitation and a strength. As a researcher, I believed that the rehabilitation process was strongly related to technology and the research question I formulated was based on it. This belief was found to be erroneous in the interviews, which led to a change and refinement in the research question to cover the rehabilitation process more broadly. In addition, the researcher has personal and professional knowledge about the conditions relating to or needing CR, which could have caused distortions in the analysis. With theoretical sensitivity, the researcher recognized her own preconceptions, previous insights, and experiences. On the other hand, the strengths of this study are its ability to examine the effects of the CR process in the rehabilitation process environment on patients, especially since the data collection only included group interviews, surveys, and measurements that were obtained before and after the rehabilitation process. Another strength of the study is the careful and transparent description of the analysis process during the dissertation project.

6.5 Implications for digital cardiac rehabilitation

The conceptual model described as *trust-building enables personalized life changes* has deepened our understanding of the implications of digital CR. This model is able to explain and resolve the patients' main concerns. This means that it is able to develop and implement a trust-building treatment option that is tailored to address needs of the patient. The model emerged from the experiences and concerns of cardiac patients in digital CR, the findings of this study have several practical implications, which will be discussed below.

First, the conceptual model can be implemented when a personalized treatment option is required; it also targets the utilization of digital CR. The main result of this project supports the idea that personalized rehabilitation will enhance the patient's trust and will subsequently promote life change. Personalized encounter depends largely on how well each patient's personal needs, goals, and plans have been considered in patient education development. These results suggest that tailored digital tools, which include biopsychosocial, and behavior change approaches that are driven by a multi-profession team (e.g., physicians, physiotherapists, psychologists, nurses, social workers working together as a team), promote trust-building in the life change process.

Second, these findings suggest the crucial importance of patient education. Control over cardiac disease symptoms, resumed activity in daily life, and maintenance of social relationships were all important goals for patients with cardiac disease. This means that the patients must be able to participate in their own decision-making and daily activities, which are only possible in individuals with sufficient self-awareness, through the understanding of their own emotions and eventually, acceptance. Personalized CR may include individualized guidance, including emotion management education, to help them learn the basics and significance of their thoughts and emotions. In addition, patient education supports the patient's own ability to seek information and achieve their own goals, as well as finding new meanings for their life. Taken together, these findings suggest the significant role of patient education in lifestyle management when promoting trust-building for life change.

Third, the findings of this study suggest that profiling and tailoring is needed to satisfy the personalized experience of patients. Digital health technology tailors solutions using BCTs and this can be a useful tool to aid in patient education (Winter et al., 2016). The results also show that empowerment within goal-setting, self-monitoring, reminders and prompts, personalized information, and feedback is crucial. The theories of change support the rehabilitation process by describing how cardiac patients' behaviors develop and change to help understand behaviors and identify the effective intervention strategies as BCTs. This study's results further support, based on behavior change theories and behavior change tools, such as self-regulatory techniques, the setting goals and prompting (Devi et al., 2014; Westland, 2019); providing individual feedback (Partridge et al., 2017); learning health skills required for change, including

providing information and joint problem-solving (Melholt et al., 2018); self-monitoring (Partridge et al., 2017; Westland, 2019); and experimenting with action (Michie & Abraham, 2004).

The results help healthcare providers identify possible technology users and determine their levels of usage when developing digital rehabilitation programs. This study also used methodological solutions to combine qualitative and quantitative data that can be used to tailor more individual CR programs.

Fourth, practical implications must be tailored by promoting the acceptance of technology as something that is friendly or "*a great buddy*", as this helps patients keep track of their daily activities. Digital rehabilitation should consider each patient's pre-existing skills and provide sufficient time to learn new skills. In addition, having a problem-free and easy-to-use technology was important; this includes technology that was encouraging and functions smoothly. This model can provide a framework for program designers to utilize when they develop health promotion programs.

Additionally, another practical application involves an interactive digital tool with personalized feedback and support; one that also allows patients share their feedback to one another. They found that it was meaningful to feel like they were on the same level as someone in their peer group, since this allowed them to share a common understanding of their cardiac event or disease. The face-to-face peer group contact and support both appeared to provide a positive impact. They also appreciated the feedback and support that they received from healthcare professionals.

Finally, the results of this research support the idea that trust-building can be used to determine the contents of a consistent and standardized staff training program. Having a multidisciplinary team can deepen the patient's understanding of trust in behavior changes may be built and supported throughout the digital rehabilitation process.

6.6 Future research

In the age digitalization, further research is needed in CR. The research results challenge the development and tailoring of guidance methods and behavioral techniques and technologies that are used in rehabilitation to meet the needs of different patients appropriately. Although the purpose of this dissertation project was to create a model based on three publication articles and to conceptualize the processes of digital CR, many other research questions have also been answered. This concerns the further development of the conceptual model into a substantive theory. This means validating the main concepts of the model more broadly for its applicability to other theories as well. In this dissertation project, we were also able to compare the models between the TAM and the TPB. The combined TAM and TPB model could be further integrated to provide a more useful patient education that promotes life changes, a personalized patient encounter, and an effective trust-building strategy. Another area of research includes the

expectations of cardiac patients as models depicting potential influences on adherence to personalized life change.

6.7 Conclusion

The purpose of this dissertation project was to create a conceptual model for the process of digital CR by using the GT approach. The more specific aim of the project was to resolve the cardiac patients' main concerns and how basic social processes are able to resolve it.

This study has shown that the personalized needs of cardiac patients were important in the trust-building process. The main concern of cardiac patients was how to make personalized rehabilitation a reality**.** These findings suggest that it is important to acknowledge the diversity of the patients as technology users and their different attitudes toward utilizing technology. Positive experiences with technology also increased the patients' trust in the use of technology, even when the technology is simple, flexible, smooth, trouble-free, easy to use, and learnable. Additionally, it is important to identify cardiac patients with varying management styles for their risk factors. The findings of our study indicate that improved and increased self-management may improve the patient's trust in life changes as a means of personalized goal-setting and self-monitoring, interactive feedback, and support. In general, therefore, it seems that the cardiac patients' awareness about their attitudes was relevant to building trust in life changes. Through these trust-building processes, self-awareness may be used to reframe the patients' perspectives, including the identification of new meanings in life, as well as finding increasing trust and hope in life.

In various ways, these findings contribute to our understanding of building trust and providing a basis for personalized actions. This information can be used to develop targeted actions for patient education that is aimed at a personalized encounter. Patient education leads to a positive impact since it is able to promote internal motivation and management or adaption to the demands of the cardiac event or disorder. Patient education with personalized action may help patients by making them aware of their own feelings and thoughts and acceptance management during the rehabilitation process. Involvement in the peer support group was especially important for continued support and encouragement.

This dissertation has provided a deeper insight into how meaningful the role of trust is in life changes. These findings contribute to our understanding of trust-building and provide a basis for development of personalized behavioral change. Therefore, there is a definite need for profiling and tailoring of patient education to meet each patient's personalized needs. The digital solutions also allowed emotional and cognitive factors to be taken into consideration when implementing the rehabilitation program. The provision of personalized encounters will enhance trust and promote life change in cardiac patients requiring CR.

YHTEENVETO (SUMMARY IN FINNISH)

Digitalisaation nopean kehityksen myötä teknologian käyttö on lisääntynyt viime vuosina sosiaali- ja terveydenhuollossa sekä kuntoutuksessa. Digitaalinen sydänkuntoutus on luonut uudenlaisia toimintamahdollisuuksia kasvavaan digitalisoituvaan palvelutarpeeseen. Tämän väitöskirjatutkimuksen tarkoituksena oli käsitteellistää digitaalinen sydänkuntoutumisprosessi glaserilaisen grounded teoria lähestymistavan avulla. Ensimmäisessä vaiheessa luotiin teknologiaan liittyvät kokemusryhmät. Toisessa vaiheessa syvennettiin ymmärrystä näiden ryhmien profiileista vertaamalla niitä terveyskäyttäytymisen osa-alueisiin. Tutkimuksen kolmannessa vaiheessa tutkittiin sydänkuntoutujien antamia kuntoutusprosessin eri merkityksiä.

Tutkimus oli osa laajempaa Kelan rahoittamaa tutkimusta ”Etäteknologiasovellusta hyödyntävän kuntoutuksen vaikuttavuus sepelvaltimotautikuntoutujien fyysiseen aktiivisuuteen, toimintakykyyn, koettuun elämänlaatuun ja toimijuuteen, interventiotutkimus laitoskuntoutuksessa (Etäteknologia sydänkuntoutuksessa, EtSy)”, joka toteutettiin vuosina 2015-2018. Kuntoutujat osallistuivat moniammatillisen työryhmän ohjaamaan kolmeen viiden päivän pituiseen kuntoutusjaksoon vuoden aikana. Tutkimukseen osallistui kolmekymmentäyhdeksän 34-77-vuotiasta sepelvaltimotautia sairastavaa potilasta, joista miehiä oli 74 % ja naisia 26 %. Osallistujista 82 % oli tehty pallolaajennus ja 10.5 % ohitusleikkaus vuoden sisällä ennen kuntoutusta. Kuntoutujat käyttivät Movendos mCoach sovellusta älypuhelimen, tietokoneen tai tabletin kautta. Sovellus mahdollisti kuntoutujan henkilökohtaisten tavoitteiden asettelun ja seurannan sekä liikunta- ja kuntoutuspäiväkirjan täyttämisen sekä vertaiskeskustelun muiden kuntoutujien kanssa kuntoutusjaksojen välillä. Tämän lisäksi sovelluksen avulla toteutui fysioterapeutin kuukausittainen kannustava palaute ja automaattinen muistutus välitehtävistä. Kuntoutujan liikunta-aktiivisuuden omaseurantana ja motivaation välineenä toimi Fitbit Charge -aktiivisuusranneke.

Väitöskirjaprojektin aineisto koostui neljältä teknologiaa hyödyntävältä sydänkurssilta kerätystä aineistosta, kuntoutuksen alussa (0kk) ja päätösvaiheessa (12kk). Aineisto koostui sekä fokusryhmähaastatteluista että kyselylomakkeista ja vyötärönympäryksen ja fyysisen kunnon mittauksista. Tässä tutkimuksessa käytettiin kansainvälistä liikunta-aktiivisuuskyselyä (IPAQ, International Physical Activity Questionnaire) ja fyysistä aktiivisuutta mitattiin objektiivisesti Fitbit Zip-aktiivisuusmittarilla sekä kestävyyskuntoa arvioitiin kuuden minuutin kävelytestillä. Tämän lisäksi mitattiin vyötärönympärys mittanauhalla. Sydänkuntoutujien kokemaa elämänlaatua mitattiin Maailman terveysjärjestön elämänlaatumittarilla (WHOQOL-BREF, The World Health Organization Quality of Life-BREEF). Tämän lisäksi käytettiin liikunnallisen minäpystyvyyden (SERES, Self-Efficacy to Regulate Exercise Scale) ja itsemääräämisen (BREQ-3, The Behavioral Regulation in Exercise-3) sekä masennusoireiden tunnistamisen kyselylomakkeita (DEPS, the Depression Scale). Kuntoutujien teknologian käyttöä tarkasteltiin tehtävämerkintöjen ja viestien lähettämisen määrillä kuntoutuksen aikana.

Aineiston analyysin vaiheet olivat avoin, selektiivinen ja teoreettinen koodaus sekä käsitteellisen mallin muodostaminen. Tilastollisia analyysimenetelmiä olivat varianssianalyysi, Tukeyn testi, t-testi, Mann-Whitney- ja Kruskal-Wallis-testit. GT analyysi eteni aineistosta avoimen koodauksen kautta, jossa analysoitiin tapauksia ja verrattiin niitä muihin tapahtumiin etsimällä yhtäläisyyksiä ja eroja ja luomalla mahdollisimman monta käsitettä. Avoimen koodauksen aikana nimettiin keskeiset kategoriat ja niiden ominaisuudet. Analyysissa noudatettiin jatkuvaa vertailevaa vuoropuhelua, jonka aikana kirjoitettiin muistiinpanoja (memot). Selektiivisessä koodauksessa kategoriat ja niiden ominaisuudet ryhmiteltiin kahteen eri ydinluokkaan, jotka muodostivat yhdistävän tekijän aineistosta. Teoreettisessa koodauksessa havainnoitiin ydinkategorian ja kategorioiden välisiä suhteita ja muodostettiin niiden pohjalta teoreettinen malli.

Tulokset nostavat esille uudenlaisen näkökulman yksilöllisestä elämänmuutosprosessista ja luottamuksen rakentumisesta digitaalisessa sydänkuntoutuksessa. Tulokset osoittivat teknologian käyttöön liittyviä erilaisia asenteita ja käyttäytymistä. Aineistosta nousi esiin neljä erilaista kokemusryhmää, jotka olivat pelokas tarkkailija, innoton osallistuja, harkitseva toteuttaja ja aktiivinen käyttäjä. Pelokkaat tarkkailijat ja innottomat osallistujat osoittivat kasvotusten tapahtuvan ohjauksen tarpeen, kun taas harkitseville toteuttajille ja aktiivisille käyttäjille ohjauksen tarve oli vähäisempää. Terveyskäyttäytymisen erojen pohjalta ryhmät profiloitiin ja nimettiin uudelleen seuraavasti: itsetuntemuksen rakentuminen, sitoutumisen lisääminen, terveellisen elämäntavan tasapainon ylläpitäminen ja itseluottamuksen vahvistuminen. Luottamuksen rakentaminen oli osa elämänmuutosprosessia sisältäen aallonpohjan kokemisen, ristiriitojen kohtaamisen ja niistä selviytymisen, yhteisen ymmärryksen löytymisen vertaistuen kautta, siirtymisen terveellisempään elämäntapaan teknologia avulla ja itsetietoisuuden löytymisen. Luottamuksen rakentuminen osana kuntoutumista oli osa kognitiivisen, emotionaalisen, hyväksymisen ja sosiaalisen tuen prosessia.

Tämän pohjalta muodostui käsitteellinen malli luottamuksen rakentumisesta elämänmuutoksessa osana sydänkuntoutusprosessia. Luottamus omaan itseensä, toisiin ja omaan elämään rakentuu yksilöllisen kohtaamisen kautta. Kuntoutuksessa räätälöity potilasohjaus edistää ja tukee potilaiden elämänmuutosta, jossa huomioidaan myös erilaiset asenteet teknologiaa kohtaan. Luottamusta edistetään toimivien digitaalisten työkalujen ja menetelmien avulla kuten tieto, sosiaalinen tuki, vertaiskeskustelu, ja muistutukset. Kuntoutujan yksilöllisten tavoitteiden asettaminen ja toteutumisen seuranta edistää kuntoutumisen prosessia. Luottamuksen rakentuminen edellyttää omien tunteiden ymmärtämistä ja sairauden tuomien ajatusten tunnistamista sekä uuden elämäntilanteen hyväksymistä. Luottamuksen rakentuminen on oman elämäntilanteen lisääntyneen tiedostamisen prosessi, jossa muotoillaan uudelleen omia tarpeita, ajatuksia ja valintoja sekä löydetään uusia merkityksiä elämään.

Tulokset nostavat esille uudenlaisen teoreettisen näkökulman edistämään ja tukemaan käyttäytymisen ja elämänmuutoksen saavuttamista osana yksilöllistä digitaalista sydänkuntoutusta. Digitaalisten ratkaisujen avulla voidaan räätälöidä kuntoutusta vastaamaan erilaisten kuntoutujien yksilöllisiä kohtaamisen

ja tuen tarpeita. Tutkimustulokset haastavat kehittämään ja räätälöimään kuntoutuksessa käytettäviä ohjausmenetelmiä ja teknologioita vastaamaan kuntoutujien tarpeita yksilöllisesti sopivalla tavalla.

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ORIGINAL PAPERS

I

CARDIAC REHABILITEES' TECHNOLOGY EXPERIENCES BEFORE REMOTE REHABILITATION: QUALITATIVE STUDY USING A GROUNDED THEORY APPROACH

by

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Original Paper

Cardiac Rehabilitees' Technology Experiences Before Remote Rehabilitation: Qualitative Study Using a Grounded Theory Approach

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Abstract

Background: Even though technology is becoming increasingly common in rehabilitation programs, insufficient data are as yet available on rehabilitees' perceptions and experiences. It is important to understand their abilities when using technology for remote rehabilitation.

Objective: This is a qualitative study on technology experiences of persons affected by cardiovascular disease assessed before remote rehabilitation. The aim of the study was to explore rehabilitees' experiences and attitudes toward technology before 12 months of remote rehabilitation.

Methods: Qualitative interviews were conducted with 39 rehabilitees in four focus groups. The subjects were aged 34 to 77 years (average age 54.8 years) and 74% (29/39) of them were male. They had been diagnosed with coronary artery disease and were undergoing treatment in a rehabilitation center. The interviews were conducted between September 2015 and November 2016. Data were analyzed using Glaser's mode of the grounded theory approach.

Results: The result of the study was an "identifying e-usage" experience category, which refers to the rehabilitees' notions of the use of information and communication technologies (e-usage) in the process of behavior change. The main category comprises four subcategories that define the rehabilitees' technology experience. These subcategories are "feeling outsider," "being uninterested," "reflecting benefit," and "enthusiastic using." All rehabilitees expected that technology should be simple, flexible, and easy to use and learn. The results reflecting their technology experience can be used in e-rehabilitation programs. Rehabilitees who feel like outsiders and are not interested in technology need face-to-face communication for the major part of rehabilitation, while rehabilitees who reflect benefit and are enthusiastic about the use of technology need incrementally less face-to-face interaction and feel that Web-based coaching could offer sufficient support for rehabilitation.

Conclusions: The findings show that persons affected by heart disease had different experiences with technology and expectations toward counseling, while all rehabilitees expected technology to be easy to use and their experiences to be smooth and problem-free. The results can be used more widely in different contexts of social and health care for the planning of and training in remote rehabilitation counseling and education.

Trial Registration: ISRCTN Registry ISRCTN61225589; http://www.isrctn.com/ISRCTN61225589 (Archived by WebCite at http://www.webcitation.org/74jmrTXFD)

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KEYWORDS

coronary disease; rehabilitees' experience; focus group; qualitative study; grounded theory; remote rehabilitation; e-health; e-rehabilitation; secondary prevention

Introduction

Cardiovascular diseases are the most common cause of death globally [1]. Cardiac rehabilitation is a means of secondary prevention intervention for cardiovascular diseases that includes efforts to reduce behavioral risks such as tobacco use, unhealthy diet, obesity, physical inactivity, alcohol use, and psychosocial problems such as depression [1,2]. However, many persons with coronary artery disease are not aware of opportunities to participate in rehabilitation programs or they choose not to participate in cardiac rehabilitation for a number of reasons, including living a long distance from a facility [3,4]. It is necessary to develop new methods of rehabilitation such as Web-based programs [5]. With global digitalization, rehabilitation increasingly uses technology. Remote rehabilitation programs use a range of remote technologies and Web-based applications. Remote counseling means professionally coached and monitored rehabilitation with a clearly defined beginning and end [6-8]. Digital eHealth tools include wireless digital devices like mobile phones and tablet computers, self-care and self-monitoring devices, video call services such as Skype for Business, wearable and ingestible sensors and various digital applications, and virtual reality made possible by robots and other forms of new technology [9]. Digitalization requires new attitudes and skills from rehabilitees and professionals [10].

The use of remote technology in cardiac rehabilitation has been studied mainly by quantitative methods [11]. Research has focused on the effectiveness [6] and usability [12] of technology-intensive interventions. Issues related to rehabilitees' physical activity [6,13,14] and lifestyle change [8,15] have been another focus area. Qualitative studies are a minority, and they have focused on experiences of participation in Facebook peer groups [16,17], mHealth [18], eHealth [19], or Web-based programs [20-22].

However, research has rarely looked at the role of remote technology in cardiac rehabilitation [14,23]. Research is needed to expand the understanding of the experiences of persons who use or have used remote technology and assess the pros and cons of this technology [7,8,11]. The aim of this study was to gain an understanding of cardiovascular rehabilitees' experiences with technology and of their attitudes toward technology.

Methods

Study Approach

We used a grounded theory approach in this study. Data were analyzed using Glaser's inductive grounded theory approach. We decided to apply a methodology proposed by the grounded theory approach because we found grounded theory useful in getting to understand the rehabilitees' subjective experiences for generating a substantive theory in a relatively new research area [24]. The focus was on finding out the rehabilitees' experiences and attitudes toward technology prior to using remote technology. The rehabilitees described in qualitative interviews their experiences with computer use, social media, and other applications of modern technology.

Recruitment

The interviews were conducted in 2015 and 2016 in Rehabilitation Centre Peurunka, Finland, where the Social Insurance Institution of Finland arranges regular cardiac rehabilitation courses. The study is a part of a remote technology in cardiac rehabilitation study registered at the ISRCTN Registry [ISRCTN61225589]. The Ethics Committee of the Central Finland Health Care District approved the study.

Participants

The participants were 39 rehabilitees (10 women and 29 men); 82% (32/39) of them had undergone coronary angioplasty and 10% (4/39) had undergone coronary artery bypass about 3 to 12 months prior to rehabilitation. Most subjects had a computer (23/27, 85%) and used the internet (25/27, 92%). Many had mobile phones (16/27, 59%) and tablets (10/27, 37%), and several used wrist activity trackers (10/27, 37%). These statistics are similar to those obtained during the testing of other European cardiac patient populations [25]. According to Glaser's inductive grounded theory approach, baseline information and characteristics of the subjects were collated later for this paper and were not taken into account in the analysis [24] (Table 1).

Data Collection

The total duration of rehabilitation was 15 days spread between three 5-day periods over a time span of 12 months. Rehabilitation took place in a rehabilitation center [26]. Qualitative interviews were conducted at the beginning of rehabilitation in 4 focus group discussions, each interview lasting 30 to 60 minutes, overall 156 minutes. The interviews were conducted by the same interviewer and they were informal and semistructured. The questions were mostly unplanned and spontaneous, but the interviewer also presented the same series of open-ended questions to all subjects. They were asked questions like, "Tell me about your experience with modern technology," and "What are your expectations of remote counseling?" The interviews were audio-recorded and transcribed for analysis. The transcripts were imported into ATLAS.ti (ATLAS.ti Scientific Software Development GmbH) computer software, which enables data storage, organization, and retrieval for analysis. The number of subjects was determined according to data saturation, which is a point at which no more new experiences of the topic could be elicited [24].

Table 1. Description of participants.

Characteristic	Under 55 years, n (%)	55 years and over, n (%)	Total, n (%)
Age (years)	20 (51)	19 (49)	39 (100)
Gender			
Male	17 (85)	12 (63)	29 (74)
Education			
Vocational or course-form school or other	13 (68)	14 (74)	27 (71)
College-level education	3 (16)	3 (16)	6 (16)
University of applied sciences	2 (11)	2 (11)	4 (11)
University	1 (5)	0 (0)	1 (3)
Time of operation			
0-3 months from rehabilitation	1 (5)	0 (0)	1 (3)
3-12 months from rehabilitation	13 (65)	11 (58)	24 (62)
Over 12 months from rehabilitation	4 (20)	6 (32)	10 (26)
No operations	2 (10)	2 (11)	4 (10)
Technology			
Internet, yes	12 (100)	13 (87)	25 (93)
Computer, yes	11 (92)	12 (80)	23 (85)
Tablet computer, yes	6 (50)	4 (27)	10 (37)
Mobile phone, yes	7 (58)	9 (60)	16 (59)
Physical activity tracker, yes	4 (33)	6 (40)	10 (37)

Data Analysis

The constant comparative model guided the data collection process. Data were collected through 4 informal interviews and analyzed using the constant comparative model. We collected and analyzed data concurrently, and as the analysis progressed the research question became more focused. First, we started substantive coding [24,27]. Subcategories were created in open coding. We analyzed incidents and compared them with other incidents, looking for similarities and differences and creating as many concepts as possible, coding substantively. Being theoretically sensitive, data were closely read and questioned. Next, we identified the properties and dimensions of each subcategory. Finally, we grouped the concept into subcategories creating as many subcategories as possible and then integrated the subcategories into the category. During this constant comparative model process, we recorded our ideas and notions, which helped us process the data. Data analysis was continued until the category was theoretically saturated [24].

The following example describes the creation of the "being uninterested" subcategory. The analysis began with open coding. We analyzed data on the diversity of the rehabilitees' experiences of technology use as well as their attitudes toward, and expectations for, remote counseling. This perspective expanded from their responses and debates. Constant comparison convinced us that all codes essentially described or explained how each rehabilitee used technology or what their attitude toward technology was. Next we named properties (1) using technology occasionally, (2) limiting to use, (3) challenging problem-free technology, and (4) activating empowerment counseling. We named the subcategory for this experience as "being uninterested." Textbox 1 shows an example of the process.

The constant comparison of properties resulted in hypotheses about relationships between the subcategories [28]. We continued to collect and analyze data until no new subcategories emerged and the subcategories were saturated; a category was thereby created and named "rehabilitees identifying e-usage in the process of behavior change."

Textbox 1. Creating category for e-usage identification.

Category:

- Identifying e-usage

Subcategory:

- Being uninterested

Property:

- Using technology occasionally
- Limiting to use
- Challenging problem-free technology
- Activating empowerment counseling

Concepts (code):

- The rehabilitee is not interested in using technology in his free time.
- Being bound to technology irritates; the rehabilitee does not want to use technology all the time.
- Ineffective technology worries the rehabilitee.
- The rehabilitee waits to be communicated with by email.
- The rehabilitee expects counseling to be a motivator and to spark interest

Text:

- I'm not terribly interested in that remote stuff, because...well, I use the computer at work every day....That email reading, I may go and check my mail once a week. It's not in a way...maybe it just isn't my thing...it's no trouble to surf on the internet in the evening. Only when I must. I can check email—if a bill has arrived, I can pay it there. [Participant 9, 44-year-old man, focus group 2]
- ...but I don't like that one's got to be, like, twenty-four hours a day available. [Woman, 59 years, focus group 4I've noticed sometimes that when I've been at it for some time, the machine has broken down in the middle of my work so no one could do anything. So, that is, of course, the downside of the thing... [Participant 4, 59-year-old woman, focus group 4]
- I guess now—real nice if sometimes one could be reached out to from there by email or something else... [Participant 9, 44-year-old man, focus group 2]
- I'm waiting for it and I'm truly interested, as if I were waiting for something like a spark. That it is something, something like, motivating... [Participant 56, 45-year-old man, focus group 3]

Results

The descriptors of the rehabilitees' prior technology experience are "feeling outsider," "being uninterested," "reflecting benefit," and "enthusiastic using." The category "identifying e-usage" describes the essence of the rehabilitees' experiences with using technology and identifying its usage (Figure 1). Individuals in the "feeling outsider" and "being uninterested" subcategories need more face-to-face counseling, while Web-based coaching is sufficient for the individuals in the "reflecting benefit" and "enthusiastic using" categories. These conclusions are based on the following results.

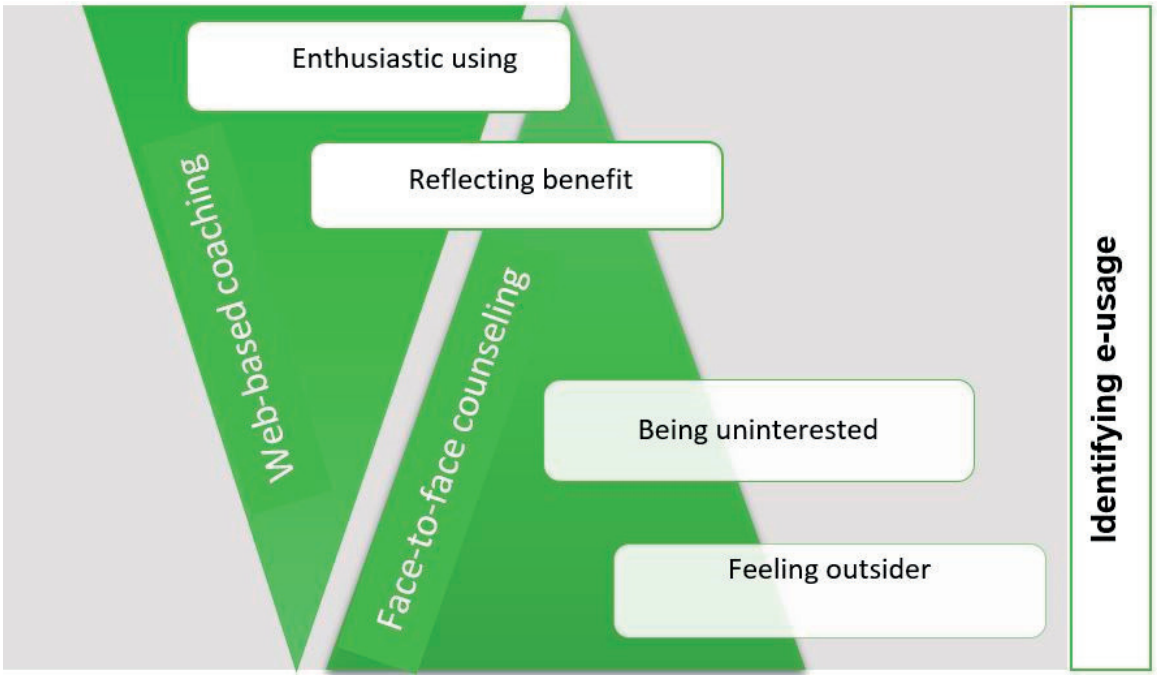
The first subcategory, "feeling outsider," consists of rehabilitees who fear that they do not have sufficient skills as computer users to participate in remote rehabilitation. They have not used the computer at all or they have only basic computer skills. In the following samples, two rehabilitees discuss "feeling outsiders."

> *Because I don't have a computer, I am a total outsider. So...because of this, I'm not so terribly interested. The only thing I know about this is that the self-tracking is great.* [Participant 39, 74-year-old man, focus group 1]

> *That technology hasn't really come...My wife taught the computer...supported, well, taught—so I went to the courses. And the kids did. I thought that if I'm still starting to tinker, there won't be enough hours in the day to learn.* [Participant 25, 60-year-old man, focus group 1]

These rehabilitees feel they do not have adequate computer skills, and few of them use computers at work. If they need help with technology, they request it from friends or family members. They feel they have no time to study computer use, and the English language is also difficult. Concerns about the impact of technology on health and security seem to be other reasons for avoiding computer use. In the following sample, a rehabilitee discusses his learning experiences with information technology.

Figure 1. Cardiac rehabilitees' different experiences of using technology and expectations of remote counseling.



> *Better that it leaves you, like if you go the bank computer, then everything gone. It doesn't help there. Still it doesn't. This isn't the only reason, but...I'm not interested. I've taken two computer courses, though. Last time I went to apply for a bus-driving license, and it was two weeks. And when I went and when I came back I was as dumb as I going there, and I come back...Of course, I know the time to buy one is coming, but I'm holding it off for as long as I can.* [Participant 58, 63-year-old man, focus group 4]

The following rehabilitee has not yet established expectations for counseling.

> *I'm not really sure...waiting to see what comes.* [Participant 64, 64-year-old, man, focus group 2]

For these rehabilitees, technology is something terrifying and almost incomprehensible. They are aware of its applications, such as Facebook, but these applications are foreign to them and therefore they feel like outsiders. Nevertheless, their positive expectations toward technology encounters are apparent although they do not expect anything amazing from Web-based counseling. They need guidance to support them in the use of technology (Figure 2). Figure 2 is a summary of the "identifying e-usage" category, which was created based on the rehabilitees' e-role and e-usage. The subjects in the "feeling outsider" subcategory regard themselves literally as outsiders and find technology fearsome; on the other hand, they look forward to overcoming this fear and expect adequate support.

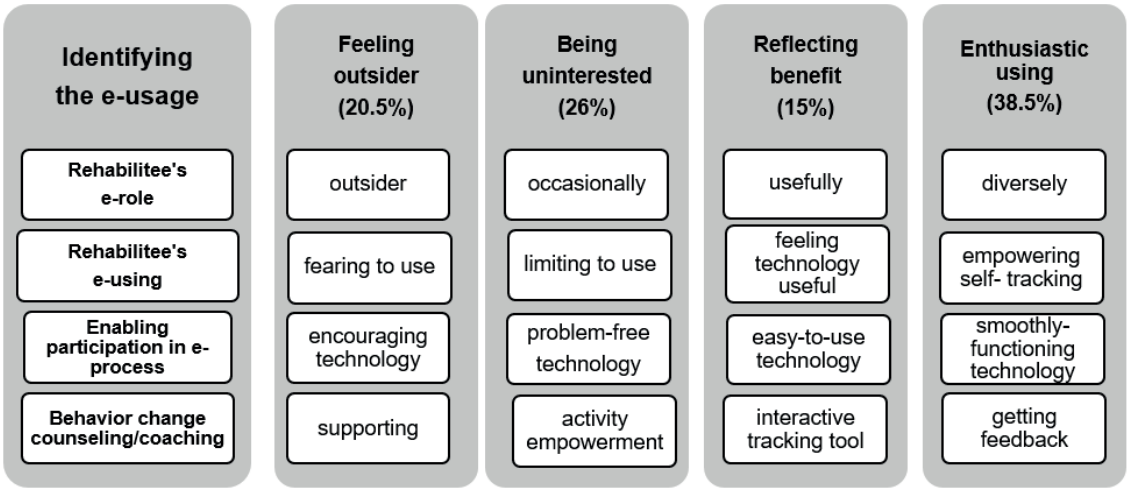
The second subcategory is "being uninterested." It is based on the experiences of rehabilitees who are conversant with technology and have experimented with social media. Their experiences are limited to necessary and occasional uses such as paying bills, renewing book loans, and reading emails. If they encounter a technical problem, their interest fades. They are not interested in using technology to connect socially via email and social media. They are worried about information security. In the following sample, a rehabilitee explains why he is not interested in technology.

> *I'm not terribly interested in that remote stuff, because...well, I use the computer at work every day...That email reading, I may go and check my mail once a week. It's not in a way...maybe it just isn't my thing...it's no trouble to surf on the internet in the evening. Only when I must. I can check email—if a bill has arrived, I can pay it there.* [Participant 9, 44-year-old man, focus group 2]

The following rehabilitee discusses problems related to technology and social media.

> *...I've noticed sometimes that when I've been at it for some time, the machine has broken down in the middle of my work so no one could do anything. So, that is, of course, the downside of the thing...* [Participant 5, 53-year-old woman, focus group 4]
>
> *But then what really irritates and frustrates me and just can't interest me—although I'm there in Facebook because my nephew forced me there.* [Participant 5, 53-year-old woman, focus group 4]

Figure 2. Identifying the e-usage category and subcategories of technology users.



The following rehabilitees discuss coaching.

> *I'm waiting for it and I'm truly interested, as if I were waiting for something like a spark. That it is something, something like, motivating, and...well...I can't say, but it like maybe not now for sure every week. If once a month, certainly something could come...a reminder.* [Participant 56, 45-year-old man, focus group 3]

> *When I could enter inputs in there, and if my own activities could be there, then I would be like a response: Is this the right or wrong direction, and...And that's when it's really somebody, something and someone monitoring what you're doing.* [Participant 41, 49-year-old woman, focus group 2]

These rehabilitees use technology occasionally and their daily use is limited. They value problem-free technology. They expect activity empowerment counseling, which should motivate and spark interest, but believe that technology demands a coach who would give feedback, assign weekly tasks, and issue regular reminders. This subcategory includes "occasionally," "limiting to use," "encouraging technology," and "supporting counseling" (Figure 2).

The subjects in the third subcategory, "reflecting benefit," maintain an interest in technology for only as long as they have an indispensable need for it in everyday life. In the following, a rehabilitee discusses his use of technology in free time.

> *Just like the pharmacy, like in that do I medications? In that case, is the prescription still valid? And like that, just in that way...Yeah, it is good to look...there are plenty of medicines left, and...Do I have to bring in, or order a new prescription? And other things, just in that way. What now happens every day or when it's needed so...so I don't go surfing on every webpage...Yes, with the children I use it, and with friends I like to connect over the internet.* [Participant 24, 65-year-old man, focus group 4]

The experiences of these persons fall into two groups. The subjects in the first group find technology difficult and need time to learn it. For example, they may find remembering passwords difficult. They need help to learn security procedures and computer usage.

> *And for paying bills I use it most, too. Some information when it's needed, well yes, I try to find it from there then. And if someone wants to find the frustrating side, well, those passwords frustrate me, because they always go missing...and a password has gotten lost, and...I can't go there anymore. Of course I can create a new password, but it is such a bother—just forget about it. And I read magazines in the computer, and...* [Participant 36, 68-year-old man, focus group 4]

Even though the use of technology is not a problem to the subjects in the second group, they still eschew technology. Since they see technology as something negative, they use it only when necessary—for example, to search for information. Some rehabilitees had experience in digital physical activity monitoring. In the following example, a rehabilitee discusses the usability of technology.

> *...But then the computer, when it runs all day—I don't want that. That's why I don't open the computer in the evening...Of course it's easy always that everything could be, like as easy-to-use as possible, because that's why I don't do it, when I could use it for remote technology. But it should be as easy-to-use as possible: it should be as automatic as possible, this thing. It, I think should be as flexible as possible.* [Participant 17, 57-year-old man, focus group 2]

In the next example, a rehabilitee discusses self-monitoring and coaching.

> *Let's put it in this way: I'm not actually now that way from being pushed, yeah. Yes it comes from my own desire. The main purpose is monitoring: it's for that. It's interesting to follow what happens if you change*

> *some exercise habits, and you can see from this, what changes have happened in the background. Very okay.* [Participant 17, 57-year-old man, focus group 2]

This subcategory, "reflecting benefit," emerged with four properties: "useful," "feeling technology useful," "easy-of-use technology," and "interactive tracking tool" (Figure 2). These rehabilitees expect technology to be easy to use and also expect it to enable communication. Essentially, they do not need a coach but they need tools for self-monitoring and helping to improve their health.

The subjects in the fourth subcategory, "enthusiastic using," show a positive attitude toward technology and have used it for a long time in a variety of ways, both in everyday life and at work through mobile phones, tablet computers, and desktop computers. In the following examples, enthusiastic users discuss the use of technology.

> *Well, laptops are always open less when you have a smartphone. In other words, I read those emails easily on my phone. Therefore I don't turn on the laptop.* [Participant 8, 61-year-old woman, focus group 2]

> *More there is, of course, invoice writing and information retrieval, but of course electrical diagrams, and...Sometimes some programming, logic, some small logic programming, and something like that.* [Participant 20, 64-year-old man, focus group 3]

These persons follow emails actively through mobile phones. Many of them have mobile health and exercise activity apps such as the Sports Tracker (Sports Tracking Technologies). They use social media such as Facebook and WhatsApp to keep in touch with friends and relatives. They do not consider internet problems particularly annoying and contact a specialist if they find this necessary. They are interested in technology and want to develop their technology skills. In the following example, rehabilitees describe what they expect from technology and from a coach.

> *I'm waiting and I'm interested. Yes, of course, this here now gives a little push in the pants. I'm already moving pretty well, that's what this thing around my arm tells me...Yeah...and then yes, I have the Sport Tracker on my phone, also. When I go somewhere, I tell it to draw a map, and I see the time and all that.* [Participant 66, 34-year-old man, focus group 3]

> *Modern opportunities. And if now, of course...from where soon could come a little spark, and that spark continues than exercise could begin. And it's really the same benefit. And then, of course, if nothing's heard from there. It sounds real good, and then reminders. Something like you can write comments, and...* [Participant 26, 61-year-old woman, focus group 2]

> *Maybe this is kind of a simple-enough device. When there's not anything amazing in here now, then owing to that, it's comfortable to use: It's not too complicated.* [Participant 15, 52-year-old man, focus group 1]

These rehabilitees use technology diversely and effortlessly, also for self-tracking. They expect Web-based intervention to be simple, motivating, easy to use, and interactive. They also expect coaches to give feedback if anything is missing. The attitude among the subjects in this subcategory is best described with the phrases "diversely" and "empowering self-tracking," and the best descriptors of expectations toward technology and counseling are, respectively, "smoothly functioning" and "getting feedback" (Figure 2).

Discussion

Principal Findings

The study shows that the diversity of the rehabilitees as technology users and their different needs for technology should be taken into account in rehabilitation planning. The four subcategories are "feeling outsider," "being uninterested," "reflecting benefit," and "enthusiastic using" (Figure 2). Some rehabilitees whose e-role is "outsider" or "occasionally using" need face-to-face communication for a large part of rehabilitation, while individuals whose e-role is "usefully" or "diversely" need incrementally less face-to-face interaction and feel that Web-based behavior change coaching will provide sufficient support for their rehabilitation. However, all rehabilitees hope that technology would be simple, flexible, and easy to use and learn, which would enable participation in an e-process. Participation in a remote rehabilitation program, as in this research, requires skills in areas such as Web-based log-ins and in reading and responding to tasks and messages. Activity self-monitoring requires downloading an activity tracker program to the computer and synchronizing the program with the computer.

The rehabilitees in the "feeling outsider" subcategory have a positive attitude toward technology, yet they do not see technology important for themselves. Their mindset supports previous research results that positive attitudes toward technology is a prerequisite for the uptake of technology [29,30] and eHealth [19]. At the beginning of remote rehabilitation, it is important to encourage rehabilitees' abilities to use various devices, since these abilities will make them more receptive to the use of technology [31] and enable participation in remote rehabilitation. Studies have also found that even though the digital skills of senior citizens have improved, they are still insufficient [32]. Rehabilitees' ability to use technology is also ensured by adequate internet technology support in remote rehabilitation [33]. Finally, it is important that apps and instructions are available in the user's own language.

The rehabilitees in the "being uninterested" subcategory were not interested in technology and eschewed its use. They felt that easy-to-use technology encourages technology use while technology that does not work frustrates, and they felt constant communication in social media irritating. They expect coach contact to maintain motivation during remote rehabilitation. However, when their expectations of technology are exceeded, the resulting experience is positive and pleasant [34,35] and maintains motivation [35], which has also been shown in previous research.

The rehabilitees in the "feeling outsider" and "being uninterested" subcategories need more face-to-face counseling during remote rehabilitation. The rehabilitees in the "feeling outsider" subcategory need supportive guidance in technology use, while the individuals in the "being uninterested" subcategory need to be motivated in order to create positive experiences. Maintaining a spark of interest and motivation requires a motivator and a coach who gives feedback, weekly assignments, and regular reminders [36]. Previous research has shown that interventions based on the behavior change theory may motivate more than those lacking a theoretical basis, but studies conducted on mobile cardiac rehabilitation have not specifically addressed behavior change strategies. Web-based interventions may provide an opportunity for real-time coaching [37,38], motivation, and engagement, allowing rehabilitees to achieve a meaningful behavior change [18]. The rehabilitees feel that they need an external motivator, and the importance of the behavior change theory should therefore be given an adequate emphasis in the planning of remote rehabilitation.

The rehabilitees in the "reflecting benefit" subcategory use technology daily, and technology challenges they encounter stem from technical problems and attitudes. They expect apps to be easy to use, secure, and in their own language. The perceived ease of technology use influences perceived usefulness and together these bolster their intention to use technology for a real purpose (usage behavior) [39]. The technology acceptance model has also been applied in the health care context [34,35]. In addition, perceived usefulness with a perceived value plays a role in the acceptance of technology [40]; for example, it provides personalized information, support, monitoring, and feedback [21,22]. The minimization of application risks increases trust in systems [21,33,35]. These rehabilitees' acceptance of technology increases when applications are easy to use and interactive, which has also been shown in previous qualitative studies.

Remote rehabilitation should enable social participation, such as peer group discussion and personalized feedback. These rehabilitees use social media as a means of communication and appreciate the possibility to interact. Social media, such as Facebook, Twitter, Pinterest, and Instagram, is part of their day-to-day life [41]. Social participation should be used in remote rehabilitation by granting them access to a peer group [16,17] and enabling problem-free peer group discussion on matters regarding the rehabilitation process. Health care rehabilitation applications allow users to receive information and interact since rehabilitees can receive assignments, record and review data, receive automated feedback, and connect with peers or health care professionals. All of these have been found to be important Web-based user experiences in previous studies [20-22,38]. These rehabilitees' experiences show little need for other services than automated feedback in the form of mainly interactive coaching, which gives a little push and supports a lifestyle change.

The rehabilitees in the "enthusiastic using" subcategory accept technology as an integral part of their everyday life. Statistics show that mobile phone use is increasing [42], and these rehabilitees use mobile phones actively. Mobile health apps are increasingly popular, and mobile phone users have downloaded mobile health apps [43]. They are keen users of sufficiently coach-supported Web-based intervention apps to boost motivation for physical activity [14,44,45]. Recent studies show that participants appreciate professional Web-based support [20]. The subjects of these studies had participated in Web-based e-rehabilitation, which reduces face-to-face interactions [45,46] and is particularly suited to an active user who adequately masters technology and is interest in it. Easy-to-use and smoothly functioning technology allows extensive personal activity and body function monitoring—in other words, self-tracking. The recently termed quantified self notion has emerged to promote self-knowledge through numbers [9]. Health change coaching is based on the behavior change theory, motivational strategies, and communication techniques [20,46].

The rehabilitees' experiences with and attitudes toward technology provide information on how to implement a counseling theory and methods for the planning of remote rehabilitation. A coach should conduct individual risk factor assessment and management, exercise training, and self-management of modifiable risk factors and provide education and psychosocial support [38]. Professional health coaches can help rehabilitees increase self-direction, set specific goals, and take action to achieve and sustain health-supporting behaviors [38,47-49]. In addition to self-monitoring, an easy-to-use interface is a desirable feature in mobile apps for promoting physical activity. Examples of these interfaces are the integration of biosensors that collect information from body and life systems such as electrocardiogram, physical activity, heart rate, blood pressure, and blood glucose measurement [50]. Digital stethoscopes, thermometers, and weight scales [9] can also be used in remote rehabilitation.

The topic is important because remote rehabilitation is already being implemented and will continue to be implemented in the future due to increasing digitization [46,47]. Technology-related studies have shown that remote technology is most successful when it is simple and designed for easy understanding and easy use [30]. Easy-to-use technology also produces positive and successful experiences [49]. As rehabilitees' skills develop, they gain self-esteem and are empowered to expect positive, successful experiences [29,32]. Remote rehabilitation must take into account the abilities of each rehabilitee in learning, cognition, and motor and perceptual skills [29,33,51] and allow an individual ample time to master new skills [29]. In the future, the recognized needs and concerns of the subjects in the "feeling outsider," "being uninterested," "reflecting benefit," and "enthusiastic using" categories should be combined with previous research and taken into account. In this way, the acceptance and use of remote technology could be upped for more meaningful and effective rehabilitation. The results of this study can also be used in designing remote rehabilitation and health coach training programs. There is a lack of quality research on the experiences of coronary disease patients, and a need exists for mixed-methods research for the development of easy-to-use effective and meaningful welfare technology.

Limitations

There are weakness that need to be considered when interpreting the findings of this study. The subjects discussed their

experiences of technology at the beginning of rehabilitation, and everyone was given the opportunity to share his or her experiences. The interviewer created an accepting atmosphere and encouraged silent participants. Despite this, it is possible that the participants were trying to please the group when answering the questions. On the other hands, there are advantages. The results have attracted interest and their relevance, credibility, and usefulness have been identified as important when implementing remote rehabilitation. They have been also used in comparative rehabilitation groups, in musculoskeletal system reconditioning, and in work ability rehabilitation.

Conclusions

The aim of this study was to explore in detail rehabilitees' experiences and attitudes toward technology. The results are the rehabilitees' technology experiences described as "feeling outsider," "being uninterested," "reflecting benefit," and "enthusiastic using," which relate to their e-usage. The results help providers and health workers to identify different technology users among potential rehabilitees and determine what use levels must be taken into account when developing remote rehabilitation. The category formed into four subcategories which define the rehabilitees' technology experience and attitude. The results can also be used more widely in different contexts of social and health care for the planning of and training in remote rehabilitation/e-rehabilitation counseling and education.

Conflicts of Interest

None declared.

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BIOPSYCHOSOCIAL PROFILES OF PATIENTS WITH CARDIAC DISEASE IN REMOTE REHABILITATION PROCESSES: MIXED METHODS GROUNDED THEORY APPROACH

by

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Original Paper

Biopsychosocial Profiles of Patients With Cardiac Disease in Remote Rehabilitation Processes: Mixed Methods Grounded Theory Approach

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Abstract

Background: Digital development has caused rehabilitation services and rehabilitees to become increasingly interested in using technology as a part of rehabilitation. This study was based on a previously published study that categorized 4 groups of patients with cardiac disease based on different experiences and attitudes toward technology (e-usage groups): *feeling outsider*, *being uninterested*, *reflecting benefit*, and *enthusiastic using.*

Objective: This study identifies differences in the biopsychosocial profiles of patients with cardiac disease in e-usage groups and deepen the understanding of these profiles in cardiac rehabilitation.

Methods: Focus group interviews and measurements were conducted with 39 patients with coronary heart disease, and the mean age was 54.8 (SD 9.4, range 34-77) years. Quantitative data were gathered during a 12-month rehabilitation period. First, we used analysis of variance and Tukey honestly significant difference test, a *t* test, or nonparametric tests—Mann–Whitney and Kruskal–Wallis tests—to compare the 4 e-usage groups—*feeling outsider*, *being uninterested*, *reflecting benefit*, and *enthusiastic using*—in biopsychosocial variables. Second, we compared the results of the 4 e-groups in terms of recommended and reference values. This analysis contained 13 variables related to biomedical, psychological, and social functioning. Finally, we formed biopsychosocial profiles based on the integration of the findings by constant comparative analysis phases through classic grounded theory.

Results: The biomedical variables were larger for waistline (mean difference [MD] 14.2; 95% CI 1.0-27.5; *P*=.03) and lower for physical fitness (MD −0.72; 95% CI −1.4 to −0.06; *P*=.03) in the *being uninterested* group than in the *enthusiastic using* group. The *feeling outsider* group had lower physical fitness (MD −55.8; 95% CI −110.7 to −0.92; *P*=.047) than the *enthusiastic using* group. For psychosocial variables, such as the degree of self-determination in exercise (MD −7.3; 95% CI −13.5 to −1.1; *P*=.02), the *being uninterested* group had lower values than the *enthusiastic using* group. Social variables such as performing guided tasks in the program (*P*=.03) and communicating via messages (*P*=.03) were lower in the *feeling outsider* group than in the *enthusiastic using* group. The *feeling outsider* and *being uninterested* groups had high-risk lifestyle behaviors, and adherence to the web-based program was low. In contrast, members of the *being uninterested* group were interested in tracking their physical activity. The *reflecting benefit* and *enthusiastic using* groups had low-risk lifestyle behavior and good adherence to web-based interventions; however, the *enthusiastic using* group had low self-efficacy in exercise. These profiles showed how individuals reflected their lifestyle risk factors differently. We renamed the 4 groups as *building self-awareness*, *increasing engagement*, *maintaining a healthy lifestyle balance,* and *strengthening self-confidence.*

Conclusions: The results facilitate more effective and meaningful personalization guidance and inform the remote rehabilitation. Professionals can tailor individual web-based lifestyle risk interventions using these biopsychosocial profiles.

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KEYWORDS

coronary disease; experience; biopsychosocial model; digital cardiac rehabilitation; mixed methods grounded theory; web-based program; physical activity; self-efficacy; quality of life

Introduction

Background

Coronary heart disease (CHD) affects working-age populations and is the most common cause of death globally [1,2]. The main risk factors for CHD include age-related, gender-related, lifestyle-related, and socially-related risk factors [3-6]. Biomedical risk factors include smoking, high blood pressure and high cholesterol, obesity, type 2 diabetes, inappropriate diet, and sedentary behaviors [3-5]. Psychosocial factors, such as depression, lack of social support, stress, and personality type, have also been shown to affect the management of cardiovascular risks [7,8]. Cardiac rehabilitation focuses on decreasing patients' biomedical and lifestyle risk factors and increasing psychosocial management, physical activity counseling, and exercise training [3,4,9-11]. Currently, technology can provide an opportunity for individually tailored rehabilitation, irrespective of time and place [12]. Digital development has led patients with cardiac disease to become increasingly interested in using technology [13]. Therefore, theory- and evidence-based behavior change methods [13,14] and approaches have been gradually developed in web-based programs for cardiac rehabilitation [15-19].

It is a widely held view that most people find it difficult to change their health behaviors [20]. Therefore, it is important to understand how physical, psychological, and social factors contribute to behavioral change [21]. This study is based on behavioral medicine from a biopsychosocial model perspective [21-24] to understand the lifestyle risk management of patients with cardiac disease. Behavioral medicine integrates behavioral and biomedical knowledge on health and illness and applies this information, for example, to the counseling process of remote rehabilitation [24-26]. This study is also founded on behavior theories in behavioral medicine, that is, theories of learning (social cognitive theory [SCT] and self-efficacy) and motivation in exercise contexts (self-determination and self-regulation).

SCT focuses on the dynamic interaction of personal, environmental, and health behavior factors [27,28]. Part of the theory relates to health behavior self-efficacy, which refers to personal efficacy and guides how well people motivate themselves and their thoughts and actions [28]. Several studies have shown that low self-efficacy in health behaviors is associated with increased cardiovascular risk behavior [29,30]. On the other hand, individuals with higher self-efficacy are more effective in managing their cardiovascular risk behavior [31,32]. Moreover, high self-efficacy in using technology may increase the participation of individuals in web-based rehabilitation settings [32,33].

Self-determination theory focuses on the degree to which human motivation, development, and personality functioning occur within social contexts [34]. This theory has been used to examine behavior self-regulation [35] in cardiac rehabilitation [36,37]. Research has shown that decreases in external regulation and increases in intrinsic motivation may positively affect the physical behavior of patients with cardiac disease [36]. Self-determination theory represents a framework for understanding the exercise motivation of patients with cardiac disease.

Biopsychosocial profiles have been studied in the context of disease [38-42]; however, research has rarely looked at the biopsychosocial profiles of patients with cardiac disease in web-based rehabilitation settings. It is important to identify the biopsychosocial profiles of patients with cardiac disease to which web-based interventions can be tailored individually. The digital context offers an expanded means of understanding individual experiences with digital health solutions [22].

Objective

The purpose of this study is to enhance the understanding of biopsychosocial behaviors for the 4 previously defined different e-usage groups [43]. In our previous qualitative study, we identified 4 different e-usage groups using the Glaser mode of the grounded theory approach. These groups were *feeling outsider*, *being uninterested*, *reflecting benefit*, and *enthusiastic using* [43]. The qualitative study shows that patients with cardiac disease were different as technology users in technology experiences and attitudes toward technology and web-based guidance. Patients who felt outsiders and were not interested in technology needed more face-to-face guidance for rehabilitation, whereas patients who reflected the benefits and were enthusiastic about using technology felt that web-based coaching is sufficient support in rehabilitation [43].

In this study, we identify biopsychosocial variables related to CHD risk factors. The main biomedical and physical risk factors for CHD include physical inactivity and obesity. Psychological risk factors, such as depression, low psychological quality of life, and poor self-efficacy and behavioral control, are associated with increased CHD and risk behavior. Social determinants such as social isolation and low participation are also well-known risk factors for CHD.

In light of the previous study [43], we hypothesize that there would be differences among the 4 e-usage groups—*feeling outsider*, *being uninterested*, *reflecting benefit*, and *enthusiastic using* [43]—in each of the biomedical, psychological, and social areas. Propositions for differences among the 4 groups are as follows:

Proposition 1: The *feeling outsider* group might benefit from developing self-efficacy in physical activity and adequate positive support, as individuals in this group consider themselves as outsiders and find technology fearsome.

Proposition 2: The b*eing uninterested* group might benefit from weight management and physical activity self-monitoring with reminders and prompts, as they feel externally motivated.

Proposition 3: The *reflective benefit* groups might benefit from easy-to-use and interactive technology, as their interest is maintained by technology with personalized information and interactive tracking tools.

Proposition 4: The *enthusiastic users* group might benefit from empowering their self-efficacy and personalized lifestyle feedback, as they have a positive technology mastery experience.

Methods

Study Approach

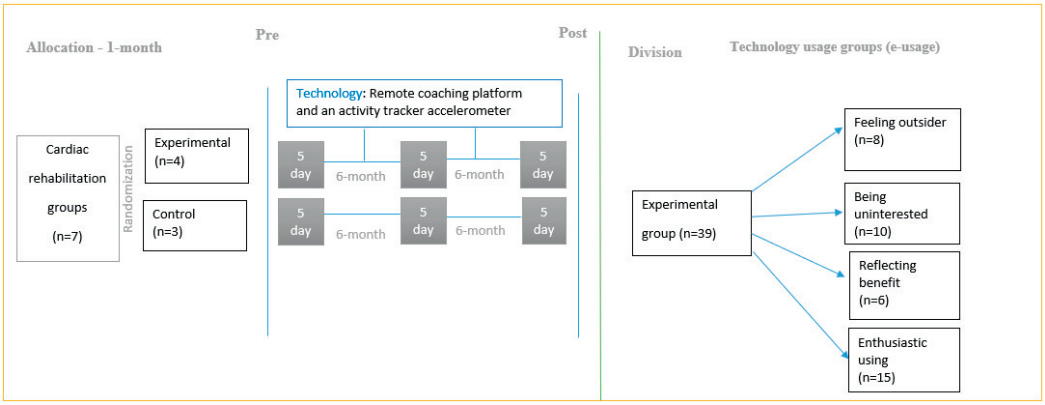
We used a mixed methods grounded theory (GT) approach in this study. During the previous study in our research project, we used the Glaser inductive GT approach and open coding strategies [44]. We derived the contents of patients' experiences with modern technology from survey responses and focus group interviews [43]. Methodologically, this study aims to further understand our previous qualitative results on the 4 e-usage groups [43] and to deepen the analysis to the core category level. Therefore, we decided to apply a qualitative and quantitative combination of the GT approach [45]. The GT methodology with quantitative data has been used across disciplines [46-49] and in health sciences because of the diversity of study questions [50]. However, it has not been used in rehabilitation settings for patients with CHD. Mixed data, methods, and techniques facilitated a balanced theory generation [49]. This helped us identify a biopsychosocial profile within 4 e-usage groups—*feeling outsider*, *being uninterested*, *reflecting benefit*, and *enthusiastic using*—and generate substantive theory.

Study Design

This study is part of a larger project, with a cluster randomized controlled trial of a rehabilitation intervention registered in the ISRCTN registry (ISRCTN61225589). The ethics committee of the Central Finland Health Care District approved the study. The intervention assessing the effect of additional remote technology rehabilitation on patients with CHD was conducted from 2015 to 2017 in a rehabilitation center in the middle of Finland, where the Social Insurance Institution of Finland arranges regular cardiac rehabilitation courses. Before 12 months of rehabilitation, the participants were randomly allocated into intervention groups (n=10 in each group) with scheduled rehabilitation sessions for each group. Groups were randomized in pairs into the experimental groups (n=4 groups, which included 1 pilot group of experiments) and control groups (n=3 groups).

In this study, participants were from the 4 experimental groups that used digital health tools in addition to the traditional 12-month cardiac rehabilitation (15 days in total). We derived the contents of patients' experiences with modern technology from focus group interviews, the details of which have been presented in our previous study [43]. Half a year after the intervention, participants were divided into 4 categorized e-usage groups—*feeling outsider*, *being uninterested*, *reflecting benefit*, and *enthusiastic using*—which were based on the results of the qualitative data (Figure 1) [43].

Figure 1. The study design of the 12-month cardiac rehabilitation (15-day) intervention within used digital health tools and division into 4 technology use groups (e-usage).



Participants

Qualitative and quantitative data were collected from participants at the rehabilitation center (10/39, 26% female; 29/39, 74% male). The participants' mean age was 54.8 (SD 9.4, range 34-77) years; 71% (27/38) participants had completed lower professional education. Of the 39 participants, 32 (82%) had undergone coronary angioplasty, and 4 (10%) had undergone coronary artery bypass surgery in the past 12 months before rehabilitation. Approximately 92% (25/27) of participants used the internet, and 37% (10/27) of participants used wrist activity trackers (Table 1 presents a description of participants at baseline by e-usage groups).

The e-usage groups of patients with cardiac disease—*feeling outsider*, *being uninterested*, *reflecting benefit*, and *enthusiastic using* [43]—were discovered in the same study population as in our previous study by using GT [43]. When we compared the groups' background characteristics, only one statistically

significant difference emerged. Mean age was significantly di erent among the groups (*P*=.003; analysis of variance [ANOVA] test). The *being uninterested* group participants were younger than participants in the other groups. The mean age of the *being uninterested* group was significantly lower than the mean age of the *feeling outsider* (mean difference [MD] −12.9; 95% CI −23.2 to −2.6; *P*=.009; Tukey honestly significant difference [HSD] test), *reflecting benefit* (MD −14.1; SD 4.15; 95% Cl −25.3 to −2.9; *P*=.009; Tukey HSD test) and *enthusiastic using* groups (MD −6.4; 95% Cl −12.6 to −0.2; *P*=.04; pairwise with 2-tailed *t* test).

Table 1. Description of participants at baseline by e-usage groups (N=39).

Description of participants	Feeling outsider (n=8)	Being uninterested (n=10)	Reflecting benefit (n=6)	Enthusiastic using (n=15)	Total
Age (years), mean (SD)	60.5 (7.6)	47.6 (5.6)	61.7 (11.2)	54 (8.2)	54.8 (9.4)
Gender, n (%)					
Female	2 (25)	4 (40)	0	4 (27)	10 (26)
Male	6 (75)	6 (60)	6 (100)	11 (73)	29 (74)
Professional education, n (%)					
Lower education level	5 (63)	5 (56)	5 (83)	12 (80)	27 (71)
Higher education level	3 (38)	4 (44)	1 (17)	3 (20)	11 (29)
Time of heart operation, n (%)					
0-12 months before rehabilitation	5 (63)	6 (60)	4 (67)	10 (67)	25 (64)
Over 12 months before rehabilitation	2 (25)	2 (20)	1 (17)	5 (33)	10 (26)
No operations	1 (13)	2 (20)	1 (17)	0	4 (10)
Technology, n (%)					
Use internet	4 (80)	7 (100)	6 (100)	8 (89)	25 (93)
Use physical activity tracker	2 (40)	4 (57)	1 (17)	3 (33)	10 (37)

Intervention

The rehabilitation of patients with CHD occurred in three 5-day periods during the year. The aim of rehabilitation was to promote a patient's adaptation to CHD and improve his or her functional capacity and ability to work [51]. A team of professionals included a physician, physical therapist, and nurse and optionally, a social worker, psychologist, or dietitian. For the remote component of the rehabilitation program, we used a secured remote coaching platform (m-coach Movendos) and an activity tracker accelerometer (Fitbit Charge HR). The 12-month web-based program involved feedback from each participant's own physiotherapist. The program sent automatic motivational messages every month, and peer support was available in group discussions. Research participants set and monitored their health-related behavior goals by keeping a lifestyle and exercise diary and completing assignments.

Data Collection

Data collection was guided by a purposeful sampling strategy called theoretical sampling in the GT method. This includes the purposeful selection of data samples to allow us to determine the variables that we would need to select to meet theoretical needs [44,45]. Table 2 presents the study's biopsychosocial variable time points for collection.

Biomedical variables comprised measures such as waistline [52] and physical fitness (the 6-minute walk test [6MWT]) [53]. Physical activity was measured with a physical activity monitor of light-intensity physical activity using a Fitbit (Fitbit Inc) tracker [54] and the self-report International Physical Activity Questionnaire (IPAQ; 9 items) [55]. The World Health Organization Quality of Life-BREF (WHOQOL-BREF) questionnaire was used to assess individuals' quality of physical health (domain 1). Other quality of life BREF domains are psychological health (domain 2), social relationships (domain 3), and the environment (domain 4) [56].

Table 2. Biopsychosocial variable time points for collection.

Biopsychosocial variables	Time point	
	0-month	12-month
Biomedical		
Waistline [52]	✓	N/A[a]
Physical fitness (6-minute walk test [6MWT]) [53]	✓	N/A
Light-intensity physical activity accelerometer (LPA) [54]	✓	N/A
International physical activity questionnaires (IPAQ) [55]	✓	N/A
The World Health Organization Quality of Life-BREF (physical health, domain 1) [56]	✓	N/A
Psychological		
Self-Efficacy to Regulate Exercise Scale (SERES) [57]	—[b]	✓
The Behavioral Regulation in Exercise (BREQ-3) [58,59]	—	✓
Questionnaire Depression Scale (DEPS) [60]	✓	N/A
Quality of Life-BREF (psychological health, domain 2) [56]	✓	N/A
Social		
Web-based participation (the number of task and message marks)	—[b]	✓
Quality of Life-BREF (social relationships, domain 3, and environment, domain 4) [56]	✓	N/A

[a]N/A: not applicable.

[b]Data not available.

Psychological variables were measured using 3 questionnaires: quality of psychological health (WHOQOL-BREF, domain 2) [56,61], Self-Efficacy to Regulate Exercise Scale (SERES) based on SCT [57], and the Behavioral Regulation in Exercise Questionnaire (BREQ-3). BREQ-3 is a 24-question instrument and is based on self-determination theory [58,59]. The Depression Scale (a 10-item DEPS) [60] was also included to measure psychological variables.

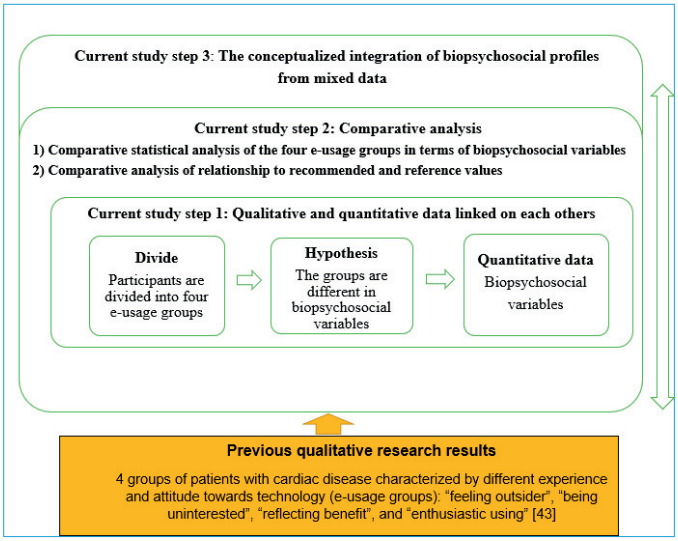
Social variables comprised participation in the web-based program and the quality of life questionnaire. Participation in the program was measured by individuals' visits to the site, including the number of pages they visited, the number of tasks they had completed (the number of completed task marks), and the number of conversations they had participated in (the number of message marks) during the 12 months of intervention. Social preintervention variables were also included in the questionnaire responses regarding the quality of social relationships and the environment (WHOQOL-BREF; domain 3 and domain 4) [56].

Data Analysis

The constant comparative method of the classic GT [44,45] guided the data analysis. That is, we analyzed data for similarities and differences at a more abstract level to move toward substantive theory building [44,46,47]. We recorded our research group's reflective discussions and wrote both theoretical and analytical memos. Memos were seen as a link between the research group's notions and theoretical ideas, and they helped us in data analysis and meaning interpretation. In the following paragraphs, we describe our quantitative analysis and use of a mixed methods GT approach.

In our previous study, we analyzed interview data using GT. The result of the qualitative study was 4 e-usage groups—*feeling outsider*, *being uninterested*, *reflecting benefit*, and *enthusiastic using* [43]. In the first step, we divided participants into these 4 e-usage groups. A total of 2 researchers (MRA, HK) in our study independently read the interview responses of the participants. These researchers independently divided participants into 4 e-usage groups, taking into account the qualitative descriptions of the different e-usage groups: (1) technology experience, (2) attitude, and (3) expectations of remote counseling. There was moderate agreement between the 2 researchers in the coding of responses into the groups, κ=0.521 [62]. The 2 researchers compared their divided results, discussed disagreements, and reanalyzed the disagreed-upon results together. The results were also discussed with a third researcher (TS) to finalize the coding results. On the basis of our previous qualitative results [43], we presented a hypothesis, selected available biopsychosocial variables, and used quantitative methods and techniques to promote the generation of a substantive theory [43,44]. Figure 2 describes the entire three-step analysis.

Figure 2. Three-step analyses process.



In the second step, statistical analyses were used to examine the differences in biopsychosocial variables among the 4 groups. All quantitative data analyses were performed using the SPSS (version 24, SPSS Inc). We report descriptive statistics for the variables being compared. We examined the differences in biopsychosocial variables among the groups with probability statistics (P<.05) to determine whether the proposed differences within the group could be confirmed. As a measure of precision for the estimate, a 95% CI was reported.

ANOVA, t test, or nonparametric test (Mann–Whitney and Kruskal–Wallis tests) was used when appropriate. Thereafter, pairwise comparisons between the groups were analyzed with ANOVA (the Tukey HSD test, the Kruskal–Wallis or Mann–Whitney test (with Bonferroni correction). For comparisons of three or more group means, we performed the (one-way) ANOVA or nonparametric Kruskal–Wallis test. ANOVA was only used if the data in each group were normally distributed and the variances were homogeneous. Normality of the groups was assessed by the Shapiro–Wilk test, as all group sizes were <50. Homogeneity of variances was evaluated by the Levene test. When we had a significant result for differences between group means in the main test, we performed post hoc comparisons. For ANOVA, we applied the Tukey test, and for the Kruskal–Wallis test, we used the Mann–Whitney pairwise comparisons while adjusting the significance values by the Bonferroni correction for multiple tests.

After completing the series of quantitative analyses, we compared the results of the 4 groups in terms of recommended and reference values. We compared physical activity level (accelerometer and questionnaire) with World Health Organization's global recommendations for physical activity for health, that is, 150 minutes each week [54] and the quality of life questionnaire results with averages for the Finnish population (aged 18-98 years) [61]. In the DEPS (0-30), the cutoff point for depression is ≥8 points, which indicates sensitivity to depression [60]. The questionnaire (SERES and BREQ-3) results were compared with the mean value of the scale. The mean value of SERES is 50 (0-100) [57] and that of BREQ-3 is 0 (−24 to 24) [58,59]. We compared the number of completed remote tasks and messaging markings with the total sample mean values of participation in the web-based program (the number of completed tasks was 87 for remote tasks and 6.6 for messaging).

In the final step of the analysis, a constant comparison was performed conceptually by analyzing the meanings behind the numbers for discovering and generating substantive theory based on GT [44,45]. Quantitative data were compared systematically by theoretical coding variables within groups. We grounded profile conceptualization by critically examining and questioning the data, which was theoretically sensitive. Finally, we formed biopsychosocial profiles based on the integrated findings of the constant comparative analysis phases. On the basis of these conceptualization processes, we renamed the profile of each group and formed the main category (Table 3 shows an example of a constant comparative analysis process in the *feeling outsider* group).

The results of this study's quantitative phase align with our qualitative findings. Our analyses moved toward substantive theory when we performed a constant comparative analysis of the qualitative and quantitative data [45,46]. As Glaser stated, "it is important to fully understand the meaning behind the numbers and techniques when using quantitative data [45]." The following paragraphs describe the results of the intermediate stages of comparative analyses in more detail.

Table 3. The feeling outsider group constant comparative analysis (n=8)[a].

Variables	Feeling outsider, mean (SD)	Result in significant differences between groups	RV[b]	Values, mean/RV (%)	Profile descriptions[c]
Waistline (centimeters)	107.1 (11.1)	—[d]	<94	+13.9	The *feeling outsider* group had high-risk behavior related to overweight
6-minute walk test (meters)	575.5 (73.3)	The *feeling outsider* group had lower physical fitness (*P*=.047) than the *enthusiastic using* group.	>623	–7.6	The *feeling outsider* group had high-risk behavior related to being inactive
Light-intensity physical activity, accelerometer (n=6)	134.9 (58.6)	—	>150	–10	Self-reported weekly physical activity differed from accelerometer-measured physical activity
IPAQ[e] (n=7)	421.4 (468.4)	—	>150	+280.9	Self-reported weekly physical activity differed from accelerometer-measured physical activity
WHOQOL-BREF[f] physical health	13.6 (2.9)	—	>16.5	–17.6	Physical quality of life was low at the beginning of rehabilitation
Self-Efficacy to Regulate Exercise Scale (0-100; n=7)	67.0 (19.2)	—	>50	+34	They had a high self-efficacy to regulate exercise at the end of the rehabilitation according to their own estimate
The number of completed task mark[g]	45 (126.1)	Performing guided tasks in the program (*P*=.03) were lower in the *feeling outsider* group than in the *enthusiastic using* group	>87	–48.3	Their engagement in technological solution was low
The number of discussions mark[g]	4.3 (7.6)	Communicating via messages (*P*=.03) were lower in the *feeling outsider* group than in the *enthusiastic using* group	>6.6	34.8	Their engagement in technological solution was low

[a]Hypothesis: There would be differences between the 4 e-usage groups *feeling outsider*, *being uninterested*, *reflecting benefit*, and *enthusiastic using* [43]. Proposition: The *feeling outsider* group might benefit from developing self-efficacy in physical activity and adequate positive support, as individuals in this group consider themselves as outsiders and find technology fearsome.

[b]RV: recommended value.

[c]On the basis of these results, a profile for the group *feeling outsider* was renamed *building self-awareness*.

[d]No significant differences between the *feeling outsider* and others e-usage groups.

[e]IPAQ: International Physical Activity Questionnaire.

[f]WHOQOL-BREF: The World Health Organization Quality of Life Questionnaire, Short Form.

[g]Postintervention variables.

Results

Comparative Statistical Analysis of the 4 e-Usage Groups in Terms of Biopsychosocial Variables

The results of the comparative analysis provide an understanding of the biopsychosocial profiles of e-usage groups.

Statistically significant differences (*P*<.05) between groups were found for the biomedical variable waistline, which significantly differed between the *being uninterested* and *enthusiastic using* groups (MD 14.2; 95% CI 1.0 to 27.5; *P*=.03; Tukey HSD test). The *being uninterested* group had a larger waistline than the *enthusiastic using* group. The 6MWT also showed significant differences between *being uninterested* and *enthusiastic using* groups (MD −0.72; 95% CI −1.4 to −0.06; *P*=.03; Tukey HSD test) and between the *feeling outsider* and *enthusiastic using* groups (MD 55.8; 95% CI −110.7 to −0.92; *P*=.047; 2-tailed *t* test). The *feeling outsider* group had lower physical fitness than the *enthusiastic using* group. For the biomedical variables, light-intensity physical activity and IPAQ, there were no significant differences among the 4 groups, and the psychological and social variables, DEPS and quality of social life, were also nonsignificant (Table 4).

The results for the postintervention variables are presented next. The BREQ-3 scores were significantly di erent between the *being uninterested* and *enthusiastic using* groups in a *t* test (MD −7.3; 95% CI −13.5 to −1.1; *P*=.02); the degree of self-determination in exercise was lower for the former than for the latter. The results for SERES were nonsignificant. Participation in the web-based program (0-12 months) was the only statistically significant difference in group comparisons, with task marking di ering significantly. Pairwise comparison revealed significant di erences. Performing guided tasks in the program in the Kruskal–Wallis test (*P*=.04) and communicating via messages were lower in the *feeling outsider* group than in the *enthusiastic using* group (*P*=.03) in the Mann–Whitney test (Table 5).

Table 4. Comparative quantitative analysis among the 4 groups in terms of biopsychosocial preintervention variables.

Biopsychosocial variables preintervention	Group 1, *feeling outsider* (n=8)		Group 2, *being uninterested* (n=10)		Group 3, *reflecting Benefit* (n=6)		Group 4, *enthusiastic using* (n=15)	
	Value, mean (SD)	n (%)	Value, mean (SD)	n (%)	Value, mean (SD)	n (%)	Value, mean (SD)	n (%)
Biomedical variables								
Waistline (centimeters) [52]	107.1 (11.1)	—[a]	112.7[b] (13.6)	—	102.3 (12.3)	—	98.4[b] (11.3)	—
6-minute walk test (meters) [53]	575.5[b] (73.3)	—	558.9[c] (61.1)	9 (90)	624.3 (28.8)	4 (67)	631.3[b,c] (52.7)	—
Light-intensity physical activity, accelerometer (minutes/week) [54]	134.9 (58.6)	6 (75)	174.6 (48.8)	6 (60)	137.2 (49.1)	4 (67)	148.3 (59.8)	13 (87)
The International Physical Activity Questionnaire (min/week) [55]	421.4 (468.4)	7 (88)	461.3 (445.5)	8 (80)	320.8 (411.4)	—	291.0 (307.4)	—
WHOQOL-BREF[d] physical health (4-20) [56]	13.6 (2.9)	—	13.7 (2.2)	—	14.4 (2.3)	—	14.2 (2.2)	—
Psychological variables								
WHOQOL-BREF psychological health (4-20) [56]	14.3 (2.7)	—	14.2 (2.2)	—	14.4 (3.0)	—	15.5 (1.9)	—
The Depression Scale (0-30) [60]	6.8 (5.9)	6 (75)	6.7 (5.3)	—	2.0 (1.9)	5 (83)	4.2 (3.9)	—
Social variables								
WHOQOL-BREF social relationship (4-20) [56]	14.3 (2.5)	—	15.9 (2.5)	—	15.7 (1.9)	—	16.3 (2.9)	—
WHOQOL-BREF environment (4-20) [56]	14.9 (2.6)	—	14.3 (2.3)	—	15.3 (1.7)	—	15.0 (2.2)	—

[a]No missing data.

[b]Significant difference (P<.05) among groups.

[c]Significant difference (P<.05) among groups.

[d]WHOQOL-BREF: The World Health Organization Quality of Life Questionnaire, Short Form.

Table 5. Comparative quantitative analysis among the 4 groups in terms of biopsychosocial postintervention variables.

Biopsychosocial variables postintervention	Group 1, *feeling outsider* (n=8)		Group 2, *being uninterested* (n=10)		Group 3, *reflecting benefit* (n=6)		Group 4, *enthusiastic using* (n=15)	
	Value, mean (SD)	n (%)	Value, mean (SD)	n (%)	Value, mean (SD)	n (%)	Value, mean (SD)	n (%)
Biomedical variables								
The number of completed tasks mark	45[a] (126.1)	—[b]	31.4 (48.4)	—	116.8 (142.8)	—	156.0[a] (204.7)	—
The number of discussions mark	4.3[a] (7.6)	—	6.1 (4.2)	—	7.8 (8.0)	—	8.1[a] (6.9)	—
Self-Efficacy to Regulate Exercise Scale (0-100) [57]	67.0 (19.2)	7 (88)	56.6 (18.3)	7 (70)	62.0 (9.2)	—	54.2 (17.4)	14 (93)
The Behavioral Regulation in Exercise Questionnaire 3 (−24 to 24) [58,59]	12.0 (8.3)	6 (75)	5.7[a] (8.0)	7 (70)	11.8 (2.1)	—	13.1[a] (5.5)	14 (93)

[a]Indicates significant difference (P<.05) among the groups.

[b]No missing data.

Comparative Analysis of Relationship to Recommend and Reference Values

We compared the results of the 4 groups in terms of recommended and reference values. All e-usage groups had larger waistline and lower 6MWT values compared with the risk of disease cutoff values (waistline <94/6MWT >623); *feeling outsider* (mean 107.1/mean 575.5), *being uninterested* (mean 112.7/mean 558.9), *reflecting benefit* (mean 102.3/mean 624.3), and *enthusiastic using* (mean 98.4/mean 631.3). Regarding the quality of social relationships (>16.5), the *feeling outsider* (mean 14.3) and *being uninterested* (mean 15.9) groups reported lower quality of social relationships than that of the *reflecting benefit* (mean 15.7) and *enthusiastic using* (mean 16.3) groups. Except for the *enthusiastic using* group, which had near-average values, the quality of life results for all groups were lower than the average values for the Finnish population (Table 6).

The self-efficacy values of all groups were better than the mean value of the scale (>50). On the other hand, the opposite results were observed for variables of exercise self-efficacy, in which the *enthusiastic using* group had lower self-efficacy (mean 54.2) than the *feeling outsider* (mean 67), *being uninterested* (mean 56.6) and *reflecting benefit* (mean 62; Table 7) groups.

Table 6. Comparative analysis of relationship to recommended and reference values (preintervention).

Biopsychosocial preintervention variables	RV[a]	*Feeling outsider* (n=8)		*Being uninterested*, mean (n=10)		*Reflecting benefit* (n=6)		*Enthusiastic using* (n=15)	
		Values, mean (SD)	Level of factor, mean/RV (%)	Values, mean (SD)	Level of factor, mean/RV (%)	Values, mean (SD)	Level of factor, mean/RV (%)	Values, mean (SD)	Level of factor, mean/RV (%)
Biomedical variables									
Waistline (centimeter) [52]	<94	107.1 (11.1)	+13.9	112.7 (13.6)	+19.9	102.3 (12.3)	+8.8	98.4 (11.3)	+4.7
Physical fitness (meter) [53] (6-minute walk test)	>623	575.5 (73.3)	−7.6	558.9 (61.1)	−10.3	624.3 (28.8)	+0.2	631.3 (52.7)	+1.3
Light Physical activity, accelerometer (minutes/week) [54]	>150	134.9 (58.6)	−10	174.6 (48.8)	+16.4	137.2 (49.1)	−8.5	148.3 (59.8)	−1.1
The International Physical Activity Questionnaires (minutes/week) [55]	>150	421.4 (468.4)	+280.9	461.3 (445.5)	+307.5	320.8 (411.4)	+213.9	291 (307.4)	94
WHOQOL-BREF[b] Physical health [56]	>16.5	13.6 (2.9)	−17.6	13.7 (2.2)	−17.0	14.4 (2.3)	−12.7	14.2 (2.2)	−13.9
Psychological variables									
WHOQOL-BREF psychological health [56]	>15.5	14.3 (2.7)	−7.7	14.2 (2.2)	−8.4	14.4 (3.0)	−7.1	15.5 (1.9)	0
The Depression Scale (0-30) [60]	<8	6.8 (5.9)	−15	6.7 (5.3)	−16.3	2.0 (1.9)	−75	4.2 (3.9)	−47.5
Social variables									
WHOQOL-BREF social relationship [56]	>16.5	14.3 (2.5)	−13.3	15.9 (2.5)	−3.6	15.7 (1.9)	−4.8	16.3 (2.9)	−1.2
WHOQOL-BREF environment [56]	>16.5	14.9 (2.6)	−9.7	14.3 (2.3)	−13.3	15.3 (1.7)	−7.3	15.0 (2.2)	−9.09

[a]RV: recommended value.

[b]WHOQOL-BREF: The World Health Organization Quality of Life Questionnaire, Short Form.

Table 7. Comparative analysis of relationship to recommended and reference values (postintervention).

Biopsychosocial postintervention variables	RV[a]	*Feeling outsider* (n=8)		*Being uninterested* ((n=10)		*Reflecting benefit* (n=6)		*Enthusiastic using* (n=15)	
		Values, mean (SD)	Level of factor, mean/RV (%)	Values, mean (SD)	Level of factor, mean/RV (%)	Values, mean (SD)	Level of factor, mean/RV (%)	Values, mean (SD)	Level of factor, mean/RV (%)
Postintervention variables									
Task marks	>87	45 (126.1)	−48.3	31.4 (48.4)	−63.9	116.8 (142.8)	+34.3	156.0 (204.7)	+79.3
Discussion marks	>6.6	4.3 (7.6)	−34.8	6.1 (4.2)	−7.6	7.8 (8.0)	+18.2	8.1 (6.9)	+22.7
Self-Efficacy to Regulate Exercise Scale [57]	>50	67.0 (19.2)	+34	56.6 (18.3)	+13.2	62.0 (9.2)	+24	54.2 (17.4)	+8.4
The Behavioral Regulation in Exercise Questionnaire [58,59]	>0	12.0 (8.3)	+12	5.7 (8.0)	+5.7	11.8 (2.1)	+11.8	13.1 (5.5)	+13.1

[a]RV: recommended value.

Conceptualized Integration of Biopsychosocial Profiles From Mixed Data

The results were synthesized to build the biopsychosocial profiles for the 4 groups—*feeling outsider*, *being uninterested*, *reflecting benefit*, and *enthusiastic using*—as part of the rehabilitation process. We formed biopsychosocial profiles based on constant comparative analysis through narrative description.

Proposition 1: The *feeling outsider* group might benefit from developing self-efficacy in physical activity and adequate positive support, as individuals in this group consider themselves as outsiders and find technology fearsome:

> *That technology hasn't really come [...] My wife taught the computer [...] supported, well, taught—so I went to the courses. And the kids did. I thought that if I'm still starting to tinker, there won't be enough hours in the day to learn [43].* [participant 25, 60-year-old man, focus group 1]

The *feeling outsider* group had high-risk behavior related to being inactive and overweight. Self-reported weekly physical activity differed from accelerometer-measured physical activity. In addition, physical quality of life was low at the beginning of rehabilitation. Members of this group had a high self-efficacy to regulate exercise at the end of the rehabilitation according to their own estimate; however, their engagement in technological solutions was low. Their biomedical results were inconsistent between their self-reported physical activity and objectively measured data, which may have been because of a lack of lifestyle self-awareness. On the basis of these results, the profile for the *feeling outsider* group was renamed *building self-awareness*

Proposition 2: The b*eing uninterested* group might benefit from weight management and physical activity self-monitoring with reminders and prompts, as they feel externally motivated:

> *I'm waiting for it and I'm truly interested, as if I were waiting for something like a spark. That it is something, something like, motivating, and...well...I can't say, but it like maybe not now for sure every week. If once a month, certainly something could come...a reminder [43].* [participant 56, 45-year-old man, focus group 3]
>
> *When I could enter inputs in there, and if my own activities could be there, then I would be like a response: Is this the right or wrong direction, and...And that's when it's really somebody, something and someone monitoring what you're doing [43].* [participant 41, 49-year-old woman, focus group 2]

The *being uninterested* group had low levels of physical fitness, poor self-assessed physiological quality of life, and a high waist circumference. Their exercise behavior can be described as externally regulated, with low scores in self-determination. In addition, they were interested in self-monitoring their physical activity but were uninterested in participating in web-based coaching. Their self-monitoring technology may have motivated them to improve their physical activity levels and engagement in lifestyle changes. The profile for the *being uninterested* group was renamed *increasing engagement.*

Proposition 3: The *reflective benefit* groups might benefit from easy-to-use and interactive technology, as their interest is maintained by technology with personalized information and interactive tracking tools:

> *Let's put it in this way: I'm not actually now that way from being pushed, yeah. Yes it comes from my own desire. The main purpose is monitoring: it's for that. It's interesting to follow what happens if you change some exercise habits, and you can see from this, what changes have happened in the background. Very okay [43].* [participant 17, 57-year-old man, focus group 2]

The *reflecting benefit* group showed healthy lifestyle choices related to eating behavior and exercise. They may have had

intrinsic motivation for exercise and high self-determination, including a positive balance in life. Higher scores indicated higher self-efficacy for exercise and health technology interest. Their biopsychosocial outcomes were balanced and maintaining these outcomes could be the most important goal for them. The *reflecting benefit* group was renamed *maintaining a healthy lifestyle balance*.

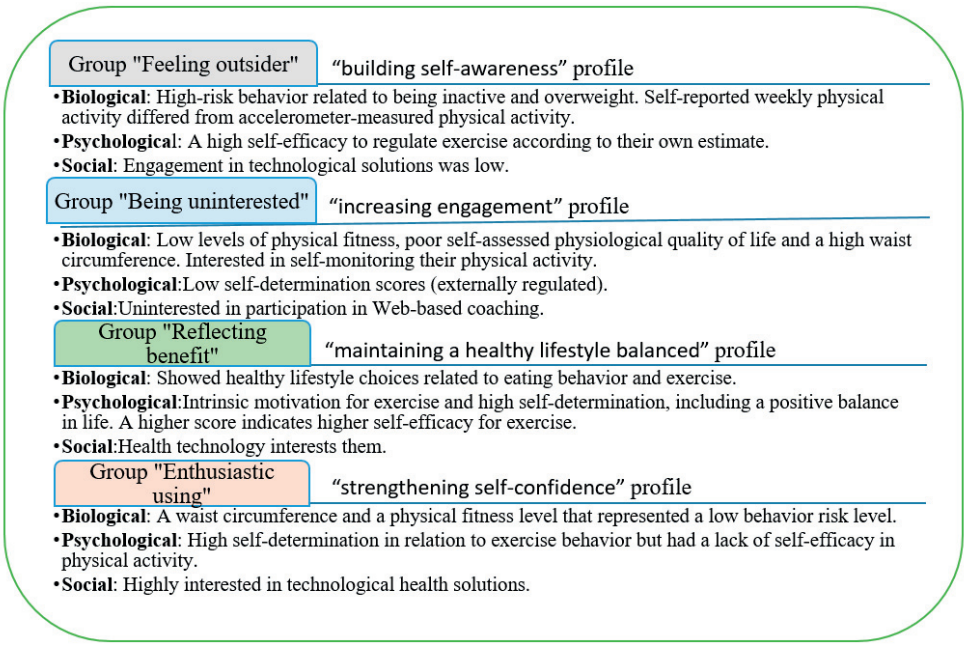
Proposition 4: The *enthusiastic users* group might benefit from empowering their self-efficacy and personalized lifestyle feedback, as they have a positive technology mastery experience:

> *I'm waiting and I'm interested. Yes, of course, this here now gives little push in the pants. I'm already moving pretty well, that's what this thing around my arm tells me...Yeah...and then yes, I have the Sport Tracker on my phone, also. When I go somewhere, I tell it to draw a map, and I see the time and all that [43]."* [participant 66, 34-year-old man, focus group 3]

> *Modern opportunities. And if now, of course...from where soon could come a little spark, and that spark continues than exercise could begin. And it's really the same benefit. And then, of course, if nothing's heard from there. It sounds real good, and then reminders. Something like you can write comments, and [...] [43]* [participant 26, 61-year-old woman, focus group 2]

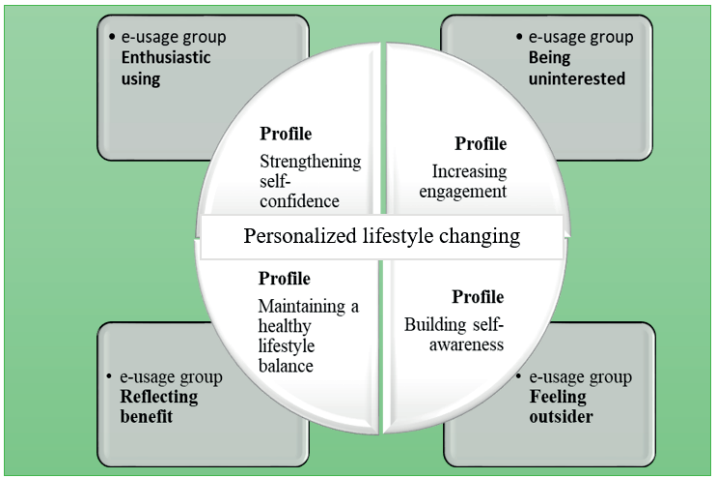
The *enthusiastic using* group had a waist circumference and a physical fitness level that represented a low behavior risk level. They had high self-determination in relation to exercise behavior but lacked self-efficacy in physical activity. They were highly interested in technological health solutions. This group had a healthy lifestyle; however, their physical self-efficacy related to exercise was low. A heart event may have lowered their self-confidence in health behaviors. The profile for the *enthusiastic using* group was renamed *strengthening self-confidence*.Figure 3 shows a summary of the groups' similarities and differences in the comparative analysis results.

Figure 3. Group biopsychosocial profile descriptions.



On the basis of these results, we were able to synthesize all groups' biopsychosocial profile descriptions to a thematic meaning, that is, *personalized lifestyle changing as part of the rehabilitation process*, which can be the start of substantive theory development integrated into all 4 groups' profile descriptions. On the basis of the analysis, we identified and renamed the 4 groups to *building self-awareness*, *increasing engagement*, *maintaining a healthy lifestyle balance,* and *strengthening self-confidence*. These profiles showed how individuals in the 4 groups identified their different lifestyle management reflections in rehabilitation progress. The main results of the analysis are shown in Figure 4.

Figure 4. Biopsychosocial personalized lifestyle changing profiles in relation to the rehabilitation process.



Discussion

Principal Findings

The main result of the study was *personalized lifestyle changing as part of the rehabilitation process,* which refers to the 4 groups' profiles related to rehabilitation progress. On the basis of the qualitative and quantitative GT analysis, we identified 4 profiles: *building self-awareness*, *increasing engagement*, *maintaining a healthy lifestyle balance*, and *strengthening self-confidence*. The main message of this study is that it is important to identify different biopsychosocial profiles with respect to the reflections of patients with cardiac disease on their lifestyle risk factor management in the counseling process of remote rehabilitation. This knowledge can give cardiac rehabilitation professionals evidence and enable them to tailor theory-based web-based behavior change interventions.

Patients in the *feeling outsider* group were afraid to use technology, and they expected supportive behavior change counseling [43]. This group, with the *building self-awareness* profile, had low daily physical activity and was overweight. In their self-reports, members of this group overestimated the amount of physical activity relative to their objectively measured data. A possible explanation for these results may be their lack of self-awareness concerning self-management of lifestyle risk factors. However, studies have shown a higher estimate of physical activity using the IPAQ than the accelerometer data [63]. Self‐management skills and attitudes included in lifestyle change are based on motivational, goal-setting, controlling, and self-regulatory skills, which require self-awareness [64]. Although promoting the ability to recognize how self-efficacy, thoughts, feelings, and actions are interconnected, rehabilitation also improves self-awareness for self-management of lifestyle change processes [30,31,33,64,65]. The group with this profile needs guidance and positive support in using technology [43] and in increasing their self-awareness. Patients in this group may benefit from web-based goal-setting tools for self-awareness. Goal setting could help these patients identify their own risk factors and set realistic and meaningful goals. Health professionals should take into account patients' aims, needs, and self-efficacy, as well as health outcome information in individual goal-setting.

The *being uninterested* group expected problem-free technology with activity-empowering web-based counseling [43]. This group, with the *increasing engagement* profile, had lower self-efficacy, and they might have quickly given up when they ran into difficulties [43]. In addition, we found that the group was uninterested in participating in web-based coaching. However, members showed interest in tracking their physical activity with a wearable accelerometer. Patients in this group showed low scores in self-determination, and thus, their motivation can be described as externally regulated. Previous studies have reported that regular physical activity can reduce cardiovascular risk factors [1-4]. Activity tracking accelerometers with feedback may boost self-efficacy, which has been shown to promote cardiovascular risk self-management [29-31]. Wearing an accelerometer itself may promote and motivate physical activity [66]. Patients in this group had low levels of physical fitness, poor self-assessed physiological quality of life, and high waist circumferences. Previous research has shown that biopsychosocial characteristics are related to lower scores in risk factor self-management, especially in women [6,37,41]. Additional support can be provided using evidence-based health behavior change techniques with the help of technology in rehabilitation [15,30,32,65]. Patients in this group may benefit from support and guidance to increase their engagement in lifestyle-changing processes. Health professionals should take into account such patients' motivations to use self-monitoring technology and their interests in personalized and regular feedback, reminders, and prompts.

Patients in the *reflecting the benefit* group expected easy-to-use and useful technology with interactive tools [43]. The group showed healthy lifestyle choices, such as healthy eating and exercising. These patients had high self-efficacy in achieving physical activity goals, and they were interested in health technology. This group, with a *maintaining a healthy lifestyle balance* profile, had a fair amount of intrinsic motivation for exercise and high self-determination for exercise behavior, which is needed to increase self‐management skills and facilitate lifestyle change [64,67]. Self-monitoring and realistic

goal setting are important factors in the process of self-regulation [10,16]. Our findings indicate that increases in regular exercise competence could improve intrinsic motivation, as shown in previous studies [35,36]. Patients with this profile may benefit from interactive and easy-to-use tracking tools through which self-monitoring allows them to manage their health. Health professionals should monitor the goal progress to meet their desired functional goals.

The *enthusiastic using* group expected smoothly functioning technology that offered empowering self-tracking with feedback [43]. This group had minor risk behavior but the lowest self-efficacy in physical activity compared with the other group profiles. The results of Kärner Köhler et al [68] indicate that self-efficacy is not related to chronic conditions. However, a cardiac event may have reduced these patients' self-confidence in their own lifestyle management. They may not have believed in their own behavior choices for reaching the desired goal. A possible explanation might be that patients conscientiously followed a healthy lifestyle. A previous study showed that people with higher conscientiousness were more intrinsically motivated [35]. Early self-efficacy support may improve individuals' participation in web-based programs [31,33]. Patients with the *strengthening self-confidence* profile may benefit from early self-management support for self-confidence. Health professionals should provide support, especially in the early stages after heart events, by focusing on positive achievements.

The profiles showed how patients in the 4 groups adjusted their lifestyles differently on the part of rehabilitation progress. Patients in the *feeling outsider* and *being uninterested* groups had high-risk behavior and low engagement in technological solutions. In contrast, patients in the *reflecting benefit* and *enthusiastic using* group profiles had low-risk behavior and good adherence to web-based interventions. Biopsychosocial profiles have been used to tailor interventions for patients with chronic pain [38,39], diabetes [40], overweight and obesity [41], and hypertension [42]. It is also important to identify the biopsychosocial profiles of patients with cardiac disease, as it allows for evidence- and theory-based and individually tailored lifestyle counseling programs in multidisciplinary fields.

Limitations and Strengths

This study has some limitations related to the sample size, which was unevenly distributed among the groups. The purpose of the study was theoretical verification using GT, and for this purpose, there was an inductive generalization regarding the phenomenon under study and no statistical generalization. We have provided detailed descriptions that were not intended for extrapolation of the findings to other settings but to provide information about the phenomenon and build substantive theory. The possible sampling bias, small sample size, and sampling strategy certainly limited our quantitative analyses; however, we used GT and mixing methods of constant comparative analysis, which was beneficial to our study when we grounded several variables. This study was based on GT, and the results can be said to be reliable based on thick descriptions, taking into account thorough descriptive information about the study setting, study participants, and processes. There are weaknesses in this study; for example, we collected data from the BREQ-3 and SERES questionnaires only at the end of the intervention. It would have been better if all questionnaire data had also been collected preintervention. However, despite this shortcoming, the BREQ-3 and SERES questionnaires provided valuable information. The mixing of methods was an innovative challenge. The credibility of the results was based on conceptualization to enable a greater understanding of patient experiences with technology in the context of digital cardiac rehabilitation. There is also a need for information on whether there might be a change in patients' experiences and attitudes toward technology during rehabilitation. The implementation of these results might be useful, especially in the planning of rehabilitation counseling and teaching.

Conclusions

The study showed that *personalized lifestyle changing as part of the rehabilitation process* relates to the profile descriptions of the 4 groups. On the basis of the profiles, we identified 4 profiles related to the rehabilitation process: *building self-awareness*, *increasing engagement*, *maintaining a healthy lifestyle balance*, and *strengthening self-confidence*. The results might help to understand what is meaningful for Finnish patients with cardiovascular disease who participate in a rehabilitation program with face-to-face and remote web components. The personalized behavior change components can be embedded in the technology part of cardiac rehabilitation, for example, individual goal setting, self-monitoring, reminders and prompts, positive social and peer group support, personalized information, and feedback. These components increase the *spark* for motivation to a lifestyle change by taking into account the different life situations, needs, and concerns of individuals and their experiences and attitudes toward the use of technology. However, future studies are needed that back up our current results with larger sample sizes and a sociodemographic structure that mirrors the study population.

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Conflicts of Interest

None declared.

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Abbreviations

6MWT: 6-minute walk test
ANOVA: analysis of variance
BREQ-3: The Behavioral Regulation in Exercise-3
CHD: coronary heart disease
DEPS: the Depression Scale
GT: grounded theory
HSD: honestly significant difference
IPAQ: The International Physical Activity Questionnaire
MD: mean difference
SCT: social cognitive theory
SERES: Self-Efficacy to Regulate Exercise Scale
WHOQOL-BREF: The World Health Organization Quality of Life-BREF

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III

PATIENTS' EXPERIENCES OF THE COMPLEX TRUST-BUILDING PROCESS WITHIN DIGITAL CARDIAC REHABILITATION

by

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RESEARCH ARTICLE

Patients' experiences of the complex trust-building process within digital cardiac rehabilitation

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Abstract

The development of digital solutions is becoming increasingly important in facing global challenges. Therefore, research on this topic is important in taking into account cardiac patients' experiences of the rehabilitation process for the design of digital counseling solutions. The aim of the present qualitative study was to explore the different meanings that patients give to the rehabilitation process using a Glaserian grounded theory (GT) approach. Qualitative interviews were conducted with 30 participants from a rehabilitation center in Finland. The findings indicated a "complex trust-building process" core category comprising five categories of trust-building in rehabilitation: feeling that one has hit rock bottom, facing and coping in a crosscurrent, understanding together as a peer group, moving toward a healthier lifestyle with technology, and finding self-awareness. The complex process of trust-building involved interactions among emotion, cognition, and acceptance and support processes. Therefore, digital rehabilitation should be incorporated into counseling based on patients' psychosocial, physical and emotional needs to help patients become aware of their own feelings and thoughts during the rehabilitation process.

Introduction

The development of digital solutions needs to be increasingly taken into account in health care [1] and cardiac rehabilitation [2,3]. Cardiac patients have also shown increasing interest in using healthcare technology [4–6] and participating in remote rehabilitation due to increasing digitization [7]. Cardiac patients are attracted to the ability of remote rehabilitation to provide convenient and flexible access to real-time personalized support [4,7]. Cardiac patients' experiences of lifestyle change issues in the digital context, such as behavior [8–10], physical activity [11], healthy eating [12], social support [13–15] and mental health [16–18], have been studied in the context of common remote interventions. However, none of these studies examined rehabilitation as a whole process.

Notably, after heart events, cardiac patients experience anxiety and depression [19,20], impairment of cognitive function and emotional distress [21], lack of social support [20] and

placed excerpts from transcripts relevant to the study in a suitable repository because sharing the excerpts violates the consent of the participants. Upon request, we may share analytics data that does not contain identification data. Data requests may be sent to The Ethics Committee of the Central Finland Health Care District The Ethics Committee of the Central Finland Health Care District Päivi Lampinen paivi.lampinen@ksshp.fi Keskussairaalantie 19, rak. 1, Minikampus (2. krs) 40620 Jyväskylä, Finland puh.+35814 269 5134.

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impacts on their self-care management. Therefore, an important aim of the cardiac rehabilitation process is to support patients' ability to adapt. There are a number of theoretical frameworks to explain the adaptation process after a cardiac event, such as the biomedical, psychological and biopsychosocial models of adaptation to illness [22,23]. The process of adjustment or adaptation to chronic illness refers to an individual's psychological reactions or responses to an illness or disability and their reorganization of their lives due to the condition [24]. These reactions also involve the meaning-making process, by which an individual continues to search for new situational meaning and relate this meaning to his or her general ways of understanding life and the world [25]. Theoretical perspectives, such as cognitive behavioral theories and treatment approaches [26–28] and social cognitive theory (SCT) [29], are helpful for understanding how an individual's behavior develops and changes as part of the rehabilitation process. In the rehabilitation process, it is important to take into account the interaction between an individual's thoughts and feelings, past experiences and behaviors [27], as well as the social environment [29]. An individual's acceptance and awareness as well as his or her engagement and behavior change strategies increase his or her psychological flexibility in the behavior change process [27]. In addition, in the rehabilitation process, the promotion of the individual's positive thoughts and beliefs alleviates emotional distress and reinforces self-esteem, which in turn contributes to external changes in behavior [27,29].

Patients' own rehabilitation processes are supported by their coping strategies and ability to adapt cognitively to the disease [24], and community social support is an important part of this process [29,30]. Coping strategies are the means that cardiac patients use in their cognitive, emotional and behavioral efforts to manage or adapt to the demands of the cardiac event that exceed their resources [31]. Coping mechanisms are often divided into two groups: problem-focused and emotional-focused coping strategies [31]. Furthermore, coping may be differentiated into approach behavior and avoidance behavior, which refer to, e.g., a patient talking about emotions with his or her peer group (approach) or trying to forget the cardiac event (avoidance) [32]. In the rehabilitation process, peer support is important and is facilitated by peers' ability to share experiences of illness or disability [30]. Cardiac patients' sense of connection with other cardiac patients as part of the rehabilitation process can decrease isolation and increase psychological well-being [20].

Notably, numerous qualitative studies have described patients' perceptions of the cardiac rehabilitation process after a cardiac event [33–37]. Qualitative studies have gradually begun to examine the experiences of patients with digital programs [7,38,39], but the present qualitative study is even more broadly related to the multidisciplinary digital cardiac rehabilitation process than previous studies. This research goal is important because there is a need to expand the understanding of the experiences of the rehabilitation processes of patients who have used digital technology. The aim of the present qualitative study was to explore the different meanings patients give to the rehabilitation process using a grounded theory (GT) approach.

Methods

The study analyzed patients' experiences of the rehabilitation process by using the Glaserian GT method [40]. We chose to use a GT approach because it is suitable for investigating phenomena to develop and apply knowledge about patients' concerns regarding social interaction in digital rehabilitation. In GT, the research problem is called the main concern, and it explains the primary focus of the substantive area of research [40]. An inductive methodology was used in the analysis process, which allowed us to approach the research with a completely open mind and without any preconceptions of the results. The analysis process required theoretical sensitivity for the research results to support the conceptualization of the data [41].

Setting

Semistructured interviews were conducted with cardiac patients (mean ages 55.46), including 22 males and 8 females, who had undergone coronary angioplasty (PTCA) (25/30) or coronary artery bypass graft (CABG) (4/30) approximately 3 to 12 months prior to rehabilitation. In Table 1 demographic characteristic of the participants at baseline is presented. The participants were recruited among adult patients with coronary artery disease (CAD) and attended the cardiac rehabilitation courses that utilized digital health tools for traditional cardiac rehabilitation (Peurunka rehabilitation centre, Finland). The inclusion criteria for participation were adults (18 years or older) who had cardiovascular risk factors or angina pectoris with physical working capacity limitation or myocardial infarction or coronary artery bypass graft surgery (CABG) or coronary angioplasty (PTCA). Participants were excluded if they had musculoskeletal problems, cognitive or memory impairment, or if they were unable to use independently computer and remote technology application. Participation in the study intervention also required the participant to have internet at home or be able to use a computer of family members or friends. Participants in the study received an activity tracker accelerometer (Fitbit Charge HR®, USA) and remote coaching tool software (m-coach Movendos, Finland), which

Table 1. The demographic characteristic of the participants at baseline.

	Percent %	n/total
Gender		
Men	73.3	22/30
Women	26.7	8/30
Marital status		
Married	60.7	17/28
Unmarried	7.1	2/28
Cohabiting	10.7	3/28
Divorced/separated	17.9	5/28
Widowed	3.6	1/28
Education		
Vocational or course-form school or other	28.6	8/28
College-level education	42.9	12/28
University of applied sciences	25	7/28
University	3.6	1/28
Employment status		
Retired	28.6	8/28
On sick leave	3.6	1/28
Unemployed or laid off	3.6	1/28
Working full-time	53.6	15/28
Working part-time/part-time retiree	3.6	1/28
Others	6.7	2/28
Operation		
Coronary artery bypass graft (CABG)	13.3	4/30
Coronary angioplasty (PTCA)	83.3	25/30
No operation	3.3	1/30
Time of operation		
0–3 months from rehabilitation	6.7	2/30
3–6 months from rehabilitation	16.7	5/30
6–12 months from rehabilitation	46.7	14/30
Over 12 months from rehabilitation	26.7	8/30

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was free to download on computers, tablets and smart phones. Patients were informed verbal and written of the study prior to rehabilitation that participation was voluntary and that they could withdraw from the study at any time. Patients also signed informed consent forms to participate in the study. Patients were also assured that whether they wanted to participate in the study or not, it would not have any negative impact on the rehabilitation process.

The rehabilitation intervention lasted 12 months and included three five-day conventional rehabilitation periods at a rehabilitation center offered by the Social Insurance Institution of Finland. The rehabilitation course provided guidance on various topics related to a changed life situation due to cardiovascular disease. The course involved exercise and group-based educational and discussion sessions given by a doctor, a physiotherapist and a nurse, and optionally, a social worker, a psychologist and a dietitian. Between the rehabilitation periods, the intervention provided patients with web-based coaching via a remote connection using web-based software (m-coach Movendos, Finland) and an activity tracker accelerometer (Fitbit Charge HR®, USA). The web-based coaching consisted of monthly tasks that aimed to increase patients' ability to cope with everyday life with cardiac illness. The physiotherapist contacted patients monthly using the software and provided feedback on their rehabilitation process. In addition, the web-based software also sent automatic motivational messages every month. The coaching software allowed patients to share their own experiences with the peer group and to send a message to their own physiotherapist if needed.

Data collection and analysis

Data collection was guided by a purposeful sampling strategy, which involves the purposeful selection of data samples according to the developing categories and emerging theory [41]. This sampling strategy is called theoretical sampling in the GT method, whereby the researcher concurrently collects codes and analyses data and decides during the analysis process which data will be collected next [41]. Following this strategy, we analyzed the cardiac patients' interview material at the beginning of rehabilitation (0 months) [4], and the analysis results obtained therein guided data collection at the end of rehabilitation (12 months).

The patients were divided into four focus groups, each of which participated in a semistructured interview conducted at the rehabilitation center at the end of rehabilitation in 2016 and 2017. The study is a part of a distance technology in cardiac rehabilitation study registered at the ISRCTN Registry [ISRCTN61225589]. The Ethics Committee of the Central Finland Health Care District approved the study. Each focus group interview included 5–9 patients and lasted an average of 30–90 minutes. The participants were encouraged to speak openly about their experiences of the rehabilitation process. The interviewer was free to vary the questions and their content and to allow for group discussion. Example questions, are as follows: "What were your meaningful experiences with rehabilitation process?"; "How was the peer group meaningful to you?"; and "What are your experiences of how technology has been a help to you in coping with daily life and lifestyle changes?" The interviewer asked follow-up questions as needed. The interviewer observed the group dynamics and ensured that everyone had an opportunity to speak. Occasionally, there were people in the focus group who talked more and guided the session, but the interviewer provided a balanced discussion by asking the quieter participants supplementary questions. Interviews were tape-recorded and transcribed with ATLAS.ti software (ATLAS.ti Scientific Software Development GmbH). In addition, manual techniques, such as systematic "sentence by sentence" analysis, were used to facilitate data analysis [40]. Throughout the constant comparative process of data collection and analysis, free-form memos were written, and interpretations were discussed in the research group according to the GT approach [40,42].

The first step of the data analysis process was "open coding", during which we were open to all interpretations [40]. We became familiar with the data by carefully and repeatedly listening to the recorded interviews. We reread the interview transcripts to familiarize ourselves with "what was going on in the data" and the "main concern" of the participants [40,42]. In the second step of data analysis, we constantly compared incidents to incidents, incidents to concepts, and concepts to concepts [40,41]. Then, we categorized the codes to form subcategories and categories to conceptualize the experiences of patients. As we created the categories, we looked for connections among the codes and tried to understand how one code related to another. We analyzed whether one concept should be categorized with another concept or whether each concept should become its own category. We also looked for important descriptive words and meaningful expressions that participants used. These in vivo terms, which were one or two words in length, described what was happening in the data [40].

In the third step, the analysis process continued until a coded category and its properties became saturated by constant comparison [40]. Open coding was complete when the core category was identified. In the fourth step, the data analysis process continued with the selection of a core category and the determination of the properties of the categories of the core category [40]. We returned to the raw data and checked our analysis by recoding and comparing the new categories to those created while writing memos. We examined whether these categories and their properties fit into the phenomenon that was becoming the core category [40]. Fig 1 presents the systematic data collection and analysis process.

Results

The experience of rehabilitation was described as a complex trust-building process by cardiac patients in digital rehabilitation. This process reflected the emotion, cognition and acceptance and support processes that patients experienced during rehabilitation. This complex process

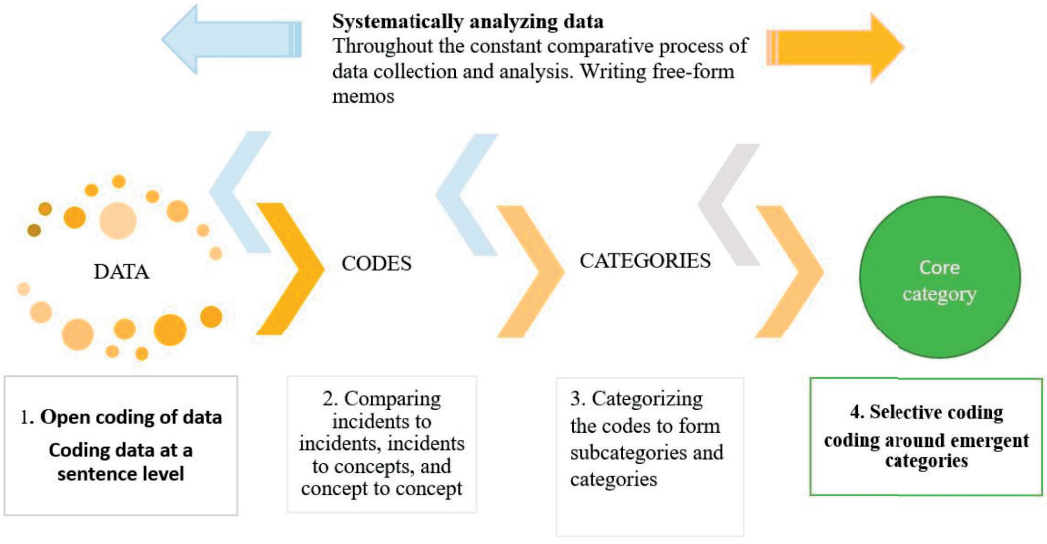

Fig 1. Data collection and analysis process of this study.

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Table 2. "Complex trust-building process" core category and its five categories.

"Complex trust-building process" core category and its five categories					
Change processes	**Five categories of being one year in the rehabilitation**				
	Feeling that one has hit rock bottom	**Facing and coping in a crosscurrent**	**Understanding together as a peer group**	**Moving toward a healthier lifestyle with technology**	**Finding self-awareness**
Emotion	Feelings of worthlessness and powerlessness	Struggling the ups and downs	Feeling of being on the "same level"	Moving forward toward self-trust	Finding hope
Cognition	Avoiding thoughts	Noting own thoughts	Giving and receiving feedback	Seeking information about activity	Developing self-care through learning, repetition
Acceptance and support	Recognizing rock bottom of one's own life	Encouraging support	The positive importance of face-to-face peer group contact	Supporting "a great buddy" technology	A time and place to increase awareness of one's own needs

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was observed through five categories of trust-building in rehabilitation: feeling that one has hit rock bottom, facing and coping in a crosscurrent, understanding together as a peer group, moving toward a healthier lifestyle with technology, and finding self-awareness. The results obtained from the GT constant comparative analyses are summarized in Table 2.

Feeling that one has hit rock bottom

All of our participants with cardiac illness focused on digital rehabilitation in the interviews, but a minority mentioned their feelings about the experience of cardiac illness. Patients described their feelings of distress after a heart event as the feeling of having hit "rock bottom" and recognized the heart event as the nadir of their lives. This life situation included a loss of self-esteem and negative emotions such as feelings of worthlessness and powerlessness and even despair due to their sudden experience of a heart event. They also reflected on the connection between work stress and heart events. Their involvement of the cardiac rehabilitation course quickly after the cardiac event, such as a cardiac surgery or angioplasty stent, was considered important. The participants also noted that going to rehabilitation challenged them to address their own thoughts and feelings about managing their new life situations. They tried to avoid thoughts or feelings that made them insecure. These reactions hindered their coping in daily life, which was reflected in one interviewee's description of feelings of experiencing cardiac illness:

> *"So. . . rock bottom becomes my life. . . When I felt myself, like that I was nothing anymore. That's it. I thought I couldn't do anything"* [Participant 18, 64-year-old woman, focus group 5].

Facing and coping in a crosscurrent

After a heart event, some patients faced crosscurrents in life. They described struggling with difficulties in life and experiencing both the ups and downs. On the other hand, some participants faced outside pressure in pursuit of a new lifestyle. Most of them wanted to return to work, and retraining had been suggested for some patients. However, some participants felt relieved to stop working, such as due to retirement. The patients' descriptions showed that they did not want to give up and that the support they received encouraged them to continue. Patients highlighted the importance of support in facing adversity and coping in a new stage in life. They felt that friends and family members and colleagues were the most important people who made them feel supported and encouraged. Some participants appreciated the feedback and support received from healthcare professionals, such as this patient who also noted the importance of having his own hobby:

"Motivation is pretty good, has been good all that time. For these things, and. . . family and work friends are of course with me, and then the motorcycling. When I have a hobby, then those guys hanging out with me, and. . .the staff here have been very nice. and things have gone well for me. . .and that's about the way it is now, then. . ." [Participant 30, 53-year-old man, pilot focus group].

The following comment describes another patient's thought process:

"That's the way it was, when I said, when I downplayed it that way. You see, I was kind of hardheaded and headstrong. Nobody tells me what to do, but well. . .then I got to the second level, then it started to get me moving" [Participant 4, 59-year-old woman, focus group 5].

Understanding together as a peer group

Almost everyone in the study indicated the great importance of peer group support. In their view, the most important aspect of rehabilitation was the experience of connecting with others. They described the feeling of being on the same level as other peer group members and the possibility of forming a common understanding of what had happened as meaningful. They emphasized that shared experience, unique group support and a sense of reciprocity were key to rehabilitation. Peer group activities were described as interactions in which patients received and gave feedback to each other. Several participants emphasized the positive importance of face-to-face peer group contact, when patients could talk about digital rehabilitation. They were concerned about isolation in remote rehabilitation without social support. Most participants described the positive experience of being at the "same level" as each other and the peer group relationship as helpful for initiating their own understanding of the adaptation process; for example, one interviewee described,

"So it is.. I feel sure that these people understand just what I've experienced myself. . . and. . .and being like on same level there" [Participant 56, 45-year-old man, focus group 3].

Moving toward a healthier lifestyle with technology

Patients' experiences of rehabilitation utilizing a remote technology application were diverse and included both positive and negative experiences. Many patients felt that the technology supported physical activity and lifestyle changes. Some patients noted that rehabilitation with technology was part of their learning and thought processes in a new life situation. The thought process included seeking information about activity, which enabled them to identify the level of physical activity and sleep quality. Many of them felt that technology helped them recognize their own development and noted that they received immediate feedback on their own levels of physical activity. Activity monitoring motivated them to move forward toward achieving their own goals. The physiotherapist provided feedback and support through a web-based program that also helped patients seek and utilize information to evaluate their goals and progress. Patients were aware that the activity results provided by the technology were different from their own experiences of activity, but this did not interfere with the positive experience with the technology. On the other hand, participants were frustrated with the technology due to a lack or breakdown of equipment. They described the technology as friendly or "*a great buddy*", as it helped them keep track of their daily activity. For example, one interviewee said,

"Yeah, that became a great buddy there, I followed it. . .and just those steps, I tried for like ten-twelve thousand. But now, when it got broken, yeah, I´m like. . ." [Participant 14, 55-year-old man, focus group 3].

Finding self-awareness

Most of the participants described the meaningfulness of rehabilitation in providing a time and place to increase awareness of one's own needs and thoughts, set goals, and evaluate and achieve them. In addition, they found hope in living and gradually forgot about the disease in their daily lives. On the other hand, some patients wanted more personalized life management and plans that took into account their life situations. Patients described their own development in self-care that occurred through their learning, repetition, and application of self-care knowledge. They found self-confidence and satisfaction and forgot about the illness, as one woman described:

"The fact that many times, it is so much to itself, probably, that when the disease is not here right now, it is a little over there, like just around the corner. That it doesn't remind me every minute, remind you. So, it's as easy as forgetting it. And don't take it like you should always think about it" [Participant 26, 61-year-old woman, focus group 2].

These results indicate that the sudden onset of heart disease could have significant psychological impacts and affect the daily lives, attitudes toward work and emotions of cardiac patients. In next section, therefore, we specifically discuss cardiac patients' experiences of the meaning of the trust-building process.

Discussion

This study aimed to build an understanding of the different meanings patients gave to the rehabilitation process. The main result of the study was the identification of the core category, the "complex trust-building process", as shown in Fig 2. Five categories of meanings of the complex trust-building were observed: feeling that one has hit rock bottom, facing and coping in a crosscurrent, understanding together as a peer group, moving toward a healthier behavior through technology, and finding self-awareness. This complex process was based on patients' different experiences and their main concerns in relation to the trust-building process. The complex trust-building process included interactions between change processes such as emotion, cognition, acceptance and support processes.

The results of this study show that the main concern of the participants in the rehabilitation process was not only related to, for example, lifestyle changes in physical activity and diet. The patients also described the rehabilitation process as relating to their psychosocial and emotional needs, as seen in previous studies [16,17,19,33–37]. On the other hand, patients described digital solutions mainly as supporting behavior change. For example, when speaking about the importance of digitalization, patients focused on the support provided by applications for lifestyle change but not for reflections about the adaptation process and the management of emotions and thoughts. They were also concerned about the implementation of the peer group in a completely digital way, as the most important aspect for them was the feeling of belonging to the peer group and sharing experiences face to face. Theoretically, the findings of this study are largely consistent with the underpinnings of cognitive behavioral theory [26–28] and SCT [29], showing how patients' trust-building occurs through emotional and cognitive processes during cardiac rehabilitation.

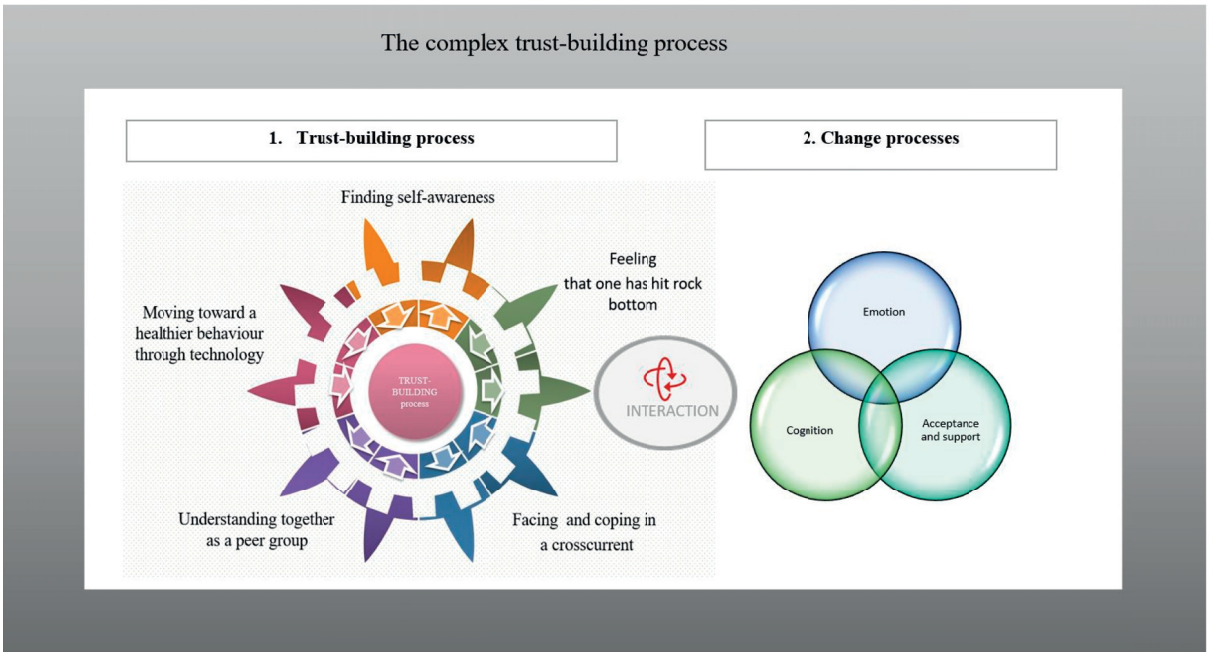

Fig 2. Interaction between change processes in the complex trust-building process.

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The heart event–an emotionally stressful situation

The psychological processes that patients described included feelings of worthlessness and powerlessness, as well as the loss of one's dreams, similar to "hitting rock bottom", after a heart event. Our study shows how patients understood the meaning of their own thoughts when coping in crosscurrents. It shows how these patients coped with internal (attitudes) and external (expectations to fulfill) challenges that may have affected their ability to adapt illness. This psychological reaction or response to crosscurrents also refers to the meaning-making process as an active coping tool, which was also demonstrated in a previous study [25]. Professional staff have an important task in supporting patients in identifying these emotional and thoughts processes, as has been previously stated [6,18,30], because how a person interprets and reframes a situation is relevant to how emotionally stressful a situation becomes [30].

Supporters

Peer support and the formation of an understanding of the meaning of the disease for one's own life became especially important in social processes. Patients described the meaning of the rehabilitation peer group to them as, for example, learning together, sharing experiences and feeling a sense of belonging, and building a common understanding of the disease and coping. Such meaning arises in interactions with other peers in the same situation by giving and receiving feedback, which has also been described in another study [30]. The results of this study support those of previous studies, which have shown how coping with different stressors in life through social support buffers a stressful environment [13–15,20,30]. The current study demonstrates the role of peer groups and spouses and other family members, friends, and

health care professionals as supporters, as previous studies have shown [13,14,30]. Patients cope with emotional distress as a peer group, and identifying the significance of such coping is relevant in the trust-building process.

Technology as part of the thinking process

In addition to the psychosocial processes described above, patients talked about the process of behavior change. Our study adds to previous knowledge by providing descriptions of how patients moved toward healthier behaviors with support from technology [8–10]. Patients reported that physical activity and sleep quality monitoring provided feedback on progress toward their goals and healthier behavior. This feedback made it possible to search for information through the monitoring of the thought process, and the use of technology as part of rehabilitation can provide patients with the opportunity to practice interactive thinking skills. [5]. These results support the findings of previous studies [7,38,39] showing that it is important for patients to also have opportunities for communication with a rehabilitation professional regarding their own health issues.

Patients desired more personalized and individualized counseling to maintain motivation during rehabilitation, which was consistent with previous digital program studies [7,38,39]. Previous research has shown that the digitalization of rehabilitation can improve the professional-patient relationship in meeting the individual needs of the patient [1–4,38,39]. Web-based counseling could encourage patients to find self-awareness for managing a positive life attitude by giving them time to ask questions and listen critically [32] and helping them to ask what is important in life [25]. Web-based support and counseling with individual feedback enhances patients' own potential to achieve goals [5,10]. Receiving individual, positive and realistic feedback is also a key part of the disease acceptance process in the remote context [16,17]. The use of technology as part of the trust-building process supports and enables lifestyle change and related thinking and experience sharing, goal tracking, and information seeking, which are also important coping strategies [24].

Finding hope and forgetting about the disease

Cardiac patients described their reactions to their illness and how finding their self-awareness and forgetting about thoughts about the illness helped them maintain a positive life attitude. In the trust-building process, they found hope to live and forget about the disease in their daily lives, which is consistent with Schaufel's (2011) study results [18]. There are similarities between the awareness process expressed in this study and the processes described by the psychological models that focus on reorientation, the life situation, acceptance to form a new or restored sense of self-concept, renewed values and the identification of new meanings in life [22–24]. Previous theories and studies have shown that patients need to have emotional management support that enables them to deal with their own thoughts and feelings toward different coping strategies [17,19,21,32]. One interesting finding of these studies is that patients' own perceptions of their ability to cope with illness and change guide their thinking processes and motivation. This finding can help multidisciplinary rehabilitation staff understand how patients cope to deepen their understanding of the disease and how to support patients in the rehabilitation process.

Finally, this study is limited because it examined the meanings of the cardiac rehabilitation process for patients in only one rehabilitation setting and because the data collection included only group interviews. Group interviews have strengths and weaknesses compared to one-on-one interviews. However, the patients spoke freely in a familiar peer group. On the other hand, the strengths of the research include the careful and transparent analysis process. The results

will be of interest to scholars in this field, and they highlight the importance of the usefulness of digital rehabilitation in its implementation.

Conclusion

The purpose of the current study was to provide an understanding of cardiac patients' experiences of the meaning of cardiac digital rehabilitation for their lives. This study showed that rehabilitation includes a complex process of trust-building, with interaction between cognition, emotion, acceptance and support processes. Within this complex trust-building complex process, multiple categories of trust-building were observed, including feeling that one has hit rock bottom, facing and coping in a crosscurrent, understanding together as a peer group, moving toward a healthier lifestyle with technology, and finding self-awareness. Involvement in the peer support group was particularly important for patients. It can be concluded that emotion management counseling and a face-to-face or digital peer format should be available to patients in digital rehabilitation for them to build trust.

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