Human support in eHealth lifestyle interventions

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GENERAL INTRODUCTION

"The months after my heart attack, there has been a consecutive stream of professionals who were helping me in my recovery. Them telling me what to do and how to improve my health has been a great support. But now rehabilitation has ended and I feel like I'm completely on my own. I know my health is my own responsibility, but if I'm honest, I don't know where to start."

The story above is not an exception. Within the Netherlands, one out of ten adults suffer from cardiovascular diseases (CVD) (Koop et al., 2021). This does not only lead to a higher burden on the healthcare system and rising costs due to an increased need for care provision and productivity loss (Wilkins et al., 2017), but also has serious consequences for patients themselves. Apart from the negative health consequences, CVD patients often experience a deteriorated quality of life, meaning that their condition impacts their social, physical, or psychological functioning (De Smedt et al., 2013). Cardiac rehabilitation programmes in the Netherlands therefore also focus on psychological and social well-being (e.g. improving mental health, going back to work), next to improving physical fitness (e.g. exercise capacity; Multidisciplinaire Richtlijn Hartrevalidatie, Hartstichting, 2011).

The impact of a healthy lifestyle

A major part of rehabilitation is aimed at improving risk behaviours associated with CVD (Hartstichting, 2011). This is not without reason, as a more healthy lifestyle could provide an important contribution to CVD risk management. Addressing behavioural risk factors such as smoking, poor diet, physical inactivity and low sleep quality shows to have a positive impact on the prognosis of CVD (Kaminsky et al., 2022; Piepoli et al., 2016; Wilkins et al., 2017). Improving the lifestyle of CVD patients can even have mortality-reducing effects that are comparable to medication intake (Iestra et al., 2005). As a result, CVD-related deaths have reduced within countries that implemented policies related to healthier lifestyles (Roth et al., 2020).

Unfortunately, many patients are not able to maintain a healthy lifestyle once they return to their everyday life, after their rehabilitation has ended (Janssen et al., 2013; ter Hoeve et al., 2015). This is not surprising, as maintaining a healthy lifestyle is a difficult task. The difficulty of transforming intentions into real behaviour, which is called the intention-behaviour gap, makes it challenging for people to maintain healthy lifestyle behaviours that were initiated during rehabilitation (Webb & Sheeran, 2006). Lifestyle behaviours are often driven by automatic processes, such as habits (Rothman et al., 2009) and influenced by environmental factors (Marteau et al., 2012). Furthermore, due to the so-called present bias, people often favour the immediate satisfaction of unhealthy behaviour above the delayed reward of a healthy lifestyle (Liberman & Trobe, 2008). It is therefore not surprising that CVD patients themselves report struggles in

developing a healthy lifestyle, and maintaining this healthier lifestyle after cardiac support ends (Murray et al., 2012) which is necessary to prevent recurrent cardiovascular events.

eHealth interventions for CVD patients

Given the fact that maintaining a healthy lifestyle seems so difficult for many CVD patients, there is an increasing need for solutions to help these patients, and eHealth technology can be such a solution. eHealth can be defined as the use of interactive new information and communication technology to support or enhance health and healthcare (Barak et al., 2009; Thomas & Bond, 2014). An increasing amount of eHealth interventions is being developed (Thomas & Bond, 2014) and eHealth is becoming increasingly relevant, which became especially evident during the recent COVID-19 outbreak (Bokolo, 2021; Silven et al., 2020). eHealth can be used to provide both remote and automated healthcare support and can be either web- or mobile-based. An example of eHealth to promote healthy living are wearables to track objective health indicators, that give users insight into their own health and lifestyle behaviour (e.g. blood pressure, steps a day). This provides users with the opportunity to set and track their personalised health goals (e.g. taking 5.000 steps per day). This is just one example of the wide range of technology eHealth can encompass to provide education and skills training.

The use of eHealth within cardiovascular care and cardiac rehabilitation has shown to be effective in both the prevention and treatment of CVD (Beishuizen et al., 2016; Lunde et al., 2018). eHealth interventions show to improve CVD patients' lifestyle behaviours, such as their physical activity levels (Patel et al., 2023) and diet (Thom et al., 2023). Besides, eHealth can be used to support patients for a longer period of time, even after rehabilitation has ended, to ensure durable lifestyle change (Janssen et al., 2013). Given these advantages, the use of eHealth is encouraged in the secondary prevention of CVD (Schorr et al., 2021). Telemonitoring has been successfully implemented in the cardiac rehabilitation of various groups of CVD patients, such as those with myocardial infarction (Treskes et al., 2020) or heart failure (Koehler et al., 2018). These patients home-monitor their health using several devices (e.g. electronic scale, pedometer, blood pressure monitor) which are connected to their smartphone to give them and their healthcare professional insight into their health and behaviour. Thus, eHealth is already imbedded and accepted within cardiac care today, and the use of eHealth will likely increase in the near future. With the rise of eHealth in cardiac care, barriers for proper use are also becoming more evident. eHealth is frequently used as a complementary tool to human care and the interference of a human healthcare professional is still required. However, healthcare professionals indicate to experience barriers in providing lifestyle support (e.g. Jallinoja et al., 2007; Jansink et al., 2010; Warr et al., 2021). For example, profes-

sionals indicate that they lack the time to provide this support, that there are no financial resources to facilitate lifestyle support, that they simply do not have enough experience to provide the required support to their patients or have doubts about the effectiveness of such interventions. And although eHealth has been suggested to help overcome these barriers, some professionals indicate to experience an even higher workload from using eHealth (Bellicha et al., 2017).

Automated support

On the upside, eHealth allows not only for the provision of remote support by a healthcare professional, but also for automated support (Barak et al., 2009). In such self-help eHealth interventions, feedback is automatically provided, making the interference of a healthcare professional no longer needed. This makes such eHealth interventions easier to implement on a wider scale (Barak et al., 2009). A practical example of self-help eHealth lifestyle interventions, in a non-CVD context, are online platforms offered by health insurance companies (e.g., Zilveren Kruis, 2021). In such web-based interventions, users are motivated to improve their physical activity levels, eating patterns, stress levels and sleep habits. Via interactive modules, users can set their own goals, track their behaviour, and receive automated feedback. Therefore, the costs are limited, and the insurance company can freely offer it to all its customers to help them engage in a healthier lifestyle.

Working alliance within eHealth interventions

Despite these important advantages of self-help eHealth interventions, there are several issues that are important to consider. One important issue of providing patients with a digital tool, is the lack of a social relationship with a healthcare professional (Brandt et al., 2018). Due to a lack of human contact, the uptake of self-help eHealth interventions is low (Lillevoll et al., 2014; Lin et al., 2018). But even when people do start using the intervention, self-help eHealth interventions suffer from a low level of adherence (Kelders et al., 2011; Kelders et al., 2012; Murray et al., 2013; Wangberg et al., 2008). This poses a problem, given that intervention adherence is related to more positive health outcomes (Donkin et al., 2011). Furthermore, there are inconsistent results concerning the effectiveness of self-help eHealth lifestyle interventions. While some studies show that self-help eHealth interventions are as effective as human-supported ones (Lustria et al., 2013; Webb et al., 2010), other studies show that the absence of (face-to-face) human support causes the intervention to be substantially less effective (Beishuizen et al., 2016; Joiner et al., 2017; Lau et al., 2020). This means that when no human support is provided, people are less likely to start using the eHealth intervention, do not use the eHealth intervention as much as they are intended to, and show less improvement in cardiovascular risk factors or healthy lifestyle behaviours.

This positive influence of human support might be due to the importance of building a relationship during the intervention (Brandt et al., 2018). Within the clinical context, this relationship, or so-called working alliance, is defined as the degree to which a healthcare professional and patient are involved in a useful and collaborative working relationship (Hatcher & Barends, 2006). The quality of the working alliance depends on three aspects, which are the level of agreement on goals that are set for treatment, on tasks that must be performed to reach this goal, and the quality of the relational bond between healthcare professional and patient (Bordin, 1979). Studies show that the quality of the working alliance explains up to a third of the variance in the efficacy of psychotherapeutic interventions (Horvath et al., 2011; Lambert & Barley, 2001). This strong positive relationship between the working alliance and intervention outcomes also holds within an eHealth context (Kaiser et al., 2021). Despite its important contribution to psychotherapy's success, the working alliance has been much less frequently applied within lifestyle-related domains. Nevertheless, a positive working alliance also increases adherence and effectiveness of lifestyle interventions (e.g. Goldberg et al., 2013; Hauser-Ulrich et al., 2020; Kowatsch et al., 2021a; Kowatsch et al., 2021b).

In an eHealth context, a good working alliance has also been shown to be a predictor of effectiveness and adherence in interventions with remote human support (Flückiger et al., 2018; Sucala et al., 2012), and even in interventions with automated support only (Bickmore et al., 2010; Clarke et al., 2016; Hauser-Ulrich et al., 2020; Kowatsch et al., 2021a; Kowatsch et al., 2021b). These latter findings might be explained by the fact that people are not only able to form relationships with other people, but also with digital tools and applications (Nass & Moon, 2000; Reeves & Nass, 1996). This idea originates from the "Computers are social actors-theory", which states that people use similar social rules and heuristics to their interactions with computers as they would do while interacting with other human beings. This behaviour applies to any digital tool, including eHealth interventions. Making the eHealth tool more "human" eases this process, and within eHealth interventions, conversational agents are often used for this task. These conversational agents are computer-based scripts which can mimic human-like conversational behavior such as responding to input, generate output, and turn-taking (Cassell et al., 1999). Studies show that the use of such human-like social rules and heuristics (e.g. showing empathy or humour) by conversational agents can increase the working alliance people experience (Bickmore et al., 2010) and thereby their adherence to the intervention (Lisetti et al., 2013). Given the importance of adherence for intervention effectiveness and thus for durable lifestyle change, it would be worthwhile to investigate the use of conversational agents to promote a working alliance within eHealth lifestyle interventions. Especially because it is yet unclear what human-like social cues and heuristics promote a working alliance with a conversational agent. There-

fore, more research is needed before such mechanisms could be applied within tools for a vulnerable CVD patient population.

The present dissertation

This dissertation has the following two aims: (1) mapping out the needs and wishes of both healthcare professionals and CVD patients with regard to (human-supported and self-help) eHealth lifestyle interventions, and (2) investigating if and how self-help eHealth lifestyle interventions could be optimised. The studies described in this PhD dissertation are part of the BENEFIT project erected by a Dutch consortium that aims to facilitate durable lifestyle change among CVD patients through a public–private partnership between academic centres, hospitals, rehabilitation centres, general practices, commercial companies and patient federations (Keesman et al., 2019). eHealth development often takes place without involvement of its core users, the patients and healthcare professionals, leading to eHealth tools that are not intuitive to use and therefore less effective (van Gemert-Pijnen et al., 2011). Together with patients, a multidisciplinary team consisting of cardiologists, psychologists, eHealth developers, and many other experts aimed to develop a so-called "ecosystem" in which the patient is emerged in a health-supportive environment. This ecosystem was built on four pillars that are essential in durable lifestyle change, which are (1) targeting both individual and environmental lifestyle factors, (2) developing interventions in cocreation with stakeholders (such as patients and healthcare professionals), (3) ensuring continuous access to these interventions, and (4) a public-private cooperation. This PhD dissertation describes a part of the research conducted to develop an eHealth platform to facilitate lifestyle changes at the individual level within this ecosystem. The research described in this PhD dissertation aims to evaluate the effect of different forms of automated and personal coaching on lifestyle maintenance. These studies were mainly conducted during the development phase, to optimise lifestyle coaching at the individual level before applying it into the BENEFIT platform.

This PhD dissertation consists of a number of journal articles, formatted as chapters, each contributing to one of the aims of this dissertation. The first part of the dissertation concerns the first aim (1) mapping out the needs and wishes of both healthcare professionals and CVD patients with regard to (human-supported and self-help) eHealth lifestyle interventions. According to the CeHres roadmap, a framework for eHealth development, implementation, and evaluation (Van Gemert-Pijnen et al., 2011), stakeholders should be closely involved in both the development and implementation phase. Therefore, we identified our most important stakeholders and asked their opinions on lifestyle interventions and the use of eHealth. Specifically, **Chapter 2** describes an interview study with healthcare professionals working in cardiac care about lifestyle support and the use of eHealth. Previous studies found that lifestyle interventions are rarely

discussed or prescribed to adults with CVD-related complaints during consultations (Hobbs & Erhardt, 2002; Milder et al., 2008; Noordman, 2010). Furthermore, studies showed that healthcare professionals experience various barriers in providing lifestyle support (e.g. Jallinoja et al., 2007; Jansink et al., 2010). Therefore we aim to investigate what factors are important in supporting CVD patients in the uptake of and adherence to a healthy lifestyle and the (potential) facilitators of and barriers to eHealth tools in providing lifestyle support to patients with CVD. We interviewed 16 professionals with various backgrounds (e.g. nurse practitioners, neurologists, physiotherapists) who all treat CVD patients about providing lifestyle support to CVD patients, and the possibilities of eHealth to help them in doing so. To follow up on this, **Chapter 3** describes a survey study investigating the views of CVD patients themselves. In order to get a representative view of their needs and wishes, we conducted a large-scale questionnaire study with members of Harteraad, a Dutch CVD patient association. We asked them whether they would like to be supported by a coach, use an eHealth tool, be supported by friends and family, or be self-supportive while working on a healthy lifestyle. Furthermore, we linked these preferences to demographic variables, to investigate what type of support works best for whom.

The next three chapters concerned the second aim of the dissertation, (2) investigating if and how self-help eHealth lifestyle interventions could be optimised. Specifically, **Chapter 4** concerns a meta-analysis investigating the effectiveness of existing interventions for patients with cardiometabolic diseases. Although meta-analyses on eHealth lifestyle interventions had been performed before, and had also already focused on the comparison between human-supported and self-help eHealth interventions (e.g. Beishuizen et al., 2016; Joiner et al., 2017), the results of these studies were inconsistent. While in some meta-analyses human-supported interventions showed to be more effective, others show no difference between human-supported and self-help eHealth interventions. We argue that this might be due to the quantity and quality of the support offered within human-supported intervention. Therefore, the aims of the meta-analysis are to investigate the effectiveness of eHealth lifestyle interventions for patients with cardiometabolic diseases, whether there is a difference in effectiveness between human-supported and self-help eHealth lifestyle interventions, and whether dose and delivery mode of human support influence the effectiveness of eHealth lifestyle interventions. **Chapter 5** investigates what user expectations play a role in people's decision to start using either human-supported or self-help eHealth interventions. As described previously, self-help eHealth interventions frequently suffer from low levels of uptake. Before paying attention to optimising self-help eHealth interventions, it is therefore important to investigate how we can make people start using such interventions. In this chapter we used an online experiment to investigate what expectations drive someone's intention to use a human-supported or self-

help eHealth intervention. We offered subjects randomly either screenshots of a human-supported or self-help eHealth intervention, and asked about their expectations towards the intervention's usefulness to achieve their goals (performance expectancy), the intervention's easiness of use (effort expectancy), the extent in which important others would support them in using the intervention (social influence), and the ability to form a relationship with the (automated) coach (working alliance). In **Chapter 6**, we aim to combine the results from the previous chapters to tackle another previously mentioned problem within self-help eHealth interventions, which is a lack of adherence. As we identified a need for self-help eHealth interventions, but at the same time a need for a human touch within lifestyle eHealth interventions, we aimed to make self-help eHealth interventions more attractive to adhere to by making them more human. Therefore, we conducted a field experiment with a self-help app-based physical activity intervention with a conversational agent. We manipulated how human-like the conversational agent within the intervention appeared and behaved, and tested in which condition users experienced the highest level of working alliance, and best adhered to the intervention like intended.

Finally, **Chapter 7** provides a discussion of all five studies in this PhD dissertation. This chapter relates the findings of each study to one another, discusses their (practical) implications, addresses their limitations and gives suggestions for further research.

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