Human support in eHealth lifestyle interventions

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SUMMARY & GENERAL DISCUSSION

SUMMARY

There is an increasing number of adults who suffer from cardiovascular diseases (CVD) (Koop et al., 2021; Wilkins et al., 2017; WHO, 2021). These patients would benefit from a healthy lifestyle, as this improves the prognosis of CVD (Kaminsky et al., 2022; Piepoli et al., 2016; Wilkins et al., 2017). However, even though improving one's health and lifestyle is the focus of cardiac rehabilitation, CVD patients need support to also maintain a healthy lifestyle after their rehabilitation has ended (Janssen et al., 2013). And although many eHealth solutions have been developed to provide lifestyle support (Thomas & Bond, 2014), this technology is not as effective as it could potentially be. One of the reasons is the lack of involvement of both patients and healthcare professionals. Many eHealth solutions are being developed without the involvement of those who use the technology, which often results in solutions that are not intuitive to use and therefore less effective than expected (van Gemert-Pijnen et al., 2011). Even though the support of a healthcare professional seems to be an important factor in successful lifestyle change, there are barriers that hinder professionals from providing lifestyle support, such as a lack of time or expertise (Bellicha et al., 2017; Jallinoja et al., 2007; Jansink et al., 2010; Warr et al., 2021). Since the involvement of healthcare professionals is also not always possible or desirable, it is important to further investigate possibilities to provide patients with a self-help eHealth intervention with automated support. This PhD dissertation thus focuses on (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.

Focusing on the first aim of this dissertation, (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, Chapter 2 and 3 aimed to investigate the views of both healthcare professionals and patients about lifestyle support and the use of eHealth lifestyle interventions. **Chapter 2** described an interview study with healthcare professionals working in cardiac care. Previous studies showed that professionals experience several barriers that hinder them from successfully supporting their patients (e.g. Bellicha et al., 2017; Jallinoja et al., 2007; Jansink et al., 2010). In this study we focused specifically on the cardiac care context, by interviewing 16 healthcare professionals working with CVD patients about both lifestyle support and the use of eHealth. We identified 12 themes describing the factors that healthcare professionals found important in lifestyle support in general, which were either intervention-, patient-, or healthcare-related. Throughout these themes, eHealth was mentioned to be a (potential) facilitator or solution to barriers that they encountered in lifestyle support. eHealth was deemed to be mainly beneficial in the themes "autonomy", "personalisation", "format of support", and "continuity of professional support".

For example, professionals indicated that eHealth could provide patients insight into their own health and thereby help them to regain autonomy, or that eHealth could help them gain more information about their patients to help personalise their support. As another example, professionals saw that eHealth gave them the opportunity to provide remote support, which would both improve the format of support for patients experiencing physical restrictions, and provide the opportunity to continue their support in the long-term. In addition to these advantages, we identified a 13th theme which described the barriers that healthcare professionals experienced in the adoption and use of eHealth. For example, professionals were concerned about the old age of their patients and thus low level of digital familiarity, and feared that they would generally prefer face-to-face contact.

To complement this study, **Chapter 3** described a study to investigate whether these experiences and expectations of healthcare professionals are recognized by a CVD patient population. A previous study found that the willingness of CVD patients to use eHealth varies (Anttila et al., 2019). We aimed to elaborate on this by not only asking patients whether they wanted to use eHealth or not, but also further specify the type of eHealth or face-to-face intervention they would prefer, and by investigating what demographic variables predict their lifestyle support preference. To do so, we conducted a questionnaire study among 659 CVD patients who were a member of the official national Dutch CVD patients' association. The results showed us that the majority of the CVD patients preferred being self-supportive when working on their lifestyle (i.e., without support from a coach, an app or internet, or family and friends). This was followed by the options of being supported by a coach (in a group, individually, or via an app or internet). Furthermore, we found that age and gender were a predictor of lifestyle support preference. We found that older patients were more likely to prefer being self-supportive. And whereas men were more likely to prefer being supported by family and friends, or to be self-supportive, women were more likely to prefer being supported by a coach, either individually or via an app or internet.With the second aim of this dissertation in mind, (2) investigating if and how self-help eHealth lifestyle interventions could be optimised**,** we wanted to find out what eHealth solutions have already been developed for patients, and whether these are effective in improving clinical and behavioural health outcomes. In **Chapter 4**, given the inconsistent results about the effectiveness of human support within eHealth interventions (Beishuizen et al., 2016; Joiner et al., 2017; Lau et al., 2020; Lustria et al., 2013; Webb et al., 2010), we compared human-supported and self-help eHealth lifestyle interventions in terms of effectiveness, and whether the amount and delivery mode of human support influence intervention effectiveness. We conducted a meta-analysis including studies testing eHealth lifestyle interventions for adults with cardiovascular diseases, chronic kidney diseases, type 1 diabetes mellitus, and type 2 diabetes mellitus. We focused on

all these four cardiometabolic diseases, as they share similar underlying risk factors, and all have a similar behavioural risk factor management strategy in terms of engaging in a healthy lifestyle. Our systematic search resulted in 104 unique studies that were included in the analysis. The multilevel meta-analysis showed that eHealth lifestyle interventions are effective in improving clinical and behavioural health outcomes. However, we did not find a difference between human-supported and self-help eHealth lifestyle interventions. Both intervention types were effective in improving clinical and behavioural health outcomes. Furthermore, we found no difference in effectiveness for the amount of human support (minor vs. major part of the intervention) or delivery mode of human support (remote vs. blended support). Based on these results, we hypothesized that the quality of the eHealth interventions in the included studies could explain the inconsistent results of different meta-analyses, as well as the level of adherence to the intervention.

Given that self-help eHealth interventions generally suffer from a lower uptake and use intention than human-supported ones (Lillevoll et al., 2014; Lin et al., 2018), **Chapter 5** studied whether user expectations predict the intention to use either a human-supported or self-help eHealth intervention. We conducted an online experiment, in which healthy participants were randomly presented screenshots from either a human-supported or self-help lifestyle app. We used expected working alliance with the (automated) coach and the constructs from the Unified Theory of Acceptance and Use of Technology (UTAUT; Venkatesh et al., 2003) to investigate which expectations predicted the use intention of human-supported and self-help eHealth interventions. The results revealed that subjects intention to start using a self-help eHealth intervention did not differ from their intention to start using a human-supported intervention. We also found no differences between the two types of interventions in terms of the working alliance people expected to have with either the human or automated coach. Nor did we find any difference in the extent to which they expected that important others believe they should use the eHealth intervention. We did however find that the effect of people's expectations about the helpfulness of the intervention and its easiness to use did differ between human-supported and self-help interventions: i.e, when subjects were offered a self-help intervention, their expectation that the intervention would be helpful or easy to use led to a higher intention to use the intervention than when subjects were offered a human-supported eHealth intervention. This effect also works in the opposite direction: when subjects expected that the self-help intervention would be unhelpful or difficult to use, they were less likely to start using the intervention compared to subjects who thought that the human-supported intervention would be unhelpful or difficult to use. In other words, negative expectations towards the intervention's helpfulness and easiness of use lead to a lower willingness to use a self-help intervention compared to a human-supported intervention.

In an attempt to solve the problem of adherence in self-help eHealth interventions, we conducted the study described in **Chapter 6**. Given that the working alliance is an important predictor of adherence within human-supported interventions (Flückiger et al., 2018; Sucala et al., 2012), and that people are able to form relationships with technology (Nass & Moon, 2000; Reeves & Nass, 1996), we aimed to use the concept of working alliance to improve adherence to a self-help eHealth intervention. We applied a text-based conversational agent to an app-based physical activity intervention, and used human cues to promote a working alliance with the user. We used two types of cues, i.e. visual and relational cues, and tested these in an experimental field study. We expected that the conversational agent using the most human cues (i.e. both visual and relational cues) would lead to the highest level of experienced working alliance, and thus highest user adherence to the intervention. In contrast, we found that the use of human cues did not affect the working alliance, but subjects who experienced a higher working alliance were more adherent to the intervention. Furthermore, when the conversational agent used visual cues, subjects were less adherent to the intervention compared to when the conversational agent used no human cues at all. Explanations for these findings might be the differences between embodied and text-based conversational agents and the importance of both non-verbal communication and transparency about the true nature of the conversational agent.

GENERAL DISCUSSION

This dissertation focused on the comparison between human-supported and self-help eHealth interventions, particularly the dilemma of the importance of human support in successful eHealth lifestyle interventions on the one hand, and the barriers that come with the involvement of healthcare professionals on the other hand. With the first aim of this dissertation in mind, (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, this discussion first focuses on the views of those who are actually involved, i.e. healthcare professionals and patients, and what we learned about their preferences with regard to lifestyle support and the use of eHealth. Secondly, regarding the second aim, (2) investigating if and how self-help eHealth lifestyle interventions could be optimised, the discussion dives into the role of human support in eHealth lifestyle interventions and how eHealth interventions could be improved for patients.

Needs and wishes of healthcare professionals and patients

Healthcare professionals seem to recognise the benefits of eHealth in providing lifestyle support to CVD patients. According to them, eHealth could especially

help in providing patients with a feeling of autonomy, personalising the lifestyle intervention and in both providing remote and prolonged support. Nonetheless, they also mentioned several eHealth barriers, such as preferences for face-to-face contact and user-unfriendly technology. Although the answers of the healthcare professionals in our study were comparable to those of professionals in previous studies, our study did uncover some findings that seem to be unique to our sample of healthcare professionals working in cardiac care. Firstly, with regard to lifestyle support in general, whereas healthcare professionals in other studies reported to have a lack of skills to provide lifestyle support and the feeling that lifestyle interventions are ineffective (Jallinoja et al., 2007; Jansink et al., 2010), the professionals in our study did not mention these barriers. Secondly, concerning the use of eHealth in lifestyle support, our study did not reveal any eHealth barriers related to organisational factors (such inflexibility of the system and a lack of time or financial resources), which previous studies did (e.g. Bally & Cesuroglu, 2020; Peeters et al., 2016). Rather, the healthcare professionals in our study were generally positive about the use of eHealth in their care for CVD patients. Their barriers mostly concerned technical issues or concerns with a lack of face-to-face contact. These findings could be an illustration of the attitude with regard to lifestyle interventions within cardiac care within the Netherlands. Possibly, there is a higher level of consensus about the importance of and/or more experience with (digital) lifestyle interventions among Dutch professionals working in cardiac care due to the relatively high use of eHealth tools in the Netherlands in cardiac care. But there could also be other methodological differences related to the different care settings and organisational structures the interviewed healthcare professionals work in that could explain this. Professionals working in primary care could have different views than those working in cardiac rehabilitation, because of their own and the organisation's experiences with and attitude towards lifestyle support and eHealth. Nonetheless, to solve the insufficient implementation of eHealth into practice (Ross et al., 2016), our results suggest that healthcare professionals do not need to be convinced about the benefits of eHealth, but rather that the barriers they experience should be resolved. In order to overcome these barriers, health policy could play an important role in the provision of support and equipment.

The healthcare professionals we interviewed emphasised that, because CVD patients are older, they prefer face-to-face contact and have little technological experience. Therefore, digital tools would not be most suitable for this patient population and human support would be a better alternative. However, the responses we got from patients suggest that the lack of interest in eHealth interventions among an older population is not so much due to an aversion to technology. This is in line with other studies, showing that older patients are willing to use technology for self-management, as long as they are accessible to use (e.g. larger font sizes) (Cajita et al., 2017; Sivakumar et al., 2023). Rather,

older patients, especially older men, seem to be less interested in lifestyle support in general and mostly prefer being self-supportive when working on their lifestyle. This finding could be explained by physical restrictions the elderly experience while engaging in physical activity, which makes it more difficult to follow a lifestyle intervention (de Boer et al., 2020a). Another explanation for the wish to be self-supportive, could be a general need among patients for autonomy or for personalised care (Bente et al., 2021). Our findings are also in line with studies showing a gender difference in health seeking behaviours (Yousaf et al., 2015), and that men perceive traditional lifestyle interventions as more suitable for women (Gavarkovs et al., 2016). Thus, in contrast to what healthcare professionals suggest, the technology itself may not be the problem. Instead, healthcare professionals could focus on the advantages of eHealth to overcome barriers that older men experience with regard to traditional lifestyle interventions. Especially given that men have an increased risk of developing CVD and are thus more often recommended to follow cardiac rehabilitation compared to women (de Boer et al., 2020b; Virani et al., 2020). For example, eHealth could help tailoring the intervention to individual needs of patients (Krebs et al., 2010), such as specific preferred changes in diet, or doing physical exercises at a time and place that suits a patient. Other possible advantage of eHealth, as mentioned by healthcare professionals, are giving patients more autonomy over maintaining their healthy lifestyle and personalising the intervention to their needs. Meta-analyses showed a positive association between both an autonomy supportive healthcare climate and personalisation of digital intervention content, and successful behaviour change (Lustria et al., 2013; Ng et al., 2012). Furthermore, eHealth shows to facilitate self-care behaviours, such as engaging in healthy lifestyle behaviours or self-monitoring (Riegel et al., 2017). These characteristics of digital interventions could provide patients more independence and could therefore possibly convince those patients who indicated to rather be self-supportive to do partake in a digital lifestyle intervention. On the other hand, the use of eHealth could not only help the high-risk group of older men, but also a subpopulation of patients who are now underrepresented in cardiac care, i.e. younger women. Younger women showed to have a more favourable attitude with regard to eHealth, which is why the increasing development and use of digital tools could ensure that also their needs are met by providing lifestyle support in a different way, tailored to their needs.

To conclude, although eHealth offers many opportunities, digitalisation may not be the only solution for all lifestyle-related concerns. The healthcare professionals indicated that the lack of face-to-face contact may be a possible barrier for using eHealth. This is in line with the views of the patients, who indicated to mostly prefer lifestyle interventions in which they would be supported by a coach (either individually, in a group, or via an app or internet). Furthermore, there is evidence that a healthy-lifestyle ecosystem, rather than a single

eHealth intervention, might better meet the needs of both patients and professionals (Breeman et al., 2021). Despite the advantages of providing automated support through self-help interventions, such as being relatively cheap, easy to implement and requiring less investment from healthcare staff (Barak et al., 2009), these results indicate that attention should be paid to the human aspect within eHealth interventions. Especially given the great number of studies highlighting the importance of a positive relationship between the patient and the healthcare professional during the intervention on intervention adherence and outcomes (Brandt et al., 2018). This so-called working alliance explains up to a third of the variance in efficacy of psychotherapeutic interventions (Horvath et al., 2011; Lambert & Barley, 2001), also within an eHealth context (Kaiser et al., 2021). This means that eHealth interventions could be offered in a blended way, meaning that self-help features and human support are combined, or that self-help eHealth interventions could integrate some human-like characteristics.

How could self-help eHealth interventions be optimised?

In order to find solutions for the barriers raised by healthcare professionals and patients, we found that self-help eHealth interventions could be promising in lifestyle support among adults with CVD. Our results showed that the level of human support does not necessarily affect an eHealth intervention's effectiveness in improving health outcomes, or a higher intention to start using the intervention. This is contradictory to previous studies showing a lower uptake of self-help eHealth interventions (Lillevoll et al., 2014; Lin et al., 2018) and lower effectiveness of interventions without human (face-to-face) support (Beishuizen et al., 2016; Joiner et al., 2017; Lau et al., 2020). However, we concluded that equal levels of effectiveness between human-supported and self-help eHealth interventions could only be achieved when the quality of the intervention is high enough. The strict inclusion and exclusion criteria of our meta-analysis may have resulted in only including high quality interventions. This may have reduced the difference in effectiveness between human-supported and self-help interventions. For example, some meta-analyses that did find a lower effectiveness of self-help eHealth interventions included a broader variety of interventions, such as those without education or skills training (Beishuizen et al., 2016) or those that were not interactive (Lau et al., 2020). Interventions that are more elaborate, for example by incorporating multiple behaviour change techniques, are more effective in improving health behaviour (Webb et al., 2010). In those interventions, the additional benefits of human support, and thus increase in effectiveness, would potentially be lower compared to its additional benefit in less elaborate, lower quality interventions. It is therefore not surprising that automated support is frequently combined with behaviour change techniques and persuasive system design principles (Asbjørnsen et al., 2019). An important

lesson is therefore that it is especially important to consider the quality of the eHealth intervention when little or no human support is provided.

The quality of the intervention shows to also be a point of concern when it comes to start using an eHealth intervention. In line with previous work, we found that the perception of the intervention's effectiveness or easiness of use affects use intention in general (Venkatesh et al., 2003). However, only within self-help eHealth interventions, the perception that the intervention might be ineffective and/or difficult to use, limited the willingness to start using the intervention. This effect is not visible within human-supported eHealth interventions. In line with this, meta-analyses show that the mere presence of a human being (even a nonprofessional) is the key ingredient in intervention effectiveness and prevention of dropout (Etzelmueller et al., 2020; Karyotaki et al., 2018; Richards & Richardson, 2012). It seems that just the option of having someone to provide you procedural or technical support seems to be helpful when the intervention's helpfulness or easiness of use is questionable. But for self-help eHealth interventions where such additional support is not an option, it is especially important that these interventions are perceived as being of a high quality to ensure that people are willing to give them a try.

However, there are some situations in which human support would be preferable. People who question whether they will reach their objectives with the help of the intervention or whether they are capable of easily using the intervention, could possibly benefit from more human support in the intervention. The presence of human support could compensate for a lack of self-efficacy that people feel either while they are starting to use or are already using the intervention (Fernández et al., 2014; Zhou et al., 2017). For example, patients with a low eHealth literacy are less likely to adhere to eHealth interventions (Richtering et al., 2017) and could benefit from such support. The results from Chapter 4 and 5 do offer some preliminary suggestions to offer support within the application of self-help eHealth interventions. Based on our results, we advise healthcare professionals to screen the patient's self-efficacy, or digital or eHealth literacy beforehand, and provide some level of human support if the patient expects any problems or barriers in using the eHealth intervention. Just procedural support could improve patients' perceptions about and their likelihood to start using the intervention, as well as ensure that the intervention is as effective as intended (Etzelmueller et al., 2020; Karyotaki et al., 2018; Richards & Richardson, 2012).

In addition to this, intervention adherence, similar to intervention uptake and effectiveness, might be another factor that would be important to consider in the optimalisation of eHealth interventions. Even though we were unable to assess adherence in our meta-analysis because only a small proportion of studies report eHealth adherence (Sieverink et al., 2017), some studies consistently showed that adherence is problematically low in self-help eHealth interventions (Kelders et al., 2011; Kelders et al., 2012; Murray et al., 2013; Wangberg et al.,

2008). Furthermore, given that adherence is related to intervention effectiveness (Donkin et al., 2011), the higher level of adherence within human-supported interventions could explain why human support is related to intervention effectiveness. Given both the low adherence levels and the positive relationship between adherence and effectiveness, it seems that more attention should be paid to optimising adherence within self-help eHealth interventions.

Optimising adherence to self-help eHealth interventions

In contrast to our expectations, we found that the use of visual human cues caused people to be less adherent to the intervention compared to when the conversational agent used no human cues at all. In contrast to our study, many studies that did find a relationship between using human cues and working alliance concern the use of an embodied conversational agent (Bickmore et al., 2005; Bickmore et al., 2010). However, as we used a text-based conversational agent, we were limited in the agent's possibilities to use human cues. An embodied conversational agent can make use of an additional range of design characteristics, such as non-verbal communication. Possibly, the lack of incorporating non-verbal communication might hinder text-based conversational agents from benefitting from establishing a working alliance with the use of human cues (Friederichs et al., 2014). Such relational behaviour in the form of human cues can positively influence the relation between the user and the agent (ter Stal et al., 2020). Nonetheless, text-based conversational agents are more commonly used in healthcare settings than embodied conversational agents (Tudor Car et al., 2020). Furthermore, making a conversational agent look like a human being through visual cues, without being transparent about it being a computer rather than human, could lead to high expectations among the people using the self-help eHealth intervention (Luger & Sellen, 2016). However, as a computer is less capable of providing feedback that meets the wishes of the user than a human being, expectations concerning the quality of the coaching would not be met, possibly leading to disappointment in the conversational agent and thus lower levels of adherence (Mozafari et al., 2020; Rapp, Curti & Boldi, 2021). When a text-based conversational agent explicitly presents itself as non-human, the establishment of a working alliance between the agent and the user is possible (Darcy et al., 2021). In sum, based on our findings, we assume that improving the working alliance could be a solution to improve adherence to self-help eHealth interventions. And although further research is required, we would advise to invest in an embodied conversational agent for any self-help eHealth lifestyle intervention, and to consider full transparency about the true nature of the conversational agent. Furthermore, the different effects for visual and relational cues stress the importance of not only testing the effects of human cues in general, but also the effects of different types of cues (Feine et al., 2019).

The findings within this dissertation could help the development of eHealth lifestyle interventions for CVD patients. Chapter 2 and 3 revealed that healthcare professionals indicated that eHealth solutions could provide a lot of benefits, and that patients were not so much technology-averse but rather prefer being self-supportive or wish for the involvement of some human interaction during their lifestyle support. For those who would like to be self-supportive, a self-help eHealth intervention might be an attractive option, as it provides patients with the tools necessary to work on their lifestyle, whilst preserving their autonomy. As there is no healthcare professional involved though, it would be extra important for these patients to ensure adherence to the intervention. For those who would like human contact during their lifestyle intervention, a conversational agent could make a self-help eHealth intervention more human and increase the feeling of a working alliance during lifestyle support. Although we found that self-help eHealth lifestyle interventions can be as effective as human-supported ones, we also found that concerns about the intervention's helpfulness or easiness of use could prevent some people from using it. All in all, based on the findings in this dissertation, we can conclude that self-help eHealth lifestyle interventions could be a valuable addition to the current rehabilitation programs in cardiac care. They could help CVD patients in starting and maintaining a healthy lifestyle, while at the same time prevent a further increase of the workload of healthcare professionals. However, to ensure intervention uptake, it would be worthwhile to consider combining these self-help eHealth interventions with some level of human contact, and to improve the feeling of a working alliance during the intervention.

Strengths and limitations

The overall strength of this dissertation is the use of various research methodologies. The needs and wishes of healthcare professionals and CVD patients have been investigated with a qualitative interview study in Chapter 2, and a quantitative questionnaire study in Chapter 3. Furthermore, we used a (multilevel) meta-analysis to assess the effectiveness of existing eHealth lifestyle interventions in Chapter 4, and an online experiment to investigate what drives the intention to start using an eHealth intervention in Chapter 5. Finally, to investigate ways to improve a self-help eHealth intervention in Chapter 6, a field experiment measuring real, objective health behaviour was used. These different methodologies each have their own qualities that complement each other and provide a more complete picture of the application of eHealth lifestyle interventions in CVD care and the role human support plays in such interventions. Secondly, an important strength of the current dissertation is its focus on clinical practice. The main aim of each of the studies was to develop knowledge to improve lifestyle support through eHealth in cardiac care. Therefore, we have included the most important stakeholders to investigate what they need and want from an eHealth

intervention, and investigated eHealth interventions that have already been developed and used in practice. And although the two experiments in Chapter 5 and 6 did not directly include these stakeholders, their main aim was to find factors that influence the uptake of and adherence to eHealth interventions, which could be applied to cardiac care in a later stage.

However, there are also some limitations that should be addressed. As mentioned above, in Chapter 5 and 6 we did not include stakeholders such as healthcare professionals or patients, but rather a healthy population to investigate use intention and adherence to self-help eHealth interventions. Therefore, these results can only be generalised to a limited extent to the CVD patient population. We chose to use a healthy sample in these studies as we did not want to unnecessarily burden a vulnerable population and rather first test our hypotheses in a healthy population. As human support is seen as essential to successful lifestyle change, studies in which this is replaced by automated support could potentially have negatively influenced the uptake of, adherence to or effectiveness of the studied lifestyle interventions. And given that we tested new principles of which the effectiveness was unknown, we felt it was unethical to test these with a vulnerable population for whom an effective lifestyle intervention is crucial. However, this does mean that further studies are needed before we can apply the results of the studies described in these two chapters to clinical practice. Secondly, please note that the samples of our studies described in Chapter 2 and 3 might not have been fully representative of all healthcare professionals working in cardiac care and the CVD patient population. Although we intentionally interviewed healthcare professionals involved in the lifestyle support of patients with CVD, this specific sample limits the generalizability of our results as our sample has experience with, and might therefore be more willing, to provide lifestyle support. As this sample already has experience with lifestyle support, their attitude towards a healthy lifestyle and eHealth might be different from the attitude of healthcare professionals in general. Furthermore, the sample of Chapter 3 represents a group of patients who are likely to have already completed cardiac rehabilitation, and who might be more empowered and self-aware of their disease and its consequences, and therefore might have a different view on lifestyle support than CVD patients who are still at the start of their rehabilitation trajectory. It would therefore be interesting for future studies to include healthcare professionals with different levels of experiences with and attitudes towards lifestyle support, and CVD patients who did not start rehabilitation yet, to investigate how this might influence their views upon lifestyle support and eHealth.

Future research

Given the importance of a healthy lifestyle for the prevention and treatment of CVD, and the needs and wishes of healthcare professionals and patients, we

would advise to further investigate the role of human support in eHealth lifestyle interventions, and the possibilities of using self-help eHealth interventions in cardiac care. First of all, it would be interesting for future studies to investigate what qualities a self-help eHealth intervention needs to make it as effective as a human-supported eHealth intervention. For healthcare professionals, knowing which self-help eHealth interventions are effective would be important in their decision to provide additional human support during the lifestyle intervention. For eHealth developers, it would be important to know what intervention content, such as education and skills training or interactivity, improve the quality of an eHealth intervention to such an extent that human support has no more additional value with regard to effectiveness. Furthermore, we argued that the level of adherence could possibly be the missing explanation for the inconsistent results found in previous meta-analyses regarding the added contribution of human support to self-help eHealth interventions. However, due to the lack of reporting, we were not able to investigate this in our meta-analysis. Therefore, we would also suggest future eHealth studies to more carefully investigate and report adherence levels. Additionally, we would advise to replicate the study described in Chapter 5 with a patient population. Based on our findings with a healthy population, we would advise healthcare professionals to ask about their patients' expectations toward the eHealth intervention's helpfulness and easiness of use before deciding on the amount of support needed for that patient. However, we would recommend to investigate whether the same expectations as those found in our study are decisive in a CVD patient's intention to start using an eHealth intervention. Finally, the results of the study described in Chapter 6 raised several questions that would be important for future studies to address. We would advise to investigate the difference between text-based and embodied conversational agents, and whether non-verbal communication is indeed key for conversational agents to improve the working alliance people experience during the intervention and their adherence to the intervention. Furthermore, we expect that transparency about the true nature of the conversational agent would have a positive influence on intervention adherence, which would be worthwhile to test in a future study. Once we have more knowledge about these mechanisms, we can further investigate how conversational agents can be used to improve the adherence to self-help eHealth lifestyle interventions for CVD patients.

Clinical implications

The results of the studies described in this dissertation have provided insight into the views of healthcare professionals and CVD patients about lifestyle support and the use of eHealth, and demonstrated that self-help eHealth interventions could be a useful alternative for or addition to human lifestyle support. Specifically, we found that healthcare professionals recognise the benefits of using

eHealth in lifestyle support. For clinical practice however, it would be important to address certain barriers they experience (such as low user-friendliness or a lack of tech-support) as these might hinder the adoption of eHealth into cardiac care. Concerning the preferences of patients, the most prevalent group within cardiac care - higher-aged men - indicated to mostly prefer being self-supportive in their lifestyle change. This highlights the need to make traditional lifestyle interventions more attractive for them in practice. eHealth provides opportunities for greater personalisation and autonomy, which would be especially attractive for those patients who would rather be self-supportive. Furthermore, our results showed that underrepresented groups within cardiac care - younger women - do find eHealth alternatives attractive. They especially preferred digital interventions in which a human coach was involved. Therefore, eHealth could be recommended to provide suitable lifestyle interventions for all patient groups within cardiac care. Our findings do show however that it would be important to consider different eHealth forms for different patient groups, for example more autonomous and personalised eHealth interventions for men, and blended interventions for women.

Furthermore, the studies in this dissertation demonstrated that human support is not as essential for effective eHealth interventions as previously expected, which is an important finding for clinical practice. As self-help eHealth interventions can be as effective as those with human support in improving cardiometabolic risk factors, healthcare professionals could consider providing such interventions to their patients when they experience barriers in providing lifestyle support themselves. An important finding was that expectations play a role in people's intention to start using the intervention. More specifically, we found that whether people think that the intervention is helpful or easy to use (or not) is decisive when there is no human support available. In practice, this implies that healthcare professionals could screen the patient's expectations towards the intervention's helpfulness and easiness of use beforehand, and provide some level of human support if these expectations turn out to be negative.

Finally, those involved in eHealth practice should not only pay attention to the working alliance between healthcare professional and patient, but also when the patient is engaged in a self-help eHealth intervention. An improved working alliance leads to a better adherence to a self-help eHealth intervention, which in turn increases intervention effectiveness. Our results hint towards the use of embodied conversational agents, which can use relational human cues to increase the working alliance with the user. Our studies also highlight the importance to focus on the working alliance in eHealth development. We would therefore recommend developers to investigate how patients experience the working alliance with the intervention during the design process to ensure their effort results in self-help eHealth interventions that are attractive for patients to adhere to. Healthcare professionals on the other hand could incorporate some form

of support when they provide self-help eHealth interventions to their patients. Although such interventions have the potential to be effective, a low working alliance could risk intervention adherence. For example, healthcare professionals could ask patients about their progress in the intervention during consultations, or send brief electronic messages through the eHealth technology. Another possibility would be to consider using blended interventions, in which self-help and human-supported aspects are combined into the same eHealth intervention. All in all, clinical practice should pay attention to the working alliance patients experience when they use any kind of eHealth lifestyle intervention.

Although not all the findings from this dissertation are ready to be implemented into the care of CVD patients, implementation is still an important topic to address at this stage. For healthcare professionals who recognise the benefits of eHealth, the opportunity to improve eHealth implementation is to resolve the barriers they experience. Often, important stakeholders are involved when it comes to the implementation phase of eHealth development (van Gemert-Pijnen, 2011). By structurally involving those who are intended to use the eHealth tool, and specifically resolving the barriers these stakeholders experience, the tool will fit their needs and wishes and therefore be easier to adopt into their daily work practice (Bally et al., 2020). Therefore not only patients, but also healthcare professionals, should be involved when further investigating the mechanisms found in this dissertation. Furthermore, the healthcare context should be taken into account when working on an implementation plan. Although we did not find barriers on the organisational level, organisational structures can either hinder or facilitate the implementation process (Bally et al., 2020; Lingg et al., 2020; Walsh et al., 2018). Think for example about privacy concerns, which may hinder the use of health-related data to personalise automated coaching. Or ethical protocols, which may hinder the acceptance of self-help interventions when compared to actual human support for patient care. Scepticism among the professionals in the organisation might also hinder technological development in their work practices. Keeping the healthcare context in mind during development, could result in eHealth tools that are compatible with the existing workflow and therefore actually be implemented into practice.

Conclusion

This PhD dissertation aimed to find an answer to the dilemma that the role of human support has been shown to be important in successful eHealth solutions for a healthy lifestyle, while the involvement of healthcare professionals is not always possible or desirable.

Concerning the preferences of the users, healthcare professionals and patients could both benefit from using eHealth for lifestyle support, but it is useful to target any barriers that they experience. Technological issues could hinder adoption into cardiac care and should therefore be solved. In addition, eHealth

should personalise interventions and increase user autonomy, to also make them attractive for patients who rather receive no lifestyle support.

Concerning human support within eHealth interventions, self-help eHealth lifestyle interventions can be as effective as human-supported eHealth lifestyle interventions in improving cardiovascular risk factors. However, since negative patient expectations can hinder the uptake of self-help eHealth interventions, such expectations should be screened to decide on the level of support a patient might need. To solve problems with non-adherence within self-help eHealth interventions, clinical practice should also focus on improving the working alliance within such interventions.

All in all, this dissertation demonstrates that eHealth interventions could be a promising solution to barriers experienced in the lifestyle support of CVD patients, and that self-help eHealth interventions could be a useful addition or alternative to human support that should be explored. Despite this, patients can benefit from human contact, which is why human aspects of interventions - such as the working alliance - should not be ignored. Even within self-help eHealth lifestyle interventions.

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