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Customization in eHealth interventions. A possibility for patients with chronic illnesses, overcoming technological barriers and promoting user engagement.

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Abstract

Background: In recent years' research concerning electronic health (eHealth) gained relevance with regards to its potential to address a wide user base. Alongside user-focused concepts to address engagement, customization could offer a novel way to improve user engagement and combat barriers like attrition or low levels of naturalistic uptake. However, no study has yet examined customization of eHealth interventions targeted towards patients suffering from chronic illness. A refined understanding of the term customization could help to provide better care, explore alternative intervention concepts and tackle barriers to eHealth applications.

Objectives: The present study aims to address the conceptualization of customization in the current literature within the field of eHealth applications for people with chronic illness. The secondary goal is to give a representative overview of possible effects customization could have on user engagement and barriers within the target group.

Methods: A scoping review of the current body of research was done based on the theoretical five-stage framework by Arksey and O'Malley (2005). 227 records were identified on the databases *PsychINFO, Google Scholar,* and *Scopus* by using a search string addressing the main search constructs customization, as well as adjacent constructs like personalization, tailoring and chronic illness. Following the composed inclusion and exclusion criteria a total of four articles where extracted.

Results: Customization was mentioned in one of the four articles where it was grouped together with personalization. Other contextual deviations included tailoring, mentioned in three articles and personalization, also mentioned in three articles. Results showed an under representation of customization, whereas tailoring and personalization were evaluated as potentially beneficial in addressing patients with chronic illnesses, who face major treatment barriers.

Conclusion: The findings suggest that a differentiation between the terms tailoring, personalization and customization rarely is addressed. The scoped literature addresses tailoring and personalization in terms of heightened user engagement. Furthermore, self-management was highlighted as an elemental skill and viable tools in overcoming technological- and treatment barriers for patients with chronic illness. Follow-up research is thus encouraged to further conceptualize customization to foster a clearer distinction between the definitions of customization, tailoring and personalization as well as look at customization as moderator on a proposed link between self-management and eHealth.

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Introduction

Technological advancements in modern healthcare are rapidly evolving. Since the time the first British general practitioner in 1970 made use of a desktop computer in his consulting room (Benson & Benson, 2002) up until now, patients are, more than ever, presented with options to improve their well-being through the use of technology. Whether it is at the GP, online, or via an application, the ever-changing technological possibilities designed to improve physical and mental wellbeing are getting more and more attention. Prosperous vehicles for the application and promotion of, for example mental health, are the use of mobile applications, *mobile apps,* or web based interventions. Mobile apps are not only useful for their potential reach through social media platforms but also because these apps are continuously evaluated to provide customized care for patients with chronic illness (Nightingale et al., 2017).

Several studies highlight the potential of mobile apps in building structures of self-management and self-monitoring. For example, Stinson et al. (2014) outlined the potential of a mobile application designed to help patients cope with their chronic pain conditions named *iCanCope with Pain*^{TM}. This mobile health (mHealth) application, a form of electronic health or eHealth, specifically targets patients' coping behavior in order to improve their mental health. During the initial needs assessment, patients highlighted the need for self-monitoring components of the mobile application, for example the option to customize the content of certain graphs or figures. In addition to that study done by Ghafouryan & Bashi (2015) highlighted positive patient feedback regarding their self-management intervention experience, making use of a mobile iPad application. In short, mobile applications can offer promising ways to support self-management. Patients' need for customization was confirmed by Gaggioli and Riva (2013) who discussed benefits of *Interreality,* a novel approach that combines cyber therapy interventions with mHealth tools to bridge the gap between *face to face* treatment and virtual experiences. In their effort to transfer skills of everyday life, customization was marked as key in tailoring the therapy to the patient's needs (Gaggioli & Riva, 2013).

Although there are multiple novel ways in which mHealth can be a great influence for patients, especially for those suffering from long lasting conditions, these applications have hurdles, shortcomings and barriers attached to them. Barriers can include optimal pain managements; the health care system in which one finds him or herself in; or even on a patient or

social level, in the case of stigmatization (Stinson et al., 2014). For example, social stigmatization, whereas patients would use mHealth less, or even accept care, due to perceived discrimination from others because of the invisible nature of chronic illness (Stinson et al., 2014). However, barriers in relation to mHealth can also be related to an application's usability and acceptability (Solem et al., 2020).

Mobile devices and their adoption however is not only based on how accessible they are to the end user. MHealth systems and application face multiple hurdles, starting with differentiating between caregiver and layperson. Even seemingly simple things like the battery life of the used technology can have an effect on its adoption so do security and privacy considerations, computing standards, or the simplicity/complexity of the data that has to be gathered (Yu et al., 2006). It could be argued that in recent times examples like the screen size of PDA-based approaches given by Yu and colleagues have to be reviewed, as the possibilities for data input have improved considerably over the last 14 years. Nevertheless, research suggests that although nowadays the physical input of data may not be of pressing concern, mHealth solutions are still facing a set of barriers that can hinder their adoption by the end user.

One of the major barriers for making use of mHealth applications seems to be its naturalistic uptake potential. Recent research listed *naturalistic uptake* as one of the key barriers for increasing the impact of mental health technologies (Van Der Meulen et al., 2019). Naturalistic uptake is defined as the users' willingness to pick up the technology outside of controlled trial situations. A study done by Chen and colleagues (2017) underlined problems in naturalistic uptake when making use of dietary smartphone applications. They found that barriers for mHealth applications ranged from "having no access to a smart device" (51%), a "lack of infrastructure" (42%) ,"lack of awareness about the best app" (41%) to "topics covered by the apps not relevant to the clientele"(21%) (Chen et al., 2017). Another issue with mHealth are high attrition rates (Birk & Mandryk, 2018). In his work " The Law of attrition" Eysenbach (2005) describes two different definitions of the term, attrition as loosing patients i.e. dropping out or *dropout attrition* and the phenomenon of no-usage, or *no-usage attrition*. Conceptual factors that influence attrition, namely relative advantage, compatibility, complexity, trial ability and observability are seen as factors of an innovation that play a role in using, stop using or dropping out (Eysenbach, 2005). As an example Eysenbach (2005) lays out that if an innovation is neither creating any benefits, thus providing a relative advantage, or has a major usability problem, thus being too high in complexity, the innovation could easily be rejected by the user. These forms of

attrition could potentially give a deeper insight as to what facilitates, or holds back the earlier mentioned concept of naturalistic uptake. These two major barriers for eHealth or mHealth solutions can pose major problems in their implementation. Especially when thinking about special target demographics or groups of people like those suffering from chronic illness. To counter these barriers a possible solution could lie in tailoring, personalization or customization of applications and interventions.

The trend in modern mobile health is to provide customized, personalized and specifically tailored content. Tailored content is adapted to the users' behavior or personal information and is extraordinarily simple to apply in digital media in comparison to print media or television advertising (Sundar & Marathe, 2010). Therefore, customization, personalization, and tailoring are widely used with recent advancements in tailored eHealth for the most various occasions, situations, physical and mental health conditions (Chen et al., 2017; Ebert et al., 2017; Fulford et al., 2016; Ghafouryan & Bashi, 2015; Goh et al., 2016; Nightingale et al., 2017; Schroeder et al., 2018; Stinson et al., 2014). As an example of the use of tailoring Hors-Fraile and colleagues (2018) tailored messages to user preferences to enhance participation and contradict attrition in smoking cessation intervention. In their study they describe the technique of giving users intervention content, after this content went through a tailoring process, as a *recommender* system. In that they designed a way to provide patients with a smoking cessation intervention via a mobile application combined with individually tailored motivational message for each patient. In terms, this could be an effective way to enable smoking cessation, whereas emphasizing the impact of tailored messages in combination with recommender systems (Hors-Fraile et al., 2018).

mHealth interventions and chronic illness

Given the earlier discussed problems with mHealth and, by extension online interventions, one could argue that a tailored approach could have major benefits. Especially patients with chronic illnesses could benefit from interventions tailored to their condition (Nightingale et al., 2017). Nightingale and colleagues (2017) research shows not only the potential benefits mHealth can have for patients with chronic illness but is also concerned with what mechanisms this approach could benefit from in terms of patient's engagement and long term use of the intervention. Their efforts, creating a care management application for young people with chronic conditions,

highlights even more the apparent usefulness of mHealth interventions for patients with a chronic illness, namely the need for customization in developing mHealth applications. In particular, the ability to customize the applications content like age, gender and personal preferences was found to be beneficial with regards to adoption of the technology. In a similar example Solem and colleagues (2020) highlighted the participants need to customize the intervention alongside their personal preference. These examples depict a gap in recent research, namely what necessary mechanism are there and are working best in combatting essential barriers with regards to mHealth interventions for people suffering from a chronic illness. In this it is of vital interest to further gather information that has been made available throughout the latest efforts in research regarding customization in mHealth technology, its benefits and shortcomings.

Customization a tailored approach

Customization, like tailoring and personalization, is an approach to individualize intervention content. Yet, according to Sundar & Marathe (2020) customization is not to be mistaken with personalization, emphasizing a big difference in that personalization becomes relevant whenever a product or service is tailored to a buyer (or patients') preferences, and customization, whenever a product or service is customized to a buyer (or patients') specifications. Customization approaches go even further in the effort to create a tailored user experience that allows the individual to actively be involved in the process of the intervention that is presented. The individual can, in a way, hereby combat the barriers that are keeping him from using mHealth applications or interventions directly. In general customization is a multifaceted concept and throughout this paper an effort will be made to further elaborate on it, as well as to equip it with a taxonomy. Still, the following will first provide a general description of customization in light of adjacent concepts like tailoring and personalization.

Tailoring is a broad term that can be defined as any combination of strategies and information intended to reach one specific person, on the basis of characteristics that are unique to that person and related to the outcome of interest, derived from an individual assessment (Hawkins et al., 2008; Kreuter et al., 1999). The idea behind tailoring is to individualize content with more information about the individual (Kreuter et al., 1999). Both tailoring and customization are understood by similar theories. Most studies make use of the Elaboration Likelihood Model (ELM) (see for example, Nguyen et al., 2018). The ELM categorizes

persuasive processes into two routes to attitude change, the central route and the peripheral route. Central route processes involve effortful cognitive elaboration and rely on the personal cognitive response as main basis for attitude change (Petty et al., 2009). It is widely suggested that tailoring induces higher elaboration, or effortful process in users, making the overall intervention more persuasive (Kalyanaraman & Sundar, 2006). As a result, tailoring, customization as well as personalization could enhance user engagement by inducing higher elaboration over user-changeable aspects, for example those of a mobile application.

Another prominent theoretical explanation for the positive effects of customization stems from Self Determination Theory (SDT) (see for example, Deci & Ryan, 2008). This theory states that human motivation can be classified through a self-determination continuum with a range from intrinsic motivation through extrinsic motivation to a state of 'motivation'(Deci & Ryan, 2000). Intrinsically motivated individuals participate in tasks or activities from a standpoint of "for my own sake" and therefore experience a high degree of self-determination (Wottrich et al., 2017). Customization is thought to increase perceived control over changeable aspects invoking a sense of self-involvement that could result in intrinsic motivation to use the intervention. This explanation is consistent with earlier findings regarding human-computer interaction, where customized portal output engendered higher user activity and involvement with websites (Sundar & Kalyanaraman, 2004). The notion is further supported by Kang and Sundar (2016) who stated that customization enables users to become active sources in the communication process.

Given this, the assumption could be made that customization, in comparison to personalization, could have more potential in combatting the before mentioned naturalistic uptake of a new application or intervention. Adding to this assumption is an argument of Sundar and colleagues (2012) stating that enabling customization would ultimately provide a more diverse combination of strategies to increase persuasiveness of applications. Further they discuss the added value customization brings with it, in term of psychological potential, namely given the user an increased sense of competence and autonomy, boosting user agency and self-determination.

Another main aspects of customization, it is a highly user driven process whereas personalization on the other hand is system driven (Nielsen, 1998). This means that the main difference between personalization and customization is the level to which the user can influence the technology. An example of personalization versus customization in mHealth would be the ability to set one's date of birth in an application (system driven personalization) versus changing

the color, information or modules of an application i.e. the context (user driven customization). Nielsen (1998) describes personalization and customization as tailoring processes. Figure 1 provides an illustration of the two concepts. In this conceptualization, tailoring is seen as "umbrella term" for content that is either user or system driven.

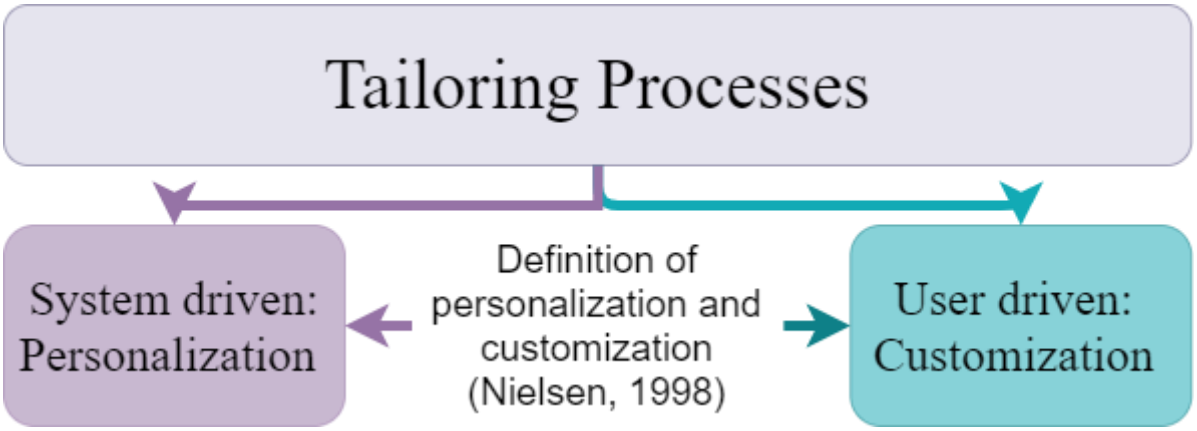

Figure 1. Illustration of tailoring processes as described by Nielsen (1998)

Research objectives

Given the vast variety of different approaches to mHealth, tailoring, personalization, customization and the barriers attached to them, two research objectives are central to the present review.

1. Addressing the conceptualization of customization in the current literature regarding its role in the field of eHealth applications for people with chronic illness.
2. Providing a representative overview of the effects of customization on user engagement and possible barriers to eHealth interventions for people suffering from chronic illnesses.

To answer this the study will closely examine user engagement with customizable technologies implemented into e/mHealth interventions and applications. The present review aims to scope methods for customization to provide more insight in the current stand of customizable interventions. Customization, as a user driven approach to improve the interaction with mHealth, will be looked at in detail, addressing its taxonomy as well as addressing how customization is

perceived by users (patients). Specifically, this scoping review will address mHealth interventions targeting patients suffering from chronic illness.

To ensure the quality and filter relevant information out of peer reviewed scientific literature a search sting will be composed, addressed in the method section. This will be done along the lines of the formal process of a scoping review defined as "preliminary assessment of potential size and scope of available research literature that aims to identify nature and extent of research evidence (usually including ongoing research)" (Grant & Booth, 2009). Finally, recommendations will be made for further research or actions that could be beneficial to the field of research under consideration of the discussed target demographic.

Methods

Overview

The present scoping review is based on the theoretical five-stage framework by Arksey and O'Malley (2005), a process of transparency, aiming for high replication potential of the strategy and a high reliability of the findings. Arksey and O'Malley's framework is conducted as follows: identifying the initial research question, as discussed above; identifying relevant studies; study selection; charting the data; and collating, summarizing and reporting the results. In following these guidelines, the present scoping review aims at determining the usefulness of customization regarding its behavioral impact on the target demographic.

Identifying relevant studies

A search strategy was constructed with regards to the most prominent topics previously mentioned. Used search engines for academic relevant literature were *PsychINFO*, *Google Scholar*, and *Scopus*. In addition to that, the scope was widened by searching via the search engine *Google*. To specify the search within academic and grey literature the PICO acronym was used (Population/Problem, Interest Intervention, Context/Compassion, Outcome), see Table 1. Selection criteria were addressed with regards to comparing the behavior of active eHealth users. This was taken into account while addressing the target demographic. Given the information

gathered from previously executed studies tested on an adult, random selected, population, this was adopted in the present review.

Table 1

Search Matrix making use of the PICO acronym

PICO	Constructs	Related Terms	Broader Terms	Narrow Terms
Population/Problem	chronic illness$	chronic pain*		chronic pain patients*
Interest/Intervention	mobile-application$	customization*	tailoring* personalized*	personalization* individualization*
Context/Comparison	e-health$ m-Health$			avatars*
Outcome	behavioral intervention$	naturalistic uptake* user interaction* engagement* attrition*	user experience*	

To develop a search string, the present study used specified inclusion and exclusion criteria to be as comprehensive as possible. By making use of the topics acquired and depicted in Table 1, a search string was developed and adopted as shown in Table 2.

Table 2

Key search constructs

Search String
"chronic illness" OR *"chronic pain"* OR *"chronic pain patients"* AND *"mobile application"* AND *"customization"* OR *"tailored-content"* OR *"personalized"* OR *"personalization"* OR *"individualization"* AND *"e-health"* OR *"m-heath"* OR "behavioral intervention" AND *"naturalistic uptake"* OR *"attrition"* OR *"user interaction"* OR *"engagement"* AND *"avatars"*

Throughout the research process and with the establishment of customization in the last 15 years it was unlikely that sources before this particular time frame would yield substantial results, other

than basic approaches of taxonomies or fundamental psychological theory. They were thus excluded from the process of scoping the literature. However, for better understanding and theoretical background like in the case of tying certain constructs together, for example the ELM or the SDT there were made exceptions. A full list of inclusion and exclusion criteria can be found in Table 3.

Table 3

Selection criteria

Criterion	Inclusion	Exclusion
Time Period	2010-2020	Studies outside these dates
Language	English, Dutch, German	Studies beyond the English, Dutch or German language
Type of article	Original research, published in a peer reviewed journal, grey literature	Biased sources, advertisement related content, sources with questionable funding
Ethics clearance	Studies or literature with approved ethical clearance	Studies without ethical review or grey literature
Study focus	These of customization or related terms, the use of specialized content tools to combat barriers like naturalistic uptake and attrition in mobile e-(mental)Health interventions and applications	All other studies, grey literature and articles not directly related to the topic
Literature focus	Articles where the overwhelming theme relates to customization, personalization and tailoring and their impact on patients with chronic illness or chronic pain.	Articles that are based on research that focuses on technical advancements instead of user engagement or user uptake
Population/Sample	Patients with chronic illnesses/pain, mental illness Specialized focus groups or pilot studies	Groups unable of using e-health or m-health due to severe bodily or mental impairments

In addition to these criteria it has to be mentioned that the choice to include chronic pain as a narrower term was motivated by the overwhelming results of a previous, initiative, search regarding the inclusion of the term chronic illness.

As chronic illness being an impactful factor to daily life and due to its high prevalence rate the search string narrowed this construct by also focusing on chronic pain in relation to customization and its adjacent concepts. This choice was motivated by the adoption of behavior regarding customized eHealth solutions or interventions that could vary to a certain degree with a broad search term like chronic illness, without narrower distinctions like on the focus of customizable user experiences.

Data Analysis

Following the guidelines for Systematic Literature Review and the PRISMA statement (Moher et al., 2010), the search sting depicted in Table 2 was executed. In accordance with Bramer and colleagues (2017) this study considered only the top 200 search results of the data base Google Scholar in order to filter out only the most relevant results.

Following this was the deletion of duplicates via Endnote and the screening of all abstracts of the remaining articles. In this step all articles that did not meet the inclusion and exclusion criteria mentioned in Table 3 were sorted out. Articles that fulfilled the inclusion criteria during the first scoping of their abstracts were then revaluated in light of their full-text qualities and in included for qualitative analysis.

Finally, following guidelines from the fourth part of Arksey and O'Mally's (2005) model for scoping reviews (data and charting collation), summaries were developed to map the scope of the literature. These summaries were composed for each article and consisted of information regarding the author, the publication year of the study, the design of the study, its methods and outcomes. With regards to the context of the present review, summaries were developed laying the focus on the conceptualization of customization or adjacent concepts. Within this step it was made an effort to summarize the article alongside four main categories, focusing on customization, namely: terms used to describe/related to customization; integration of

customization into study context; outcome in relation to customization, as well as overlap of conceptualization of customization with the present review.

Results

Study selection

A total of 227 articles were identified. After removing the duplicates 216 articles remained. Within the next step the abstracts of the remaining articles were evaluated alongside the inclusion and exclusion criteria. In this step 175 articles were excluded. 30 articles were excluded because of exceeding the time frame (2010-2020), two articles were not available in German, Dutch or English and 143 articles were excluded due to not addressing customization or similar concepts (tailoring, personalization) in detail. The remaining 41 articles were then screened in detail, reviewing the full text. After close individual inspection 19 of those did not address customization or similar concepts to an extent that could have been used in the conceptualization of customization. In addition to that, 18 articles did not address either chronic illness, chronic pain or an e-health aspect in relation to customization or its similar concepts. A total of four articles remained, which were deemed sufficient and included in the review. Figure 2 depicts the process of selecting relevant articles in detail.

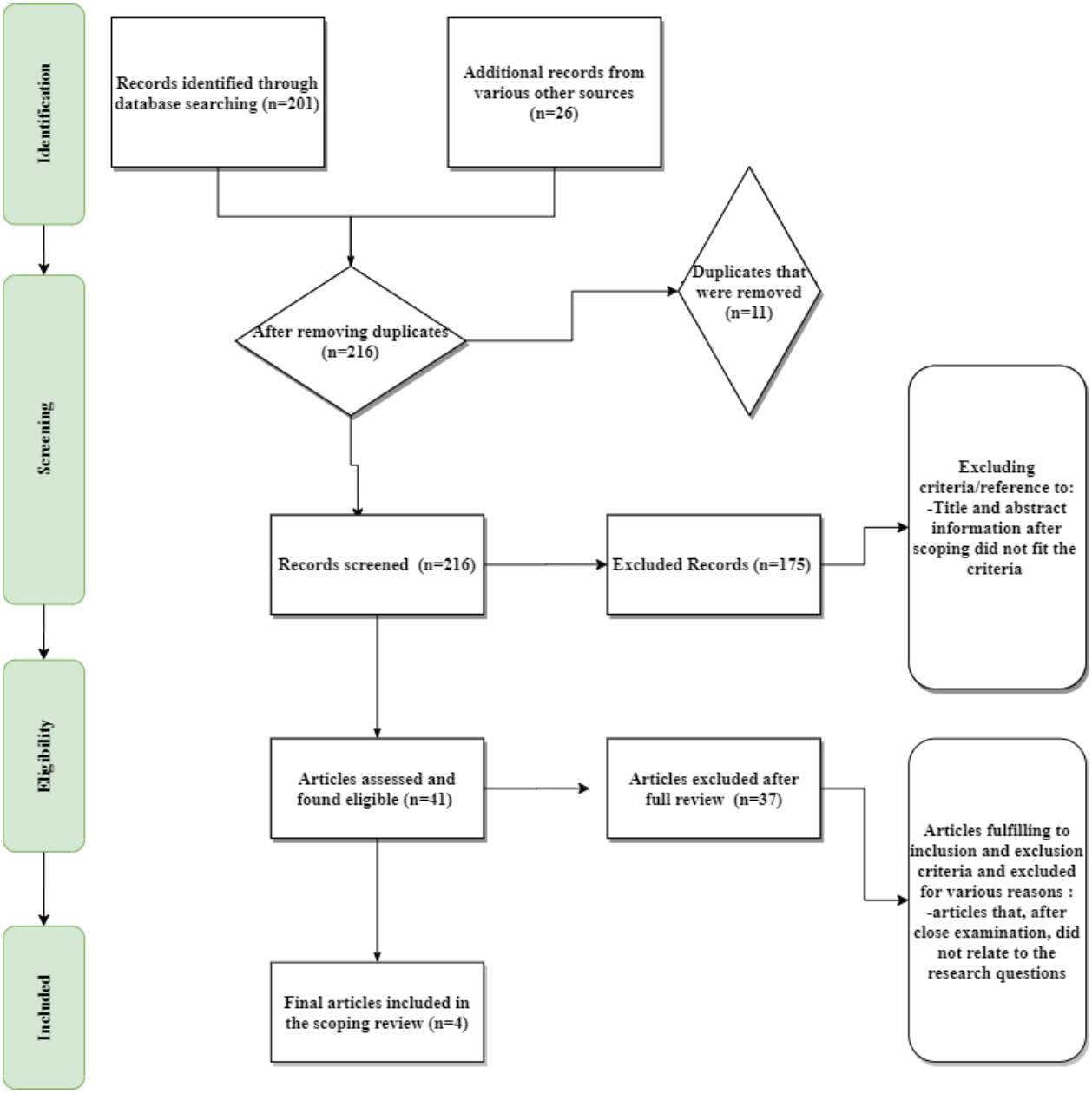

Figure 2. Flow diagram of selected studies

Data charting and collation

The final four articles included were one narrative review (Ebert et al., 2017), one pilot study (Ghafouryan & Bashi, 2015), one feasibility study (Schroeder et al., 2018) and one design and development study (Solem et al., 2020). Published from 2015-2020 these articles are part of recent research in the field of eHealth regarding their relation to chronic illness, customization and user engagement. Three of the articles featured single mHealth interventions or applications

(Ghafouryan & Bashi, 2015; Schroeder et al., 2018; Solem et al., 2020) and one a review of several mHealth interventions (Ebert et al., 2017). A list of the study characteristics as well as short individual summaries, addressing the conceptualization of customization is depicted in Table 4.

In terms of the overall goals, three articles emphasize the use of mobile eHealth interventions in order to improve self-management (Ghafouryan & Bashi, 2015; Solem et al., 2020), either via increasing patients' knowledge of their condition or providing personalized tools for everyday use (Ghafouryan & Bashi, 2015; Schroeder et al., 2018; Solem et al., 2020). The technological interventions of these three articles were based on mobile smartphone or iPad applications and were concerned with engaging with the user in order to facilitate treatment intervention options using eHealth solutions. Targeted populations were adult patients with underlining chronic conditions. These included: 54 patients with chronic *heart failure* (HF) (Ghafouryan & Bashi, 2015), 73 patients with an underlining chronic mental condition within *dialectical behavioral therapy* (DBT) (Schroeder et al., 2018) as well as a 17 chronic pain patients (chronic condition lasting longer than three months) (Solem et al., 2020).

In contrast, the narrative review article by Ebert and colleagues (2017) introduced the effectiveness of internet- and mobile based interventions regarding the prevention of mental health disorders via a systematic review. In their article they emphasize tailoring specific modules based on individual risk factors as a way to improve the adoption of healthy behaviors by the patients. Their study focusses solely on mental health conditions and their potential for becoming chronic conditions. The chosen population samples consisted of nine adult- and one adolescent group of people suffering from a wide range of mental health problems including depression, eating disorders and generalized anxiety disorder.

Table 4
Characteristics of studies making use of customization and adjacent concepts

Study number Author, Year	Intervention /Context	Study Design /Aim	Population	Terms used to describe/related to customization	Integration of customization into study context	Outcome in relation to customization	Overlap of conceptualization of customization with the present review
(1) Ebert, Cuijpers, Muñoz & Baumeister, 2017	Prevention of mental health disorders	Narrative review: to provide an introduction to the subject of Internet- and mobile-based interventions (IMI) and review the available evidence for the effectiveness of IMIs with regard to the prevention of mental health disorders onsets.	Multiple population groups; 9 Adult groups; 1 Adolescent group	"tailoring"	Tailoring specific modules based on individual risk and need profiles	• Tailoring is considered as potential starting point for further empirical research to compare the approach to standardized non-tailored approaches for efficacy	• There is no differentiation in the global terms tailoring, personalization and customization. • Customization is not directly addressed. • Tailoring is considered a preamble for possible intervention success.
(2) Ghafouryan & Bashi, 2015	Treatment for patients heart failure (HF)	Pilot study: to increase patient's HF knowledge and self-management skills by an innovative teaching tool delivered through an	54 adult patients with HF	"tailoring", "self-tailoring", "personalized messages", "self-management", "patient tailored"	Inducing the adoption of healthy behaviors through interventions that make use of tailored, "self-(mood) management" interventions	• Limited evidence of the effectiveness of web-based self-management interventions for chronic illness • Recommendation to further explore the effect of tailored interventions and self-	• Customization is not directly addressed. • "patient tailored interventions" is conceptualized as a way to challenge web based program design. • "patient tailored" is mentioned as concept but not

Customization in eHealth interventions.

		iPad application.				management programs	defined, nor related to other concepts.
(3) Schroeder et al., 2018	Treatment of chronic mental illness	Feasibility study: to address the web application "Pocket Skills", regarding patient's improvement in DBT skills via smartphone (mHealth) and promoting user engagement in mental health treatment, helping people cope with their psychological disorders.	73 adult Patients within DBT	"non-personalized messages", "semi-personalized messages", "tailored"	Participants received semi-personalized tailored messages (personal goal or progress reminders i.e. "your goal was mindfulness, keep practicing") or non-personalized messages (information's regarding the app itself i.e. "the Practice section gets you to the skills ASAP!")	• Participants in the "semi-personalized group" practiced more with the application then participants in the "non-personalized" group • Regardless of the group, participants reported decreased depression, anxiety, and dysfunctional coping, as well as increased DBT skills resulting in faster improvements	• Customization is not directly addressed • Integration of personalization in the context of "semi-personalized messages" in form of an individual progress reminder. • Increased user engagement in the "semi-personalized" group • 31 participants practicing with the application enjoyed the interactive interface and found it engaging however there was no directly changeable or customizable feature of the application.
(4) Solem et al., 2020	Mobile chronic pain intervention	Design and development study: to design a user centered, self-management , eHealth intervention for people	33 adult participants: 17 patients experiencing chronic pain, or having experience chronic pain for more	"customization" "personalization" "automatic tailoring" "avatar" , "self-management"	Personalization and customization are identified as the highest valued design elements	• Customizable content of the intervention emerged as heavily favorited design element • Customization is seen as part of personalized content in the development of	• Customization is addressed as feature of personalization i.e. adjustment of the intervention based on individual needs and personal preferences. • Customization is explored as design features with the goal

		with chronic pain	than three months, 2 spouses of patients and 13 health care providers	an intervention with a user center approach. • Automatic tailoring as the automatic adoption of previously favorited, personalized, content	to stimulate user engagement • Customization is addressed as idea for specific content, in particular customizable avatars within the intervention

Note. HF=Heart Failure, DBT= Dialectical Behavior Therapy, ICT= Information and Communication Technology

Technological tools and current interventions

The reviewed studies used different approaches to optimize interventions for patients. For the greater part, interventions were mHealth based and delivered via smartphone (Schroeder et al., 2018; Solem et al., 2020). In one case this was done via a website that could be loaded onto an iPad (Ghafouryan & Bashi, 2015). Three articles, concerned with intervention feasibility and design, overlapped in their efforts to tailor personalized content for specific users (Ghafouryan & Bashi, 2015; Schroeder et al., 2018; Solem et al., 2020). In addition to that, Schroeder and colleagues (2018) as well as Solem and colleagues (2020) described this effort in terms of enhancing user engagement. An exception formed Eber and colleagues (2017) study whose mHealth interventions aimed to increase patients' knowledge about their conditions and teaching new skills or supporting skills they already had. In the case of Ghafouryan and colleagues (2015), these efforts were to increase patients' knowledge about chronic HF, whereas Schroeder and colleagues (2018) aimed to improve patients' skills with DBT to help them cope with their disorders.

Conceptualization of customization

Addressing the first research objective, customization as a concept was only defined by Solem and colleagues (2020). The study described customization in the same context as personalization, putting them together in the category "*Design element/feature"* as: "*Customize how things are presented/look in the app. For example, you can customize colors, styles, or specific parts of the app that you want to use."*. In their study, stakeholders rated customization/personalization as the most desired feature for their mHealth intervention. Customization by Solem and colleagues (2020) was seen as option to actively customize the content of the application and personalize its features. Even though customization was not explicitly mentioned as a concept by the other articles included in the present scoping review, similarities regarding bordering concepts were found in the studies of Ghafouryan and Bashi (2015) and Schroeder and colleagues (2018).

In all four reviewed articles, some overlap of conceptualizations of customizations was found. For personalization the overlap in conceptualization was between personalized messages (Ghafouryan & Bashi, 2015) and semi-personalized messages (Schroeder et al., 2018). Semi-personalized messages were defined by Schroeder and others (2018) as personal goal or progress

reminders i.e. "*your goal was to use mindfulness, keep practicing*", whereas non-personalized messages gave specific information about the application itself i.e. "t*he practice section gets you to the skills ASAP!*" It was found that users who received semi-personalized message practiced with the intervention more often, as opposed to users receiving non-personalized messages (Schroeder et al., 2018). Adding to this, in the study by Solem et al. (2020) similar could be said about personalization and in detail about personalized content. Studies showed similar effects on users, i.e. greater interest in- and participation with the interventions.

Alongside personalization, another adjacent concept to customization was tailoring (Ebert et al., 2017; Ghafouryan & Bashi, 2015; Schroeder et al., 2018; Solem et al., 2020). Tailoring was found to have several contextual deviations. First, self-tailoring (Ghafouryan & Bashi, 2015), a concept that was explained by Lorig & Holman (2003) as applicable by learning the principles for changing behaviors and self-management to be able to begin and enhance, for example, an exercise program. Ghafouryan and Bashi (2020) addressed self-tailoring as an important issue and skill for patients with chronic illness, in how they can learn to live and manage their condition themselves on a day to day basis. Second, patient-tailored, also addressed by Ghafouryan and Bashi (2020), a concept that describes the need for interventions to tailor their content to patient preferences as well as to be patient-centred rather than healthcare-centred. Lastly the concept of automatic tailoring was brought up by Solem et al. (2020). In their design and development study for a mobile chronic pain intervention they address this concept as the ability of the mobile application to give the user suggestions based on previous preferences.

Tailoring Processes

As mentioned above, customization was defined by Nielsen (1998) as a tailoring process that is highly user driven. In contrast to that, Nielsen (1998) defines personalization as a system driven tailoring process. The reviewed articles did not make any distinction between user or system driven processes, nor did they categorize these concepts in any other specific way (Ghafouryan & Bashi, 2015; Schroeder et al., 2018; Solem et al., 2020). However, tailoring, in one case, was directly linked to, and described as, the option to customize the self-management portion of an application for people suffering from chronic pain (Solem et al., 2020). The results further show that customization was closely linked to self-management and self-tailoring (Ghafouryan & Bashi, 2015) as well as to personalized messages. As mentioned in the introduction, user- and

system driven tailoring processes are addressed as independent concepts in the human-computer interaction literature. The present results however, showed an overlap of these processes in the psychological literature. This became clearer, examining personalized content i.e. personalized messages and semi-personalized messages, which were given to the users in form of reminders (Schroeder et al., 2018). These reminders were composed by the application/intervention but were based on the user's preferences, making personalized content in the reviewed studies both system and user driven (Ghafouryan & Bashi, 2015; Schroeder et al., 2018; Solem et al., 2020). To elaborate on this, the user has no active role in changing the application, or customizing it, but the system adjusts its contend based on information the user has provide. Additionally, personalization was described as content that is user specific, adding traits, treatment plans or whole application features in the form of customizable content (Solem et al., 2020). Solem and others (2020) addressed another example of personalization within their research namely customizable, simple, behavior trackers which were evaluated by stakeholders and deemed essential features for chronic pain eHealth interventions.

Customization and user engagement

Addressing the second objective of the present study as to how customization effects user engagement for patients with chronic illness, no direct effect of customization or adjacent approaches on user engagement could be identified throughout the reviewed articles (Ebert et al., 2017; Ghafouryan & Bashi, 2015; Schroeder et al., 2018; Solem et al., 2020). However, Schroeder et.al (2018), found that the group of participants in the semi-personalized message condition of their study practiced slightly more with their application "*Pocket Skills*" than the group of participants that received non-personalized messages. This effect was recorded but not further explored as it was deemed not significantly viable in terms of added value personalization features had on user engagement. Solem and colleagues (2020) also suggested, but did not test, that presenting the intervention material in a way that would meet the users' interest could promote engagement with the application. In accordance with this, they included customizable avatars as potential feature for participants to vote for. However, participants in their study rated customized avatars as possibly challenging and dismissed the concept by not voting for it (Solem et al., 2020).

Customization and barriers to eHealth

Regarding the earlier discussed barriers to eHealth interventions, both the concepts of attrition and naturalistic uptake where not addressed in the scoped literature (Ebert et al., 2017; Ghafouryan & Bashi, 2015; Schroeder et al., 2018; Solem et al., 2020). However, several other potential barriers were identified. These included the amount of time it takes to develop eHealth interventions; defining beneficial intervention content; patient involvement regarding the process of developing the application as well as privacy and security issues regarding the patient's data (Solem et al, 2020). Furthermore, Ebert and colleagues (2017) found that barriers included the level of acceptance that could be inherent to specific target groups. They stressed the need for further research to investigate potential obstacles in order to develop new strategies to overcome these. In addition to that they discussed the issue of additional research in the field to further determine the potential internet and mobile interventions can have for the immense disease burden of mental health disorders at the population level (Ebert et al., 2017). Adding to this Schroeder et al. (2018) described the barrier of "perceived intervention efficacy" that states that people with depression who do not believe the intervention to be correct would not likely engage with the app, applying the need for users trust in the given materials. They further report that patients enjoyed their intervention (*Pocket-Skills*) and that it was picked up well because it was based on material of a well-known and respected figure, the target population was already familiar with (Schroeder et al., 2018).

Discussion

The present literature review aimed to address what role customization plays in the field of current eHealth for people with chronic conditions. Therefore, the first research objective was the conceptualization of customization by scoping recent literature regarding interventions and applications for people with chronic illnesses. Results showed that the concept of customization was not clearly defined. The current body of literature does not distinguish between tailoring, customization or personalization (Ebert et al., 2017; Ghafouryan & Bashi, 2015; Schroeder et al., 2018; Solem et al., 2020). Starting with customization these three concepts and their definitions, according to the scoped literature, will be discussed in the following.

Customization is addressed in only one of the four articles and conceptualized as the user's ability to change design elements of an application i.e. colors, styles or specific parts of the application (Schroeder et al., 2018). These characteristics of customization are generally in line with Nielsen's (1998) description of customization, being a user driven process (Figure 1). However, none of the collected articles defined customization explicitly in terms of being either system or user driven. To further conceptualize customization, the adjacent concepts tailoring and personalization have to be addressed. Tailoring, and its related concepts automatic tailoring (Solem et al., 2020); self-tailoring and patient tailored (Ghafouryan & Bashi, 2015), is used to describe intervention content that can be modified by either researchers and/or developers as well as users. Personalization on the other hand was addressed as the adjustment of an intervention, based on individual needs and personal preferences (Solem et al., 2020). Given that this does not distinguish between a user or system driven effort either, one could argue that the reviewed literature fails to address customization, tailoring and personalization as different concepts, that are fully distinct from each other.

Given Nielsen's (1998) definition of tailoring processes the current findings can further be discussed in terms of a possible new model, breaking with the hierarchical structure as depicted in Figure 1. The results show that customization and personalization cannot be divided merely by being user or system driven. A reconceptualization of the earlier discussed model of tailoring processes being either system driven or user driven, under consideration of the findings of the present study is depicted in Figure 3.

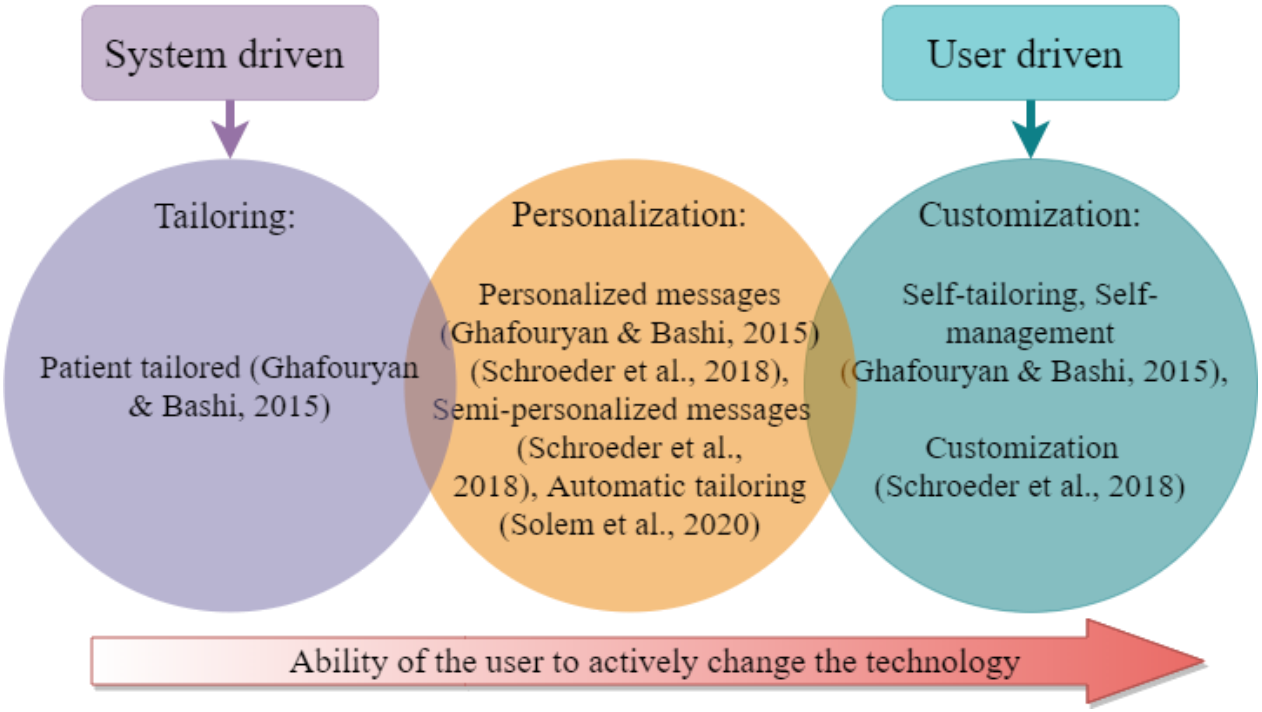

Figure 3. Reconceptualization of system- and user driven tailoring processes

The reconceptualization still categorizes tailoring processes in terms of user- and system driven, however their use suggests a new overlapping arrangement in concepts rather than a clearly defined hierarchical structure. This overlap in concepts could explain why customization is rarely mentioned as perquisite for the adoption of eHealth interventions for chronic illness treatment (Ghafouryan & Bashi, 2015; Schroeder et al., 2018; Tobler-Ammann, 2020). Elaborating on the reconceptualization, the results of the present study showed that by applying the characteristics of user-and system driven tailoring processes a new spectrum emerges in terms of the level to which the user is able to change the technology to their personal preferences. As an example, patient tailored interventions were addressed as interventions tailored to specific patients (Ghafouryan & Bashi, 2015), whereas self- tailoring interventions actively involve the user in learning to live with, for example, a chronic condition (Ghafouryan & Bashi, 2015). In the case of automatic tailoring, personalized messages and semi-personalized messages the user is partly involved as these concepts use previously set user preferences as the basis to further change the application (Ghafouryan & Bashi, 2015; Schroeder et al., 2018; Solem et al., 2020). On the other end of the spectrum, customization, self-management and self-tailoring depict highly user driven processes enabling the user to actively change the intervention (Ghafouryan & Bashi, 2015; Schroeder et al., 2018). Arguably, the inclusion of self-management under the category of customization could

be subject to further evaluation. However, the present study addresses self-management as a perquisite skill, enabling the user in decision making, ultimately leading to self-tailoring (Lorig & Holman, 2003). Under the revisited processes of tailoring, customization can thus be seen as part of a combination of strategies on the basis of unique personal characteristics, derived from individual assessments (Hawkins et al., 2008; Kreuter et al., 1999) instead of an "umbrella term". Customization, as depicted in Figure 3, highlights that customizable aspects can be individual, user driven processes like self-tailoring as well as self-management. One could argue that within the present reconceptualization, self-management skills could be associated with the level of customization and vice versa.

The second objective of the present study was to provide a representative overview of the effects of customization on user engagement and possible barriers to eHealth interventions for people suffering from chronic illness. The study found no effects of customization or adjacent concepts on user engagement that could be identified throughout the reviewed articles. However, Solem and colleagues (2020) pointed out that presenting the intervention material in a way that would meet the users interest could promote engagement with the application. To further elaborate on this, they discussed the concept of *gamification* via customizable avatars. However this concept was dismissed as patients in their study reported that it could be overwhelming while simultaneously dealing with symptoms of a chronic illness (Solem et al., 2020). However, the concept of customizable content via gamification is otherwise seen a strategy to enhance self-efficacy and alter health behaviors in chronic disease self-management (Nightingale et al., 2017).

Because of the aforementioned problems with user engagement, one has to address possible barriers patients with chronic illnesses could have with eHealth interventions. Arguably customization could be seen as tool to combat these barriers, nevertheless the present study found no connection between customization and the previously discussed barriers of naturalistic uptake and attrition. Due to customization being only addressed by one of the four articles the argument could be made that there is a lack of research on the topic of customization and its impact on barriers to eHealth for patients with chronic illnesses. Even though it was not possible to address customization in relation to naturalistic uptake or attrition, the earlier mentioned concept of self-management could be seen as possible tool to address impediments to eHealth interventions. As a perquisite for the development of skills to untimely be able to use user driven tailoring processes (Figure 3), self-management otherwise enhances adoption and maintenance of positive health habits like adherence to treatment regimens (Nightingale et al., 2017). Furthermore, the present

study argues that successful self-management skills could enable the user to make use of self-tailoring (Lorig & Holman, 2003), an adjacent concept to customization.

Strengths and Limitations

The present scoping review revealed a body of literature concerning the role of customization in the field of eHealth interventions for people with chronic illness. It was possible to depict the scope of customization addressing a wide range of literature out of a narrow and recent time frame (2015-2020). Furthermore, a reconceptualization of customization and processes of tailoring as user and system driven (Nielsen, 1989) was addressed and discussed (Figure 3). In addition to that, the relevance of innovative eHealth interventions in relation to presumed barriers like naturalistic uptake and attrition was examined, marking self-management as possible point for further research (Birk & Mandryk, 2018; Chen et al., 2017; Van Der Meulen et al., 2019).

However, the present review also had several limitations. First and foremost, the main concept of customization appeared only in one of the four articles (Solem et al., 2020). Adjacent concepts of customization appeared in three other articles. In relation to this, customization was either not used as a terminology within the psychological literature or not listed alongside similar concepts such as personalization (Solem et al., 2020) and tailoring. The lack of literature on customization narrowed the options of the present study to conceptualize and address customization in terms of its assumed potential in tackling barriers for people with chronic illness. However, because of this, the study was able to address customization and its adjacent concepts, provide a reconceptualization and stress an apparent need for further research on the subject.

Second, the reviewed literature (Ebert et al., 2017; Ghafouryan & Bashi, 2015; Schroeder et al., 2018; Solem et al., 2020) did not address information about key barriers to eHealth interventions for people with chronic illness, like attrition or naturalistic uptake. Lastly the present scoping review could not make a case for specialized eHealth interventions, like for example customizable avatars (Pimentel, 2019) as only one study briefly addressed this topic (Solem et al., 2020). The assumption can be made that up to this date there is no “one fits all” customizable eHealth intervention technology for patients with chronic illness.

Implications for research and practice

Implications for further research can be twofold, building up on the discussed research objectives of the present study. First, the conceptualization of customization could be further broadened via research within different target populations. Distinguishing between customization, personalization and tailoring could arguably lie in further differentiating between system and user driven approaches. With respect to the model of tailoring processes as described by Nielsen (1998), the reconceptualized model the present study provided could be further evaluated using different target populations. As Solem and colleagues (2020) point out, patients with chronic illness could feel overwhelmed by an intervention or application that provides too many options for customization. A possible target group could be people suffering from mental health disorders as the use of internet and mobile- based interventions allows for the provision of tailored interventions on large scale other than traditional face to face approaches (Ebert et al., 2017).

With respect to the second goal of an effects of customization on user engagement and possible barriers to eHealth for people with chronic illness, a follow-up study could address the issue of self-management. As mentioned before, self-management can provide a user with the necessary skills to effectively use concepts as self-tailoring (Lannin, 2017). In addition to that self-management based interventions are regarded as key component of care for patients with chronic pain (Goh et al., 2014). Therefore, the earlier presumed association between customization and self- management could be the subject of further research, potentially addressing the question whether self-management skills could have an effect on the use of customization or vice versa.

Conclusion

The present scoping review has contributed first and foremost to the broadening of research on customization in eHealth. The study showcased that to this date there is no unified consensus on what customization entails in relation to eHealth interventions and applications for patients with chronic illnesses. However, by developing a reconceptualization of customization an effort was made to clarify the current role of customization for researchers and users alike. Alongside the concepts of user and system driven processes an overlap between the main concepts tailoring personalization and customization was pointed out and discussed. In addition to that it was

discussed that within follow up research, scoping could be adjusted for the target group to widen the reach and address customization from different angels, like eHealth interventions for people with mental health disorders.

Due to the current state of research on the subject of customization and the limited amount of studies addressing this topic the present study could not determine any direct effects of customization on user engagement or barriers to eHealth for patients with chronic illness, like attrition or naturalistic uptake. Nevertheless, the possibility of addressing self-management skills in order to enable patients to make use of customization or its adjacent concepts was discussed. The relevance of self-management skills promoting customization, as well as its adjacent concepts, as a driving factor for user engagement was evaluated and addressed in the present study. Further implications for follow-up research could be the exploration of presumed effects of self-management on customization and vice versa. It can be stated that a clearer distinction of the mentioned concepts could be beneficial to further address the role of customization in modern eHealth.

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Appendix A

Papers included in scoping literature review

(1) Ebert, D. D., Cuijpers, P., Muñoz, R. F., & Baumeister, H. (2017). Prevention of mental health disorders using internet- and mobile-based interventions: A narrative review and recommendations for future research. *Frontiers in Psychiatry*, *8*(AUG). https://doi.org/10.3389/fpsyt.2017.00116

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