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RESEARCH ARTICLE



# Factors influencing the use of an artificial intelligence-based app (SELFBACK) for tailored self-management support among adults with neck and/or low back pain

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## ABSTRACT

**Purpose:** Tailored self-management support is recommended as first-line treatment for neck and low back pain, for which mHealth applications could be promising. However, there is limited knowledge about factors influencing the engagement with such apps. The aim of this study was to assess barriers and facilitators for engaging with a self-management mHealth app among adults suffering from neck and/or low back pain.

**Materials and methods:** We carried out a qualitative descriptive study among adults with neck and/or low back pain. The artificial intelligence-based SELFBACK app supports tailored self-management of neck and low back pain and was used for 6 weeks. After these 6 weeks, participants were interviewed by phone.

**Results:** Thirty-two adults (17 males) with neck and/or low back pain participated (mean age = 54.9 (SD = 15.8)). Our results show that the mode of delivery and the novelty of the SELFBACK app were perceived most often as a barrier to use the app. The action plans of the app and health-related factors were perceived most often as facilitating factors.

**Conclusions:** This study provides insight into possible strategies to improve an mHealth service. Furthermore, it shows that adults with neck and/or low back pain are willing and ready to receive blended treatment.

## ARTICLE HISTORY

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## KEYWORDS

Barriers; facilitators; mHealth; low back pain; neck pain; artificial intelligence; self-management; telemedicine

## > IMPLICATIONS FOR REHABILITATION

- Adults with neck and/or low back pain are willing to receive blended care (combination of face-to-face contact with healthcare professional and use of eHealth service)
- When implementing eHealth services in rehabilitation treatment of adults with neck and/or low back pain, rehabilitation professionals need to choose an eHealth service which includes individual action plans, evidence-based content with health benefits, goal setting and rewards and incentives.
- When implementing eHealth services in rehabilitation treatment of adults with neck and/or low back pain, rehabilitation professionals need to choose an eHealth service which can be used on someone's own smartphone.
- When implementing eHealth services in rehabilitation treatment of adults with neck and/or low back pain, rehabilitation professionals need to educate their patients about the importance and possible long-term benefits of self-managing their pain.



## Introduction


Neck and/or low back pain (N/LBP) among adults are main contributors to years lived with disability worldwide [1,2]. Chronic N/LBP is associated with reduced quality of life, increased risk of sick-leave, and increased use of healthcare services [3–6]. Tailored self-management is recommended in the treatment of N/LBP [7–9]. Self-management refers to a person's acts in managing their health state, for example, adopting a healthy lifestyle or dealing with a chronic condition [10]. A promising approach to offer self-management strategies is the use of mHealth or eHealth services, as research indicates these are as effective as therapist-led interventions [11] and as research indicates their potential with

healthcare staff shortages [12]. In this context, mHealth refers to solutions based on smartphone apps while eHealth refers to the whole spectrum of electronic/digital health services.

Lots of different eHealth services are developed focusing on adults with N/LBP [13–16]. Regarding the efficacy of eHealth services targeting people with N/LBP, different studies showed a positive effect on the health status in adults with pain when using an eHealth service [17–19]. Thus, this shows that eHealth solutions could be a viable and potentially effective treatment for people with N/LBP.

It is reasonable to assume users must engage with eHealth services for a certain amount of time to achieve the desired behavioural change and eventually improvement in health [20,21]. However, in general, when implementing eHealth services, a

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common problem is non-adoption. Buhrman and colleagues [22] found a substantial variation in drop-out rates of using eHealth services when reviewing literature about these services focusing on people with chronic pain. These drop-out rates ranged from 4% to 56%. Furthermore, previous studies have shown higher drop-out rates in eHealth interventions compared with face-to-face interventions [23–25]. This phenomenon is being referred to as the law of attrition in eHealth [26] and poses a threat to the adoption of eHealth services among the target population. Non-adoption within eHealth implementation processes, negatively affects the effectiveness of the eHealth services [27].

In previous studies in which eHealth services were used over multiple weeks, different reasons are given for users dropping out of eHealth use. Examples are lack of time [17,28], experiencing technical problems [29], experiencing medical problems, or dealing with personal issues [17,29,30]. Some studies do not even provide any reason for the drop-out found in their study [31–33]. Perski and colleagues [34] developed a framework to conceptualise user engagement in an eHealth behaviour change intervention. In their framework, they found that there are four main factors which influence the engagement: population factors (such as psychological characteristics, demographic characteristics), setting factors (such as physical environment, time), content factors (such as reminders, incentives) and delivery factors (such as mode of delivery, complexity).

The literature focusing on barriers and facilitators to use eHealth for self-managing N/LBP is sparse. A review by Svendsen and colleagues [35] focused on identifying barriers and facilitators for using an eHealth service to self-manage low back pain. They found limited literature (5 papers) on this topic and concluded that there is a knowledge gap concerning barriers and facilitators when using an eHealth service as well as strategies that can improve the adoption of eHealth services aimed to improve self-management of low back pain [35]. The aim of the current study was therefore to describe the barriers and facilitators perceived by adults suffering from N/LBP when using a self-management mHealth service, a type of eHealth, in a real-world setting and their use of this mHealth service. This will provide insight into factors that should be considered to ensure high user engagement and to increase adoption of eHealth when developing eHealth services. As a secondary aim, we focused on identifying the attitude towards self-managing N/LBP, the attitude towards eHealth in general and the use of a self-management mHealth service among people with N/LBP.

## Methods

### Study design

To answer the objectives of this study, we conducted a qualitative descriptive study among adults with N/LBP, with semi-structured interviews. We conducted this study according to the principles of the Declaration of Helsinki (64th-WMA General Assembly, Fortaleza, Brazil, October 2013) and in accordance with the Medical Research Involving Human Subjects Act (Dutch law). The Medical Research Ethics Committee CMO Oost-Nederland stated that this study did not require formal medical ethical approval (file number: 2020-6501). Each participant signed an informed consent form before participating.

### Study procedure

A 6-week study was carried out in which an mHealth app (SELFBACK) was used as a self-management tool. In this paper, we report the study based on the COnsolidated criteria for REporting

Qualitative research (COREQ) [36]. Participants started the study by completing an online pre-test questionnaire, consisting of demographics only. Then they received an account for the mHealth application, which they could use for 6 weeks. Before using the app, they completed a baseline questionnaire to enable individual tailoring of the app content toward the individual needs and characteristics. After using the app for at least 4 weeks, the participants were invited to participate in a semi-structured interview by phone which was audio-recorded. These interviews were conducted by one female researcher (MH) with a background in health sciences (MSc). During this study, MH was working as a junior researcher at Roessingh Research and Development (the Netherlands), and she was experienced in conducting interviews. The interviews were conducted between 4.5–6.5 weeks of using the app, and the actual interviews lasted for approximately 15–30 min per participant.

### Study population

The study population consisted of adults (18 years or older) suffering from N/LBP. The participants were recruited through advertisements in local newspapers. If a participant was not able to read and speak Dutch, or did not have a smartphone (with internet connection), they were excluded from participation in this study. We targeted to include 30 participants.

The participants of this study, and the interviewer had no relationship. The participants were aware that the interviewer conducted this study to gather data for her PhD thesis.

### Intervention: an mHealth application

In this study, participants used the SELFBACK app (see Figure 1), a decision support system, which has been developed to support tailored self-management among people with N/LBP [37]. The SELFBACK app provides weekly tailored self-management recommendations, focusing on advice on physical activity, strength/flexibility exercises, and educational content. The app also encompasses information about N/LBP and a toolbox with for example a sleep tool, a goal-setting tool, two mindfulness audios and pain-relieving exercises. For the app to give personalised recommendations, the user needs to complete the SELFBACK baseline questionnaire about their N/LBP and other factors that influence prognosis and the self-management process [37–39]. To tailor the weekly self-management recommendations, the app uses case-based reasoning, a branch of knowledge-driven artificial intelligence [40,41]. The SELFBACK app was available in four languages: Norwegian, Danish, Dutch and English. This app is intended to be a supplement to usual care (i.e. treatment at primary or secondary healthcare organisation). The SELFBACK app is described in more detail in the papers of Marcuzzi and colleagues [37], Mork and Bach [38], and Sandal and colleagues [39].

The effectiveness of the SELFBACK app has been evaluated in two randomised controlled trials (RCTs) targeting adults in two different care settings: primary healthcare (conducted in Norway and Denmark among adults with low back pain) [39] and secondary healthcare (conducted in Norway among adults with N/LBP) [37]. The results of the RCT in primary care have been published, showing that the intervention group had reduced low back pain-related disability compared to the control group at 3 months, but the effect was small and of uncertain clinical significance [42]. The results of the RCT in secondary care did not show significant improvement in the group using the SELFBACK app compared to usual care or web-based self-management support without tailoring [43].

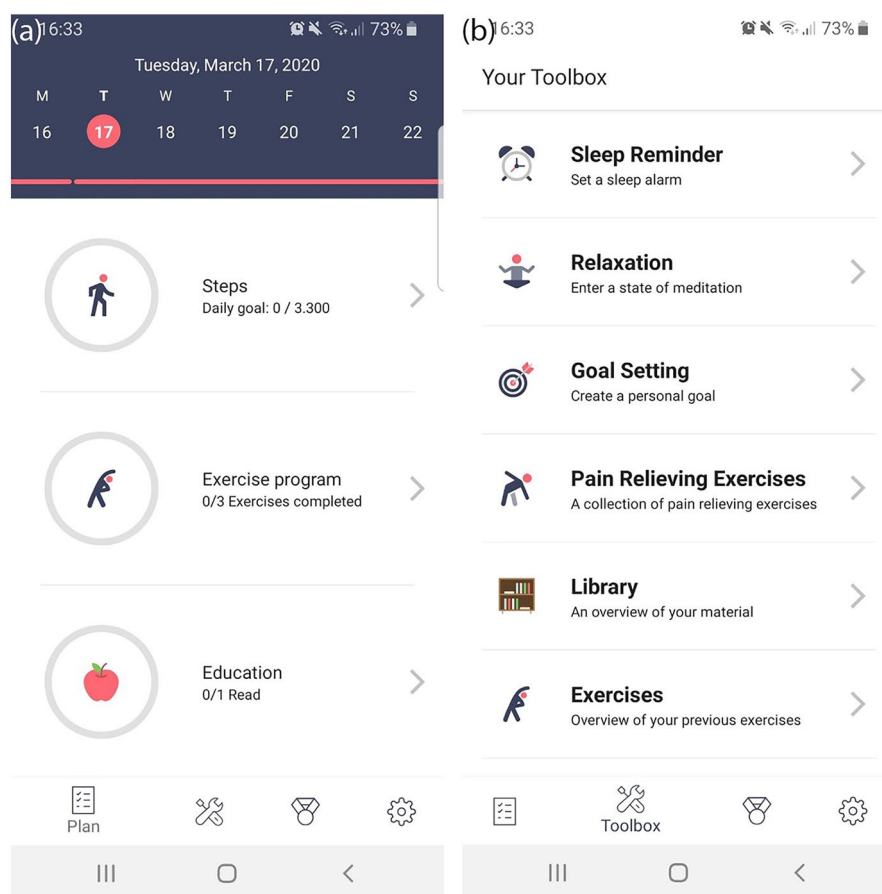


Figure 1. Screenshots of the SELFBACK app. Left picture (a) shows the home screen. Right picture (b) shows the tools available within the app toolbox.

### Data collection

The main study outcomes are barriers and facilitators for using the SELFBACK app, assessed in semi-structured interviews. The complete set of interview questions are shown in [Supplementary Material A](#). To assess the barriers and facilitators, we asked three different questions for both factors. We chose to ask multiple questions to find out as many barriers and facilitators as possible, and we chose to ask open questions. One question (question 9, [Supplementary Material A](#)) for identifying the perceived barriers was closed, but we asked an open follow-up question to have more in-depth information. An example question asked to identify barriers is: “What is the most important reason for you to not use the SELFBACK app?” An example for identifying facilitators is: “What is the main motivation for you to start using the SELFBACK app (over other options)?”. After these questions, we also asked follow-up questions, for example: “Are there any other reasons?”, or “Could you explain your answer?”

The secondary study outcome was the use of the SELFBACK app, evaluated within the same semi-structured interviews (also shown in [Supplementary Material A](#)). We asked participants how many times they used the SELFBACK app during the previous 6 weeks, how they used the app, which parts of the app were valued most and what it meant for them to use the app. Furthermore, we also asked participants about their willingness to use the SELFBACK app in the future, as well as some more general questions (i.e. the kind of help needed to manage their pain, self-management before the study, contact with healthcare professional during the study, general opinion about using mHealth apps).

### Data analyses

Descriptive statistics (frequency, mean, standard deviation and percentages) were used to describe demographics and use of the SELFBACK app. Qualitative interview data were analysed with ATLAS.ti, version 9.0.24 for Windows. Interviews were recorded, transcribed, and simultaneously coded by two researchers (MH (experienced in coding) and SJK (extremely experienced in coding)). Discrepancies between the researchers were discussed, and a decision was made upon this discussion. The transcripts of the recordings and findings of the interviews were not given to participants for feedback. We conducted a content analysis, with a deductive approach for coding. The coding themes were identified in advance of conducting the interviews. The coding themes for barriers and facilitators were based on a review by Perski and colleagues [34]. They conceptualised factors that influence engagement with digital behaviour change interventions and suggested a framework for how to measure why users do or do not engage with the intervention – thereby indicating how engagement can be improved [34]. These factors are categorized into four categories: content, delivery, population, and setting. Content and delivery factors are related to the intervention. Content factors cover the features within the intervention (e.g. having a goal setting mode, receiving reminders). Delivery factors cover factors related to how the intervention is delivered to the user (e.g. the mode of delivery, whether the intervention delivers new updates to the user on a regular base, i.e. novelty). Population and setting factors are related to the context of eHealth use. Population includes characteristics of the users: psychological characteristics (e.g. motivation, expectations), demographic characteristics (e.g. age,

education), and physical characteristics (e.g. weight, comorbidities). Finally, setting factors include the engagement factors related to the social environment in which the eHealth service is being used: social/physical environment, time, and access to technology. [Supplementary Material B](#) shows the coding tree.

Within our Results section, we added quotes of participants to give more in-depth qualitative information. The quotes are translated from Dutch to English by MH. After every quote, we give the following information about the participant: participant number, work situation (employed, retired, volunteer/caregiver or other) and pain location (neck and low back pain (NLBP), low back pain (LBP) or neck pain (NP)).

## Results

A total of 112 adults with N/LBP were interested in participating in the study. After receiving information about the study, 58 adults indicated that they were willing to participate, and the other 54 adults lost their interest (mostly because the SELFBACK app was not suitable for their health situation, i.e. specific N/LBP). In the end, 32 were included in this study. Twenty-five adults could not participate as they had an iPhone smartphone, and the SELFBACK app was eventually only available on Android smartphones. After completing the pre-test questionnaire, two participants dropped out: one because of owning a smartphone, which declined downloading the app, and one was lost-to-follow-up. In total, 30 participants used the SELFBACK app, of which 29 were interviewed. One participant was lost-to-follow-up after using the SELFBACK app. During the interviews, most participants mentioned they signed up for this study to relieve their pain ( $N=16$ ) or to learn new skills to manage their pain ( $N=8$ ).

The demographics of the study population is shown in [Table 1](#). Gender was equally represented in the study sample (53.1% man and 46.9% woman). The mean age was 54.9 (SD = 15.8) years. Most participants had completed a higher vocational

**Table 1.** Demographics of study population ( $N=32$ ).

Characteristics	N (%) or Mean (SD), range
<b>Gender – N (%)</b>	
Man	17 (53.1%)
Woman	15 (46.9%)
<b>Age – mean (SD), range</b>	54.9 (15.8), 23–81
<b>Level of education – N (%)</b>	
Preparatory secondary vocational education	3 (9.4%)
Higher general secondary education, pre-university education	7 (21.9%)
Higher vocational education, university	22 (68.8%)
<b>Living situation – N (%)</b>	
Married/living together with others	26 (81.3%)
Alone	5 (15.6%)
Other	1 (3.1%)
<b>Employment status – N (%)</b>	
Employed	15 (46.9%)
Volunteer/caregiver	1 (3.1%)
Retired	10 (31.3%)
Other	6 (18.8%)
<b>Pain location – N (%)</b>	
Low back pain	15 (46.9%)
Neck pain	5 (15.6%)
Neck and low back pain	12 (37.5%)
<b>Contact with healthcare professional during this study – N (%)<sup>a</sup></b>	
Yes	5 (81.5%)
No	22 (18.5%)

<sup>a</sup>Data only available for 27 participants.

education or a university study, were married or lived together with others, and were employed. Regarding the pain location, most participants reported to have LBP or a combination of NLBP.

During the interviews, we first asked participants how they self-managed their pain before enrolling in this study. Different strategies were mentioned, and some participants mentioned more than one strategy. The most mentioned ones were being treated by a healthcare professional ( $N=16$ , 42.1%) and exercising ( $N=14$ , 36.8%). Other strategies used to manage their pain were doing nothing ( $N=3$ , 7.9%), relaxing ( $N=3$ , 7.9%) or avoiding particular movements ( $N=2$ , 5.3%). The main advice healthcare professionals gave these participants were mostly to exercise ( $N=13$ , 65%). Other advices were resting ( $N=3$ , 15%), accepting the pain ( $N=1$ , 5%), trying out alternative medicine ( $N=1$ , 5%), not making extreme movements ( $N=1$ , 5%) and paying attention to your posture ( $N=1$ , 5%). During our study, only five participants had contact with a healthcare professional, of which most of them said that the advices from the healthcare professional were in line with those of the SELFBACK app. The kind of help participants needed from the SELFBACK app was mainly guidance in self-managing their pain ( $N=8$ , 40%), and receiving physical exercises to perform at home ( $N=7$ , 35%). Furthermore, participants indicated they want the SELFBACK app giving them a positive prompt or nudge ( $N=4$ , 20%) or giving them guidance from a healthcare professional through the app ( $N=1$ , 5%).

Furthermore, during the interviews, we noticed that most of the participants have a positive attitude towards self-managing N/LBP ( $N=23$ , 82.1%) and towards the use of eHealth in general ( $N=21$ , 72.4%). One participant even said the following: *“I think self-management is the greatest remedy for people in pain.”* (P-5, retired, NLBP). This shows that the acceptance of implementing eHealth focussing on self-managing your own health is high among the adults that used the SELFBACK app. However, not for all users, eHealth will be the solution. There was one participant that had a sceptical attitude towards using eHealth in general: *“Well, I’m very critical regarding eHealth. [...] I find it problematic to think that my phone should replace my physical therapist. I find this a strange thought.”* (P-12, other, NLBP).

## Perceived barriers and facilitators

### Perceived barriers and facilitators

Various barriers were mentioned by the 29 participants that were interviewed. Five participants mentioned they do not experience any barrier when using the SELFBACK app: *“I don’t see a reason to not use it.”* (P-10, retired, LBP). [Table 2](#) shows that most barriers that were mentioned were related to delivery factors (43.1%) while most facilitators were not related to one of the four main categories (47.8%). Looking at only the main categories, most facilitators were related to content factors (36.3%).

**Table 2.** Number of times and percentages each engagement factor is mentioned as a barrier or as a facilitator.

Category	Barriers		Facilitators	
	N	%	N	%
<b>Content factors</b>	12	18.5	41	36.3
<b>Delivery factors</b>	29	44.6	9	8.0
<b>Population factors</b>	7	10.8	1	0.9
<b>Setting factors</b>	5	7.7	8	7.1
<b>Other factors</b>	12	18.5	54	47.8
<b>Totals</b>	65	100	113	100

### Barriers

Perceived barriers within the content factors category were mainly related to goal setting ( $N=6$ ). The algorithm within the SELFBACK app suggests a new daily step goal for the coming weeks depending on the number of steps completed in the preceding week. There is a flexibility in the app for the user to adjust the daily step goal within  $\pm 10\%$  range. However, users indicated that they want to have more self-control over the daily step goal, especially when participants nearly never reach the minimum of 3000 steps.

"It always says you need to reach 3,000 steps. That would be a reason to say I don't want to use it anymore if they say that every time, and you're not allowed to set it [the step goal] yourself." (P-24, retired, NLBP)

"One of the things that really annoyed me is that the app keeps raising my goals. [Question: The step goal?] Yes. Raising my step goal is something I'm inclined to do myself, which I had to stop doing. Because otherwise I exceed my limits and I have to deal with more pain the next day. [...] Now the app says: 'Yeah, your average is this high, so I now suggest you to increase your average by this much'. I think this is annoying." (P-12, other, NLBP)

Within the category of delivery factors, the most frequently mentioned barrier was related to the mode of delivery of the SELFBACK app ( $N=15$ ). To record total number of daily steps is necessary that users carry their smartphone the whole day. Alternatively, participants could connect a smartwatch or wristband with the app for counting steps; however, sometimes another app needed to be downloaded to assure the synchronization with the SELFBACK app. This did not always work perfectly, which was also seen as a barrier. Furthermore, novelty was also mentioned quite often as a barrier ( $N=9$ ). Users became discouraged to use the SELFBACK app, because there was too much repetition within the physical exercises and the educational messages.

"It is totally linked to your mobile phone. Therefore, you are obliged to have it in your pocket the whole day to measure your steps." (P-2, retired, NLBP)

"If at a certain point it appears that nothing new is coming in. You have to keep incentives for novelties." (P-29, other, LBP)

Within the population factors category, the only barriers mentioned were related to psychological characteristics ( $N=7$ ). The reasoning users gave were: not being intrinsically motivated to use the app, and knowing their own limits regarding physical activity. Which they perceived as a barrier to use the SELFBACK app.

"My laziness, my own laziness. Yes. [...] You know, it is my own motivation which does not make me wanting to use the app." (P-7, volunteer/caregiver, LBP)

"I have the feeling I know my own boundaries. I don't want an app to be hounding me." (P-12, other, NLBP)

The least barriers were mentioned within the setting factors category, with time being mentioned as the most common barrier ( $N=4$ ). Users experienced that they have to invest a lot of time to use the app and to perform the physical exercises. They did not always want to invest their time in this, or due to other circumstances, they did not have available time to use the SELFBACK app.

"The attention it needs. You need to invest energy into it, and people are often busy. You can do something else during that time." (P-20, employed, LBP)

"You have to invest half an hour every day. That is the only disadvantage." (P-27, employed, NLBP)

Finally, other barriers were mentioned not related to one of the four engagement factors. The most mentioned barrier was related to health. For example when users experience more pain when using the SELFBACK app, it acted as a barrier. But also when users experience less pain, it acted as a barrier to use the app, because then there is no incentive to continue using it. Other health-related reasons to stop using the SELFBACK app were if one does not see any progression or if one does not want to give active attention to the complaints. Other mentioned barriers were that the app did not appear to have any added value beyond physical therapy, that they felt scientific evidence was lacking, and that they felt they do not need the app.

"I experienced less complaints, so then. Yeah, the stimulus is gone." (P-9, employed, LBP)

"The fact is that it gives me active attention to my back. [...] Every time you read that you need to relax. Distraction is good. But with an app like this, you pay more attention and then you feel the pain more frequently. All these years, I have learned to not pay attention to the pain. That is my biggest resistance to use it: 'Do I really want to be actively involved in this again?' " (P-20, employed, LBP)

### Facilitators

Regarding perceived facilitators, the most mentioned content factor was action plans ( $N=29$ ), i.e. the weekly self-management recommendations in the app. Users enjoyed having a weekly plan focusing on daily step activity, physical exercises and educational messages. This plan acted as a facilitator to continue using the SELFBACK app, as it changed each week depending on their feedback (i.e. the responses in the weekly tailoring sessions). Besides, more content factors were mentioned multiple times: rewards and incentives ( $N=5$ ), and goal setting ( $N=5$ ).

"The main motivator for me to use the app is that I hope and expect to learn something, to gain more confidence, to not give up. This is what I received from the SELFBACK app. The education appealed a lot to me." (P-11, other, NLBP)

"I also think that the app stimulates you to use it because you can win 'prizes'. I think this motivates me." (P-26, employed, LBP)

Two main delivery factors were mentioned; the aesthetics and design of the SELFBACK app ( $N=3$ ), and the mode of delivery ( $N=3$ ). Regarding aesthetics and design most users appreciated the physical exercise videos, the professional design of the app, and its user-friendliness. Mode of delivery was the most frequently mentioned barrier; however, some other participants perceived this as a facilitator, i.e. having a self-management app on their own smartphone acted as a facilitator, because the user did not had to contact a healthcare professional.

"The videos are appealing. I think the app looks professional." (P-6, employed, NP)

"And what I also liked very much, I remember now, the exercises were very clear to see. I only have one eye. And what I also personally really liked, there was no sound. I don't need that, I find it distracting. The exercises were very clear with that person and text underneath. It really couldn't be better." (P-11, other, NLBP)

Only one participant mentioned a population factor, related to psychological characteristics, as a facilitator. This user felt obliged to improve their health intrinsically.

"A sense of duty. We're talking about my health status." (P-20, employed, LBP)

Access to technology is the most mentioned facilitator within setting factors ( $N=7$ ). Users perceived that having access to this app was acting as a facilitator to use it. Having access to it, motivates and acts as a positive prompt or nudge to use it.

"I can open it whenever I want, I have my phone close to me, you're looking at your phone quite often. So then I take a look and I see: 'Oh, I've already reached 8,000 steps', and then I see: 'Oh yeah, that exercise needs to be done.'" (P-16, employed, LBP)

"If I go to the physical therapist and I have to perform physical exercises at home, I will perform them. But as soon as the physical therapy finishes, I stop performing the exercises. But now by having this SELFBACK app, it gives me something to hold on to." (P-28, other, NLBP)

Finally, regarding other factors which were mentioned as facilitators, most of them were health-related ( $N=20$ ). Some users stopped using the app when the pain disappeared, while for others the disappearance of pain gave a boost to continue using the app. Other reasons mentioned in this category were using the app as prevention for N/LBP, using the app to live a healthy lifestyle, or using the app to feel more fit. Furthermore, research-related facilitators were mentioned also quite often ( $N=9$ ).

"My motivation to use it is to try relieving my back pain." (P-17, retired, LBP)

"Knowing it's for a research, gives you motivation." (P-28, other, NLBP)

Table 3 shows an overview of the most mentioned barriers and facilitators in total. For every barrier and facilitator mentioned in the table, we added a quote of participant as example that was coded as that factor. The whole list of barriers and facilitators mentioned during the interviews are shown in [Supplementary Material C](#).

#### Use of the SELFBACK app

During the interviews, participants were asked to estimate the frequency of their use of the SELFBACK app. Most participants ( $N=13$ , 44.8%) indicated they used the app daily during the study

period. Others indicated they used it almost daily ( $N=9$ , 31.0%) or a couple of times a week ( $N=6$ , 20.7%). One participant initially used the app daily, but after 4 weeks their use declined: "I used it for four weeks, and then I felt better, so I did not use it for a while." (P-9, employed, LBP). When asking participants whether there was a change in their use pattern of the SELFBACK app during the study period, most indicated they used it less frequently, or there was no change in use. The majority of the participants indicated they had a regular pattern in using the SELFBACK app, for example:

"I start the day by reading the educational message. Then I go to my training programme to do the exercises. Then the day starts with measuring my steps. During the whole day I look at my steps. Every now and then I look at the average of the steps over the past time: How am I doing compared to yesterday, last week?" (P-26, employed, LBP)

Participants mostly used the weekly self-management plan of the app, but some also used the toolbox which included, among others, pain-relieving physical exercises and an option to set personal goals not related to the step goal. The option to set personal goals was experienced positively. However, one participant did mention they would like to be reminded about their personal goals during the weekly evaluations.

Participants were asked about which part(s) of the app they appreciated the most. The physical exercises in the weekly plan were mentioned most often, followed by the step count data and educational messages. Moreover, participants also appreciated the pain-relieving physical exercises in the toolbox, the rewards or the app in total. Furthermore, participants were asked what it meant for them to use the SELFBACK app. Most participants said that using the app gave them insights in how to manage their pain and that using it relieved their pain. Other responses given by participants were that they have a more positive mindset and are happier ("Well, using it made me a little happier. [...] Because you have a bit less pain, and you are a bit more mobile." (P-4, retired, LBP)), and they learned new ways to manage their pain. Some participants did not experience any meaning from using the app.

Table 3. Most mentioned barriers and facilitators for using SELFBACK app.

		Barriers		Facilitators	
	Engagement category	Example quote	Engagement category	Example quote	
Mentioned 15 times or more	Mode of delivery [delivery factors]	"That pedometer thing, that combination.. I need to have the phone with me all the time for that [measuring steps]. ... That pedometer thing, I find it a handicap." (P-15, employed, LBP)	Action plans [content factors]	"Because you perform structured exercises, you are aware of your behaviour and the theory behind it. That does help prevent back pain." (P-29, other, LBP)	
			Health-related factors [other]	"Well, that has been my motivation, I wanted to reduce the pain in my neck." (P-3, retired, NLBP)	
Mentioned 10-14 times	–	–	–	–	
Mentioned 5–9 times	Novelty [delivery factors]	"Because I kept getting the same exercises and I found that less fun, less interesting" (P-6, employed, NP)	Research-related factors [other]	"To be honest, to help you with the research." (P-12, other, NLBP)	
	Health-related factors [other]	"Because with certain exercises, I was getting some pain in my back. ... I slowed down my use of the app. Initially I stopped for a while, and later I started again." (P-4, retired, LBP)	Access to technology [setting factors]	"At one point, I also received back exercises from my physical therapist, ... but the urge behind it lessens after a few weeks. And with an app like this which activates daily, it becomes a habit at some point." (P-4, retired, LBP)	
	Psychological characteristics [population factors]	"You need to have the willingness to use it daily." (P-23, employed, NP)	Rewards and incentives [content factors]	"That it gives compliments. ... I liked that yes, especially in the beginning." (P-6, employed, NP)	
	Goal setting [content factors]	"I can imagine that.. What I just said about the pedometer, like gosh I have to walk so much. That can become a barrier." (P-7, volunteer/ caregiver, LBP)	Goal setting [content factors]	"You also have a goal you give yourself, including the number of steps. And that encourages me to work on it every day." (P-16, employed, LBP)	

### Future use of the SELFBACK app

Using the SELFBACK app had a positive influence on participants in raising awareness concerning their health. For example, one participant told us that they will buy a wearable activity tracker to monitor their daily steps more accurately. When asking the participants whether they would recommend the SELFBACK app to others with N/LBP, almost everyone ( $N=26$ , 89.7%) indicated they would. The majority of the participants wanted to continue using the SELFBACK app ( $N=19$ , 65.5%). Eight participants did not want to continue using the app, and two participants were in doubt. In total, 16 participants provided a reason for why they want to continue using the app. Relieving pain ( $N=7$ , 43.8%) and wanting to have this external motivation ( $N=3$ , 18.8%) were mentioned multiple times. Regarding willingness to pay for using the SELFBACK app, almost 60% of the participants were willing to do this. The amount of euros differed between 1 and 2 euros to 17.50 euros per month. The participants were also asked whether they are willing to pay for eHealth in general (without directly knowing the impact already for that eHealth application) and, only 31% said they were willing to pay.

During the interviews, we sometimes discussed the role of physical therapists within the management of N/LBP. These participants talked about blended treatment: receiving physical therapy, and using the SELFBACK app at home. Fourteen of the 16 participants with whom this topic was discussed, had a positive attitude towards this blended treatment. The other two participants had no strong opinion. Participants thought that when a healthcare professional recommends an app, the motivation to use it will increase. One participant was very enthusiastic about blended treatment that they already had asked their physical therapist: *"I asked my therapist about it, he said he tried but it didn't work for him."* (P-5, retired, NLBP). One participant also indicated that they think maybe physical therapists are reluctant towards eHealth, as they could think that introducing eHealth in practice will reduce the number of persons that need treatment: *"But maybe the physical therapist is afraid that he will lose his patients."* (P-3, retired, NLBP). Physical therapists do recommend physical exercises to people with N/LBP, but unfortunately on paper: *"He [the physical therapist] gave me a sheet of paper with exercises. Performing these exercises became less and less. I was not motivated to perform those exercises, as it was on paper, and then you have to figure it out yourself."* (P-16, employed, LBP).

Finally, within this study, we found that participants experienced the SELFBACK app more useful during the COVID-19 pandemic, according to them the added value of eHealth increased due to this pandemic: *"Especially in this time of corona this is a fantastic tool."* (P-7, volunteer/caregiver, LBP). The COVID-19 pandemic showed us that mHealth, and eHealth in general are wanted by potential users. These users are ready to implement eHealth in their treatment and daily lives.

## Discussion

This study aimed at describing which barriers and facilitators adults suffering from N/LBP perceive when using a self-management mHealth app and identifying their use of such an mHealth application. Currently, there is a knowledge gap concerning which strategies to incorporate to improve the adoption of eHealth services for self-management of low back pain [35]. Our study is a first step in addressing this gap by describing the perceived barriers and facilitators when using a self-management mHealth app among adults with N/LBP.

The main barriers users perceived were mode of delivery, novelty, health-related factors, psychological characteristics, and goal setting. Regarding mode of delivery, participants mostly criticized the way the app measures their steps. This barrier can be overcome by using a wearable activity tracker which is directly linked to the mHealth app. To tackle the barrier "novelty" (one of the delivery factors), more variation in content is needed within the weekly self-management recommendations. More variation in content is also recommended in a previous review [44]. The health-related factors which act as barriers for some users (e.g. pain intensity), are more difficult to overcome. Woo and Dowding [45] found that the acceptance of eHealth increases if users have knowledge about its benefits. Thus, educating the users about the importance and possible long-term benefits of self-management may reduce the drop-out rate. Furthermore, the psychological characteristics which act as barriers are also hard to overcome (e.g. not intrinsically motivated). The effect of lack of intrinsic motivation on interacting with the SELFBACK app can be counteracted by increasing external stimuli [46]. A blended treatment approach was valued as positive among the users and reinforcement from a healthcare professional may represent a possible strategy to increase motivation and engagement with the intervention. Another strategy to increase users' intrinsic motivation is to help the user to clearly identify personal intentions and benefits from engaging with the intervention [47]. Similar to addressing health-related barriers (e.g. pain intensity), educating users about the importance and long-term benefits of self-management may increase the intrinsic motivation. Finally, to tackle the barriers related to goal setting, it is important that tools such as the SELFBACK app provide users with some more flexibility in deciding their goals. In other words, having some control over the functioning of the mHealth service will also influence on how the service is used. There should be an appropriate mix between factors the user has control over within the app and factors the user cannot control [48].

Our study showed multiple factors which facilitated and reinforced the use of the SELFBACK app. These factors may be useful to consider when developing similar eHealth services. First, an eHealth service should include action plans (e.g. self-management recommendations). Second, improvement in health-related factors (e.g. experiencing less pain or feeling more fit) were acting as a facilitator to use the SELFBACK app. Thus, using evidence-based content with documented health benefits and effect on symptoms is crucial to ensure user engagement. Documented effective eHealth services are mentioned in several reviews as a facilitator for using an eHealth service [49,50]. Third, a frequently mentioned facilitator was access to technology. Because the app was available on their own smartphone, participants indicated that this facilitated the engagement with the intervention. They could always open the app whenever they wanted and wherever they were. Svendsen and colleagues [35] also found in their review that easy accessible eHealth services facilitate their use. Several other studies involving other types of eHealth services support the notion that accessibility promote user engagement [44,51,52]. Furthermore, setting goals in the app acts as a facilitating factor. Participants were pleased by setting weekly personal goals about the weekly action plan, but also by having the option to set own personal goals not related to this plan. In line with this, Lyzwinski and colleagues [44] found that an option for setting own personal goals encourages users to interact with the eHealth service. Finally, including rewards and incentives within the app acts as a facilitator and motivates users [53]. However, Peng and colleagues [54] found in their study that users rather have tangible rewards (e.g. using points to receive discount on a web shop), instead of only



**Table 4.** The perceived main barriers and facilitators and their derived strategies.

	Category	Derived strategy
Five main barriers	<i>Mode of delivery</i>	mHealth app needs to have a direct link to a wearable activity tracker
	<i>Novelty</i>	mHealth app needs to have weekly variation in content
	<i>Health-related factors</i>	mHealth app needs to inform users about benefits of using the app
	<i>Psychological characteristics</i>	mHealth app needs to include external stimuli mHealth app needs to identify users' personal intentions and benefits from using it
	<i>Goal setting</i>	mHealth app needs to give users more influence in goal setting
Five main facilitators	<i>Action plans</i>	Including individual plans telling users what to do
	<i>Health-related factors</i>	mHealth apps needs to be effective
	<i>Access to technology</i>	mHealth app needs to be installed on personal smartphone
	<i>Goal setting</i>	mHealth app needs to include weekly goals mHealth app needs to give users option to set personal goals
	<i>Rewards and incentives</i>	mHealth app needs to give users rewards or incentives when interacting with the app

points within the mHealth service. From our interviews, we noticed a large inter-individual variation whether these external motivators actually act as a facilitator for use. We also found that multiple participants indicated they used the mHealth service because the context was a research setting, i.e. they wanted to help the researchers. To summarise, an eHealth service for self-managing N/LBP needs to include individual plans/recommendations, be effective, be easy accessible, have an option for setting personal goals, and needs to provide rewards and incentives to users. Incorporating these factors is likely to increase the use of eHealth services. In Table 4, we summarised the main barriers, main facilitators and derived strategies.

An additional but important finding of our study is that these adults with N/LBP have a positive attitude towards receiving blended treatment. The COVID-19 pandemic gave a boost to their acceptance of eHealth. However, only few physical therapists implement this in their practice, and physical therapists still hand out physical exercises on paper to persons to perform at home, although these persons may feel less committed to perform the exercises in this way. Future research should focus on the attitude of physical therapists towards adopting eHealth services within their treatment. By knowing their attitudes, developers and researchers can react on this and thereby better fit eHealth services to a blended care approach.

### Study limitations

A possible limitation of this study is selection bias due to the recruitment method (i.e. self-enrolment). This method can attract a study population that is more positive towards eHealth than the general population. Additionally, some participants suffer from specific N/LBP, whilst the SELFBACK app aims at supporting self-management of non-specific N/LBP. This might lead to a less positive attitude towards the app, because the content was not addressing the specific needs and/or symptoms of the participants. However, considering our main aim to describe barriers and facilitators, we do not think this had a significant influence.

Furthermore, we wanted to include quantitative use data in this article. However, the server that measures log history of the app, experienced a 10 days downtime during our study. Due to this the quantitative use, data were not reliable during these days, so we only presented our qualitative use data. Next, some participants only used the SELFBACK app, while others used the app together with treatment from a therapist or chiropractor. The perceived barriers and facilitators may differ between these groups. However, due to the small study sample, we did not consider this in our analysis. Finally, to be able to better understand the impact drop-out in eHealth has on the society, we would benefit from having insight into the costs of drop-out. However, we do not have this information and are not aware of other studies providing this information. So, we would suggest future research to focus on this aspect.

### Conclusions

In conclusion, this study gave us two important insights. First, our study showed that it is relevant to investigate the perceived barriers and facilitators in using an eHealth service before implementing it. Based on the perceived barriers and facilitators, we can give developers of and researchers strategies to incorporate in their eHealth service. By incorporating these, they can try to increase adoption of services among the end users. Second, this study adds to the body of literature that at least a part of the adults with N/LBP are willing to receive blended care, but not all physical therapists are. With our study, we hope to convey a message to the healthcare professionals that it is important to go along with these adults, as they are ready to use eHealth.

### Disclosure statement

The authors report no conflicts of interest.

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### Data availability statement

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

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