Engaging with EPIO, a digital pain self-management program: A qualitative study

Katrine Bostrøm

Oslo University Hospital

Cecilie Varsi

Oslo University Hospital

Hilde Eide

Oslo University Hospital

Elin Børøsund

Oslo University Hospital

Olof B Kristjansdottir

Oslo University Hospital

Karlein MG Schreurs

University of Twente

Lori B Waxenberg

University of Florida

Karen E Weiss

University of Washington

Eleshia J Morrison

Mayo Clinic

Elise Flakk Nordang

Oslo University Hospital

Audun Stubhaug

University of Oslo

Lise Solberg Nes (✉ lise.solberg.nes@rr-research.no)

Oslo University Hospital

Research Article

Keywords: digital, eHealth, application (app), chronic pain, self-management, engagement, EPIO, qualitative study

Posted Date: November 30th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-952389/v1>

Abstract

Background:

Chronic pain conditions entail significant personal and societal burdens and improved outreach of evidence-based pain self-management programs are needed. Digital cognitive-behavioral self-management interventions have shown promise. However, evidence is still scarce and several challenges with such interventions for chronic pain exist. Exploring patients' experiences and engagement with digital interventions may be an essential step towards developing meaningful digital self-management interventions for those living with chronic pain.

Objectives:

This study aimed to gain insight into the experiences of people with chronic pain when engaging with EPIO, an application (app)-based cognitive-behavioral pain self-management intervention program.

Methods:

Participants (N=50) living with chronic pain received access to the EPIO intervention for 3 months. During this time, all participants received a follow-up phone call at 2-3 weeks, and a subsample (n=15) also participated in individual semi-structured interviews after 3 months. A qualitative design was used and thematic analysis was employed aiming to capture participants' experiences when engaging with the EPIO intervention program.

Results:

Findings identifying program-related experiences and engagement were organized into three main topics, each with three sub-themes: (1) Engaging with EPIO; motivation to learn, fostering joy and enthusiasm, and helpful reminders and personalization, (2) Coping with pain in everyday life; awareness, practice and using EPIO, and (3) The value of engaging with the EPIO program; EPIO – a friend, making peace with the presence of pain, and fostering communication and social support.

Conclusions:

The current study explored participants' experiences and engagement with EPIO, a digital self-management intervention program for people living with chronic pain. Findings highlighted identifying valued aspects related to motivation for engagement, incorporating content in support of daily coping, and encouraging a sense of acceptance and relatedness as vital components for facilitating program engagement.

Trial Registration: ClinicalTrials.gov NCT03705104; <https://clinicaltrials.gov/ct2/show/NCT03705104>

Background

Chronic pain can impact physical, emotional and social functioning for the individuals living with pain, often resulting in significant personal and societal burden [1]. Multi-disciplinary care approaches, with the patient at the center of managing pain, are therefore increasingly recommended [2, 3], often pointing to the importance of raising awareness of the many physical, psychological and social aspects of pain, as well as encouraging and facilitating patient self-management, including planning and carrying out own goals [4].

Among pain self-management treatment approaches, cognitive-behavioral therapy (CBT) and acceptance and commitment therapy (ACT) interventions have been associated with improved psychological and physiological well-being, including improved quality of life, pain acceptance and self-efficacy, as well as reduced pain, anxiety and depression [5–7]. For various reasons (e.g., availability, geographical distance, personal preference and/or pain itself), such in-person treatment interventions are not always accessible to individuals living with chronic pain and new solutions and delivery options are needed [8].

Digital or electronic health (eHealth) solutions available via smartphones and tablets have potential for increased access and sophisticated strategies to help users implement self-management interventions into their everyday lives [9, 10]. Supporting this notion, existing digital cognitive-behavioral interventions for self-management of chronic pain have shown potential to improve quality of life and support emotional well-being for people living with chronic pain [11–14]. Studies have also shown eHealth solutions for pain management, especially application (app)-based interventions, to be usable and well-liked by patients, health care professionals and researchers [15]. However, research examining existing digital self-management interventions is still at an early stage, with mixed findings and a number of identified limitations, including limited theoretical foundation [16], limited stakeholder (e.g., patients, health care providers) involvement in the development process [17], issues with attrition/adherence [18, 19], limited evidence of efficacy [10, 15] and limited implementation and actual use post study [20, 21].

A solid theoretical foundation of digital solutions is necessary in order to facilitate evidence-based treatment and support. Stakeholder involvement in the development of digital solutions is also essential to ensure that user needs and requirements are met [17, 22]. In order to strengthen probability of use, however, fostering and understanding user engagement in the actual use of these solutions is vital [23, 24]. Despite the importance of this aspect, there is still a lack of clarity about how engagement should be conceptualized within eHealth and digital solutions, and definitions range from psychological processes relating to user perceptions and experiences to actual intervention usage [24–26], the latter sometimes being the main, or only, conceptualization of digital user engagement. Researchers argue that the reasons why individuals choose to engage with eHealth interventions might be more important than the actual time spent using the intervention [25, 26], and have suggested that engagement should be conceptualized and specified within every new context used, and involve the user's behavioral as well as psychological relations to, or with, the digital program [26].

User engagement and adherence to an intervention, including intervention use as intended, raises the likelihood that the intended effect will be achieved [19, 22] and individual health-related goals reached

[27]. The significant attrition, or disengagement, challenge occurring with eHealth solutions so far is therefore a major concern [18, 28, 29]. Seeking to address this issue, inclusion of persuasive designs that can motivate and engage users, even during difficult times, has been suggested [19, 29–31]. For example, there is evidence that design features such as personalization, praise, reminders and communication elements can foster user engagement and positive outcomes [18, 29–32]. To better understand engagement in digital solutions, however, psychological aspects should be thoroughly examined in addition to the frequently explored system use factor [26, 33]. This is particularly important to better understand the interplay between user perceptions, usage and effectiveness. Why do individuals engage in digital solutions, and how do they actively incorporate the intervention program into everyday life [34]?

The current research team designed and developed an app-based cognitive-behavioral pain self-management intervention called EPIO (i.e., inspired by the Greek goddess for the soothing of pain, Epione) [35–37] in response to some of the issues raised by existing research focusing on eHealth pain management programs. The EPIO intervention program is developed based on clinical and research-based scientific evidence, in close collaboration with key stakeholders, including people with chronic pain and related health care personnel [35–37]. EPIO's overall goal is to support self-management and well-being for people living with chronic pain in general (i.e., not pain condition specific). The current study builds on this research line, aiming to gain insight into the experiences of people living with chronic pain when engaging with the EPIO intervention program.

Objectives:

This qualitative study aimed to explore the experiences of people with chronic pain when engaging with the EPIO intervention program. The exploration of engagement followed participation in a feasibility pilot-study [38], and centered around gaining insight into the participants' behavioral and psychological experiences and considerations related to the intervention program and their engagement with it.

Methods

Study design

This exploratory qualitative study reports on qualitative findings from follow-up phone calls and individual interviews conducted with participants in a pilot-study examining the feasibility [38] of EPIO, an app-based cognitive-behavioral pain self-management intervention program [35–38].

Description of the EPIO intervention program

In the feasibility pilot, the EPIO program intervention was delivered in a simple blended care delivery model with one in-person introduction session, access to the app-based program, and one follow-up phone call [38]. The app-based program content is CBT-based with some aspects of ACT and consists of nine modules designed with several interconnected parts of educational information (e.g., coping strategies, thought challenges and the importance of activity pacing) and related exercises (e.g.,

diaphragmatic breathing, graded behavioral activation, mindfulness and progressive muscle relaxation) for people living with chronic pain. See Figure 1 for an overview of the EPIO program.

The program also allows for daily tracking (i.e., individual registrations) of sleep, rest, activity level, pain and mood. To encourage program content practice, a 3-day delay occurs from completing each module until the next module opens (i.e., *practice-mode*). An animated avatar or “buddy”, a bird called “EPIOS”, accompanies and guides the user through the program. Details about the EPIO program, including the design, development and feasibility pilot testing processes have been previously published [35–38].

Recruitment and participants

Recruitment for the feasibility pilot-study was conducted January - May 2019 [38]. Inclusion criteria were: age ≥ 18 years; living with chronic pain in general (i.e., not pain condition specific); pain duration ≥ 3 months (i.e., self-reported); access to a smartphone or tablet; being able to understand oral and written Norwegian; and being able to attend an in-person introduction session at a health care facility near the participants’ place of residence. Exclusion criteria included having an untreated severe mental illness, migraine, or cancer-related pain (i.e., all self-reported “yes”/“no” questions) [38].

A total of 50 people living with chronic pain participated in the feasibility pilot-study [38]. As part of the study procedure, all participants completed outcome measures at baseline and approximately 3-months follow-up, participated in an introduction session and received follow-up phone calls at 2-3 weeks post introduction session [38]. During the follow-up phone calls, participants were asked whether they would be willing to participate in an individual interview post-study. In order to ensure insight from a heterogeneous sample of the pilot-study participants, an inclusion matrix was developed where potential participants were selected for post-study interviews based on distribution of age (study range; 29-74) [38], gender (50/50), work-status (50/50) and program progress (i.e., how many modules they had completed by 3-months feasibility study completion). Based on this matrix, the research team then contacted relevant participants by telephone or text message to see if they were still willing to be interviewed and if, so, to indicate a suitable time for the interview. The research team contacted 17 participants, of whom one declined to participate and one did not respond. A total of 15 participants were subsequently interviewed. Please see Table 1 for participant demographics.

Table 1
Baseline participant demographics

Characteristics	Feasibility pilot-study sample (N=50)	Qualitative interview sub-sample (n=15)
Age, mean (range)	52 (29-74)	52 (34-74)
Gender, n (%)		
Female	40 (80)	8 (53)
Male	10 (20)	7 (47)
Race, n (%)		
Caucasian	48 (96)	14 (93)
African American	1 (2)	
Asian	1 (2)	1 (7)
Employment status, n (%)		
Full-time/part-time work	14 (28)	6 (40)
Sick leave/disability benefits or retired	36 (72)	9 (60)
Program completion status at 3-months, n (%)		
Completed all nine modules	14 (28)	5 (33)
Completed at least six modules	31 (62)	5 (33)
Completed less than six modules	5 (10)	5 (33)
Years living with pain, n (%)		
1-3 years	10 (20)	2 (13)
3-5 years	3 (6)	1 (7)
5-10 years	13 (26)	6 (40)
>10 years	24 (48)	6 (40)

Data collection

Follow-up phone calls – during intervention

The participants in the feasibility pilot study received a follow-up phone call from a member of the research team at 2-3 weeks after the introduction session to see how things were going and inquire about

any questions or comments regarding the use of the EPIO intervention program [38]. The phone calls lasted approximately 10-15 minutes and the research team member making the call took notes during the conversations.

Semi-structured interviews – post-intervention

Interviews were conducted post follow-up outcome measure completion in the feasibility pilot-study [38], at approximately 3-months. The individual, semi-structured interviews lasted 30-40 minutes, were conducted by telephone by a member of the research team and were audio-recorded and transcribed verbatim. A semi-structured interview guide (see Multimedia Appendix 1) was used to guide the interviews. Themes explored were related to engagement and included behavior (e.g., actual use), motivation (e.g., program content practice), design features (e.g., animated avatar, rewards and trophies, individual registrations, and reminders), communication (e.g., involvement of healthcare professionals in use of the EPIO program, and their perceptions of in-person support such as follow-up phone calls), perceived value and satisfaction with the EPIO intervention program.

Ethical Approval

and Informed Consent

The EPIO feasibility pilot study was approved by the Regional Committee for Medical and Health Research Ethics (REK 2018/8911) and the Oslo University Hospital Institutional Review Board equivalent function (PVO 2017/6697) [38]. All participants provided written informed consent.

Data analysis

The data material (i.e., notes from follow-up phone calls and interview transcripts) were uploaded to the software program NVivo version 12 (QSR International, Victoria, Australia) and analyzed using Braun and Clarke's [39] six-step thematic analysis approach to capture user experience themes with a codebook approach analysis [40]. The first step involved the first author (KB) listening to the audio-recorded interviews while taking notes, then reading the transcribed interview data and the notes from the follow-up phone calls while taking additional notes. In line with an inductive approach, within step 2, codes were derived from the data, extracting embedded meanings in the sentences. The first and second authors (i.e., KB, CV) then reviewed and compared the codes in step 3 and categorized them into themes. In the fourth step, main themes and subthemes were compared with the codes and refined to ensure coherence before comparing with the entire data material to ensure representation. Then, in the fifth step, the themes and subthemes were thoroughly reviewed and compared within the core research team (i.e., KB, CV, LSN and HE), before final results were written up in step 6.

Results

The findings from the thematic analysis provided insight into participant's experiences when engaging with the EPIO intervention program and were identified and organized into three main topics: (1)

Engaging with EPIO, (2) Coping with pain in everyday life, and (3) The value of engaging with the EPIO program. Please see Figure 2 for an illustration of findings.

Engaging with EPIO

The participants described EPIO as presenting a new way to learn pain self-management, with valuable content and design features, and options for encouragement and support while facing the challenges of daily life with pain. Aspects described as important when engaging with EPIO were sorted into three sub-themes; motivation to learn, fostering joy and enthusiasm, and helpful reminders and personalization.

Motivation to learn

Several participants described being motivated to participate in the study and use the EPIO program because they were curious and willing to try something new that might help with their pain. Similarly, other participants stated that they wanted to learn how to better manage their pain, without the use of pain medication, for example through stress management and relaxation exercises. These participants described their motivation as being able to take control of their situation and feel better about themselves, and expressed hope for improved well-being. As stated by one of the interviewees:

“My motivation is to try to get control of my pain. I have promised myself that I will try everything to overcome the pain, and if I do not become pain-free, then I will at least get control of it and improve my quality of life. That’s what’s in my head. So, my motivation is really that I am to feel better about myself. And I have read a lot in recent years, and have concluded that there are many things one can do to decrease the pain, without using medication. And a lot of it concerns stress and relaxation”. (Interview, participant 5)

Another type of driver for motivation to engage and learn was the availability and easy access of EPIO. Some compared the accessibility and sophistication of the EPIO program to a subway ticket program they could have on their phone, to use whenever needed or whenever they felt like it. As one participant stated:

“I look at the phone, there’s my subway ticket, so then I have to bring my phone, and then I also have access to EPIO any time it suits me, I think that’s great”. (Interview, participant 2)

Fostering joy and enthusiasm

Most participants described the EPIO program, its content and design features as engaging and motivating for use. They used words such as: excited, happy, surprised and hopeful when talking about the program and some even compared EPIO to a gift. As expressed by one participant:

“I’m so excited about the app – it’s amazing! It’s like a Christmas present – I’m eager and always looking forward to opening it”. (Interview, participant 12)

Several participants also expressed their enthusiasm regarding EPIO's avatar elements, such as the animated bird, EPIOS. Most of the participants described EPIOS as funny, engaging, and with useful quotes of wisdom, and reported perceiving EPIOS as a good companion and friend throughout the program. As one participant said:

"It's so cute. It looks happy. All the great wisdom it's sharing and everything, super". (Interview, participant 1)

Some participants did however express mixed feelings, stating that the bird appeared too often and that while joyful and fun, EPIOS could also be a tad annoying. As stated by one of the participants:

"Good - and also a little bit annoying. Getting some advice and input here and there was good, but maybe not after every single exercise or question". (Interview, participant 20)

Two of the interviewed participants, based on previous experiences with gaming, suggested having even more "fun" parts included in the program to enhance engagement. One of them stated:

"If you can bring in elements that make you think it's a little bit more fun, then it will be easier to use the app all the time. Because... that's dangerous, you should not become too addicted, but everything that is addictive brings with it a mindset and a thought pattern". (Interview, participant 17)

The obtainable rewards and trophies in EPIO, aiming to praise, were reportedly also perceived as fun and motivating for use and several of the participants described being excited when receiving a trophy, such as the "master of practice" trophy. Others, however, did not express strong opinions about the rewards and trophies, describing them as neither motivating nor discouraging for their EPIO program engagement. Instead, these participants described finding enthusiasm and joy in mastering an exercise or completing aspects of the program, describing this as a reward in itself. As one participant said:

"The reward for me is to feel good afterward, so ... yes. Of course, it feels good to complete a chapter, it does. But that feels good in and of itself, so I do not need trophies. Then, again, people probably differ". (Interview, participant 49)

Helpful reminders and personalization

Most participants reported finding it challenging to use the EPIO program when work or everyday life became stressful or hectic. Some participants described this as somewhat of a conflict between work - family responsibilities and setting aside time or space to engage in the program. As expressed by one participant:

"Lately, I have been very busy in life and at work in general, so it's not been that much. And it's really typical that when you're stressed, that you should use it (laughs a little). Because that is when you feel pain and discomfort and everything ..." (Interview, participant 49)

Participants also expressed wanting to use the EPIO program but not always having the energy due to health conditions (e.g., increased pain) or “high-stress levels”, also describing sometimes finding relaxation and breathing exercises challenging at such times. As one participant said:

“I just thought about the acidification in the muscles - due to short breath, I have not had the time to breathe in day-to-day life. To focus on taking the time to do it, we have so many duties, you know”. (Follow-up phone call, participant 50)

Most participants did however describe the *reminder* function in EPIO as very helpful, stating that being reminded, for example to do reading or exercises at a specific time could be a highly useful feature in a hectic everyday life. As expressed by one participant:

“... but I easily forget to use it so reminders are nice, have to get it into everyday life”. (Interview, participant 34)

Participants also expressed appreciating the option to personalize the content and mark topics and exercises as *my favorites*. That way they could create a list of their favorite aspects of the program, making that content more accessible when needed. They also described appreciating being able to change the favorite content when desired, as their interest and needs changed throughout the program.

A few of the participants also expressed a wish to be able to receive push alerts related to their favorites, and some of the participants described wishing for personal or customized built-in messages such as: *how are you feeling today? And here is one of your favorite exercises.*

The options for personalization were described as valued features, including the option for daily individual registrations (i.e., sleep, rest, activity level, pain or mood), as participants stated that it could be easy to forget previous mood or activities (e.g., what you did yesterday) when living with chronic pain. None of the participants described discovering significant variations in everyday life based on their personal registrations in EPIO, however. Some of the participants described not really caring one way or other about the personal registrations, while others stated that such registrations would only represent a negative focus for them. As expressed by one participant:

“Every time I got those registrations, it's like ... you try to tell yourself that you sleep well every night, you feel good, and things like that ... But then it's like you have to start to notice, and feel, that you are not actually doing so well after all”. (Interview, participant 12)

Coping with pain in everyday life

The participants described the potential role of EPIO when aiming to cope with pain in everyday life as helping increase awareness about pain and the impact of pain, stress and pain self-management, highlighting the need to practice content and exercises often to achieve the desired effect, and pointing to EPIO as something to lean on when dealing with the daily challenges of living with pain. Topics raised were sorted into three sub-themes; awareness, practice and using EPIO.

Awareness

The interviewed participants described how their engagement with the EPIO program had been meaningful to them in many ways, gaining new hope of being able to cope with pain and of living a life with pain in better ways than before. Many of the participants described increased self-awareness of own condition, and of the little things that one can do to make oneself feel better, rather than focusing on the things that one cannot change. As illustrated by one participant:

"Awareness, that's the best word I can use to describe it. Awareness that there are things that can make you feel a little bit better. And it's all about doing things, and not doing things, if you know what I mean?" (Interview, participant 17)

Several of the participants described diaphragmatic breathing as something that had always been a challenge for them, stating that the EPIO program had provided them with increased awareness of what pain and stress could do to their body, and reminded them of the importance of knowing how to calm down through focusing on breathing and deep diaphragmatic breathing. As one participant stated:

"Yes, it has given me this reminder and an attempt at relaxation. So, a reminder, yes, that now you breathe too high in your chest, and now your shoulders are too tense". (Interview, participant 47)

Underlining increased understanding of the importance of stress management, the participants' favorite parts of the program were described to be the breathing and relaxation exercises. One participant stated:

"It has given me exercises to help reduce stress a bit. To let things go, that it's not so important, perhaps, and to breathe with your stomach". (Interview, participant 49)

During the follow-up phone calls and interviews, several participants mentioned that they were already familiar with the type of content found in EPIO, and that they had not necessarily learned a lot of new material. They did however emphasize that the program raised awareness and served as a valuable reminder of all the strategies that can be used to cope with the pain, for example finding a good balance between activity and rest, and being kind to oneself. One participant stated:

"Yes. I think it has been useful in the sense that it increases understanding. Really of what all health professionals you meet say is important, that you have to take small steps and that you have to find a balance between rest and activity ..." (Interview, participant 24)

Practice

Most participants described EPIO as a valuable tool for self-management of chronic pain. They did however highlight the need to practice program exercises often in order to achieve the desired effect, regardless of whether one experienced pain or whether life was hectic. As illustrated by one participant:

"Yes, but then I will be the first to say that then you have to practice, much more than what I have done. Because then you have to, I believe you have to be very determined and use these breathing exercises and

relaxation methods repeatedly. Preferably several times a day, if you get to it and that is my opinion". (Interview, participant 34)

Regarding the 3-day delay between modules in order to encourage practice, most participants stated that they understood the value of this *practice-mode*. They did however express mixed feelings, describing having been somewhat impatient in the beginning, but then experiencing that not rushing through the program made them feel better. Several participants described changes in thoughts and attitudes towards the concept of practice in this process. As one participant said:

"I think it was very good to get to know the exercises ... or the topic at hand. Because then you were forced to go back, and then the exercises that were not so ... well, that did not appeal to you at first ...and then wow, they were great, right? So I actually think I could have missed a lot, so I think it was very nice". (Interview, participant 4)

Using EPIO

Most of the interviewed participants described their use and involvement in EPIO as structured, with a daily routine. Some stated that they preferred to do EPIO exercises in the morning as a way to "wake up tired bodies" and get a positive start to their day, others stated that they enjoyed engaging in relaxation exercises in the evening, while others again reported doing both. Regardless of timing and setting of use, participants described being able to have something to lean on when dealing with the pain as the most important factor. As stated by one participant:

"I think it's very nice to use it in the morning. So that I, in a way, can lean on it, on days when I struggle as the day progresses. That I sort of carry it with me in the back of my mind". (Interview, participant 4)

Most participants described being at home as their favorite place for using EPIO and practicing the material, while a few reported having used EPIO at work during a break, or when traveling. Participants described liking being able to choose between reading and listening, stating that their preferences depended on the situation they were in at the time of practicing. For example, if they wanted to relax, they described it as preferable to lie down on their bed and listen. Most of the participants also stated that being able to concentrate, in quiet surroundings, was very important when engaging with EPIO. As stated by one of the participants:

"I have kind of mainly been at home. That is where I, in a way, can be mostly left alone and do it, in a way, on my own. Because when all of this was new, I did not know what would be next, so I have, in a way, consciously used it at home to be able to concentrate". (Interview, participant 36)

The value of engaging with the EPIO program

Having described central aspects for engaging with EPIO and ways in which EPIO could be used to cope with pain in everyday life, the participants also described additional values of engaging with the EPIO program, including potential benefit of use for many, not just people living with pain. EPIO was also described as a potential "friend" in day-to-day life, and as having the potential to enhance understanding

and self-acceptance for people living with pain, as well as aiding with communication and social support. Topics were sorted into three sub-themes; EPIO - a friend, making peace with the presence of pain, and fostering communication and social support.

EPIO – a friend

When asked if they would recommend EPIO to other people living with chronic pain, most participants said yes, and also stated that they believed that people in general, not just those living with chronic pain, could benefit from using the EPIO program. One participant stated:

“ Well... It kind of, deals with the whole person. With emotions and social network and work tasks and ... well, the total, overall picture. Instead of just focusing on where it hurts right there and then”. (Interview, participant 2)

The participants displayed vulnerability in the interviews, sharing information about their relationships and how it can be very challenging to communicate with friends and family members about their pain. Describing it as easier to withdraw than to talk to people, they stated that living with chronic pain entails a major risk of becoming isolated and uninvolved in social activities. Some of the participants reported perceiving EPIO as “a friend when in need”. They described listening to the voice of the EPIO program, a voice that was perceived as calm and pleasant, and feeling as almost having a real human friend, making them feel less alone. As illustrated by one of the participants:

“If you are in a lot of pain, then you are, in a way, quite alone. And if you are not so good at sharing, describing how you are feeling to others. It's not so acceptable or popular to say that you are in pain and ... well, that things can be a little tough sometimes. People would rather not hear about such things. I have felt that you can withdraw and listen to the soothing voice, and what you can do ... it has given me a break....., and it has provided relaxation”. (Interview, participant 13)

Making peace with the presence of pain

Some of the participants reported that EPIO had provided a better understanding of their own situation living with pain, facilitating self-acceptance, perhaps even pain acceptance. Describing consequently having gained a sense of confidence, these participants expressed a need to make peace with the presence of pain. As described by one participant:

“What is useful with EPIO is to become more ... to achieve a degree of inner peace, in relation to my pain. These are things like ... I will never get rid of my pain, so I have to ... rather than arguing with it all the time, standing on separate sides of a courtyard, fighting, to be a little more in tune. So, becoming better friends with the pain sort of, and work with the pain, not just against it”. (Interview, participant 4)

Participants also reported recognizing the importance of prioritizing themselves and setting aside time for themselves, although recognizing that this might be easier said than done. As one participant stated:

"I have learned to relax; when I have the time (laughs a little). And I have learned various breathing exercises and relaxation methods that I was not familiar with before. And I have learned that you have to take the time, in a stressful everyday life. Even if you are at home, sick, and in pain, you have to prioritize yourself. It is of course so easy to say - not so easy to do". (Interview, participant 34)

Fostering communication and social support

When asked what they thought about receiving a follow-up phone call during the study, most participants stated that they appreciated being able to talk to a member of the research team, someone who had experience with and/or knowledge about the EPIO program and its self-management strategies. Despite the brief nature of the phone call, they reported feeling that the research team cared about them, showing interest in their well-being, and a few of the participants stated that having lived with pain for a long time, it is "rare to receive personal follow-up". One of the participants stated:

"For me personally ... well, you are a bit left to yourself in the health care system. Here, there's actually someone calling. If there is anything my, if we can call it that, patient group needs, it's often to talk to someone. Regardless of what it is. And especially someone who has a certain understanding of what it is you are doing and what it is you are going through". (Follow-up phone call, Participant 17)

A few of the participants reported having used the EPIO program together with their provider (e.g., physiotherapist, psychologist), in group therapy at a rehabilitation center, or with other people who also live with chronic pain. Having shared the use, or experience of use, was described as positive and working with EPIO described as easier due to having the support of another person. One participant stated:

"So, using the app that way is ... and hearing the experiences of others, people I know, who use it, if you know what I mean, it has been very helpful. And then we can discuss and talk about how we... how do you use it, how do I use it. Oh, you think about it that way, and then we go through it a bit....where the information about.... getting to know the pain, and stuff like that, so how we choose to interpret it. That has been very useful". (Interview, participant 10)

A couple of participants also mentioned that family members and friends should consider engaging in EPIO to gain insight into how it is to live with chronic pain, maybe attaining a better understanding and becoming more supportive or at least more informed. As stated by one participant:

"The advantage with that is that you can get an understanding of people who may struggle, even though it's not visible to others. That one becomes more generous perhaps, and more understanding with regards to that part". (Interview, participant 1)

Discussion

The current study examined the experiences of people with chronic pain when engaging with the digital pain self-management intervention program EPIO. Participants described experiencing motivation to learn new ways to self-manage pain, and reported feeling enthusiastic, encouraged and supported by the

program. They also reported being able to incorporate the content of EPIO in support of daily coping, stressed the importance of practice, and portrayed the program as facilitating increased awareness of the many aspects of living with pain. EPIO was also described as being a potential “friend”, fostering acceptance, improved communication and social support, and was referred to as something people in general, not just those living with chronic pain, could benefit from using. The following sections elaborate on these aspects and how an eHealth self-management solution such as EPIO can engage and be of potential value for people living with chronic pain.

Motivation for engagement

Participants in the current study described desire to learn and try something new to better manage their own pain as the main motivation for engaging with the EPIO program. They expressed motivation to take control of their own lives, and wanting to have something, such as coping strategies, to lean on when dealing with the presence of pain in day-to-day life. These findings are in line with existing research stating that people's desire and motivation to self-manage pain often are related to their goals and values (e.g., autonomy), and that engaging with self-management programs is a valued way to maintain a sense of control over life [41, 42]. Findings also show how participants found the EPIO program engaging and motivating for use, fostering enthusiasm and joy. Such positive emotions may also be a motivator for change, engagement and for exercising personal control over their situation [43], as expressed by the participants in the current study.

Digital, app-based programs allow users to control when, where, and how they engage with a program or intervention [44, 45], and the availability and easy access to the EPIO program (i.e., via smartphone or tablet) was highlighted by participants as a motivating factor for engagement. They also emphasized the program content (i.e., educational information and related exercises) as engaging, beneficial and of great value to them, displaying personal initiative and self-guidance with the EPIO program content. This is also in line with existing research showing that when users can identify themselves with the self-management program, their engagement increases [46].

Participants in the current study did however express finding it challenging to prioritize program use during hectic and stressful periods of time, highlighting difficulties setting aside time and mustering energy for practice in parallel with demanding day-to-day activities. The effect of self-management interventions likely stands or falls with practice [47, 48], and participants did recognize this, expressing appreciation for the EPIO program reminder functions and options for personalization of content, underlining the need to practice content and exercises often to achieve the desired effects.

Participants also expressed enthusiasm related to the design features of EPIO. Design features may enhance or regulate people's emotions, behavior and choices regarding self-care [29, 32, 49], and the participants in the current study described positive relations to the program as well as feelings of joy, excitement and curiosity for continued use. Reasoning that if the experience of using a digital solution is a pleasant one, people will be more inclined to continue use and engagement, researchers have proposed

that such affective experiences of design features play an essential role in achieving effectiveness of digital interventions or solutions [18].

As part of the program design, the EPIO program contains obtainable rewards and trophies, aiming to praise and motivate for engagement and use [36]. However, participants in the current study did not describe these features as vital for their engagement with EPIO. Instead, they described mastering exercises or completing steps in the program as rewarding enough. As such, intrinsic motivation appeared prevalent. When people are involved in opportunities that allow for personal initiative and self-guidance, as with the EPIO program, autonomous motivation can thrive, and they are more likely to feel interested and engaged [41]. Self-determination theory [50, 51], centering around motivation based on fulfilling needs for competence, relatedness and autonomy to achieve self-determination, may also shed some light as to why some participants were more motivated by their values than external factors such as praise and rewards. When people are more motivated by their values, interests and enjoyment of behavior change, they tend to stay continually engaged in the self-management process and be more satisfied [41, 42]. This is also of interest for the eHealth adherence/attrition conundrum [16, 26, 27].

The EPIO research project has employed stakeholder involvement throughout all design and development phases [35–37] to ensure vital input for program use, usefulness and usability, as well as for adherence/attrition related aspects of the program [17]. Among key input from end-users (i.e., people living with chronic pain) during the early phases were requests for daily registration options, for example personal daily registrations of sleep, rest, activity, mood and pain [35]. Options that facilitate pain focus, such as daily pain level registrations, are not necessarily in the best interest of living well with chronic pain. However, as the early involved stakeholders expressed strong wishes for these options [35], the opportunity for such registrations were incorporated into the EPIO program [36]. Findings from the current study did however reveal that daily registrations were not perceived as particularly helpful for the participants, with some even describing them as rather demotivating. The pain registration variable was subsequently removed from the EPIO program post pilot study in preparation for the RCT, while the other variables, potentially less destructive to pain self-management, still remain. It is however possible that other aspect than currently included, for example aspects targeting intrinsic motivation or self-regulation, could support motivation for use, engagement and practice as a part of daily registrations.

Digital pain management in everyday life

The participants in the current study described the EPIO program as supporting self-management and coping in their daily life, increasing their awareness about pain and pain self-management, helping find a balance between rest and activity in everyday life, and also pointed to EPIO as a resource to lean on during challenging times. They did however recognize the need to practice strategies with some regularity in order to achieve the desired effect, and also acknowledged the potential challenge with this, stressing the need for diligent and determined use despite day-to-day life obstacles.

Several factors may influence how well people use strategies in a self-management program and how long they stay engaged. For example, self-efficacy, or one's belief that one can utilize the self-

management techniques, may play an important role in this type of engagement [42, 52] and as several participants in the current study described an improved sense of control and self-confidence from the use of EPIO, this may indicate a potential digital self-management - self-efficacy link to be further explored. Self-regulatory capacity, that is, one's capacity to regulate thoughts, emotions and behavior [53, 54] is another factor that may play a role in terms of ability to engage and undertake the necessary practice in a digital self-management setting.

Living with chronic pain entails a multitude of challenges [1] that can make frequent and continuous use of self-management programs and tools complicated and arduous. In the current study, participants reported family issues, time constraints and illnesses as the main reasons when and if they struggled to engage with the program, all known barriers to the use of digital solutions as well as self-management programs in general [24, 48, 55]. However, having attained an increased awareness and experienced desired benefits of at least parts of EPIO (e.g., relaxation exercises), participants also reported being aware of the potential negative impact of stress on pain, breathing and the "mind-body" connection. Being aware of these potential negative consequences appeared to encourage participants in the current study to deal with obstacles in new ways and to continue using the EPIO program. This was for example seen in the perceived importance of breathing exercises as valuable tools for managing high levels of stress and pain, a finding also in line with existing research [56–58].

Additional values engaging with digital pain management interventions such as EPIO

Participants in the current study described EPIO as an intervention program that could be of benefit to people in general, not just those living with chronic pain. They also referred to EPIO as having the potential to help valued people in their life (e.g., friends, family) gain a better understanding, perhaps subsequently becoming more supportive, of those living with chronic pain. This result is in line with existing research indicating that people's desires and motivation to learn self-management of chronic pain also can entail a need for connection and a sense of belonging (e.g., relatedness) [41, 42, 48]. This may also explain why some of the participants chose to share their EPIO use and experiences with others (e.g., health care personnel and peers), as they described opportunities for meaningful interaction and communication. These findings are consistent with existing research indicating that app-based solutions may facilitate valuable discussions between patients and their health care personnel [59]. The fact that participants described sharing the use of EPIO as beneficial, providing a sense of support and making program engagement easier, is also a finding that may be important for the future implementation of digital interventions such as EPIO.

EPIO was also described as a friend, allowing participants to feel less alone in their day-to-day struggles living with pain. This suggests facilitation of a supportive interpersonal aspect, and is also consistent with engagement-related research indicating that users are often willing to engage more and create relations with intervention technology that share features similar to human relationships [60, 61], and such human-technology relationships may increase the perceived meaningfulness of digital interventions

[61]. This also points to the importance of communication and social support, going beyond the technical aspects of digital solutions, highlighting the necessity of taking these factors into account when aiming to foster user engagement [62].

The complexity, demands and challenges of living with chronic pain may lead to a draining of the capacity to self-regulate [53, 54, 63]. Participants in the current study reported that EPIO provided them with a better understanding of their own situation, fostering acceptance. This new understanding and acceptance appeared to have brought with it a wish to make peace with the presence of pain, working *with* the pain rather than against it. Participants also described having realized the importance of prioritizing their own needs and goals in this process, which again allowed them to focus on self-management and self-regulation. Continuing to find ways to help people with chronic pain build or strengthen their self-regulatory capacity and support motivation to engage in pain self-management strategies, such as the EPIO program, appears vital [64].

Finally, there are some indications that eHealth programs may yield better adherence and positive outcomes when combined with in-person support [17, 65–67]. The EPIO intervention program was therefore delivered in a blended-care model (i.e., one in-person introduction session, nine app-based modules, and one follow-up phone call) to support adherence and user engagement. Participants in the current study reported appreciating the contact with the research team, albeit limited, valuing being able to ask questions concerning their use of EPIO and describing generally feeling engaged, supported, and taken seriously. The findings also point to the difficult aspects experienced by many people living with chronic pain; the feeling of being alone and not experiencing being heard, seen or understood [68]. Could digital self-management solutions, such as EPIO, delivered in a simple blended care model entailing some, although minimal, contact with providers, contribute to alleviating some of these substantial challenges for people living with chronic pain?

Strengths and limitations

The current study has a number of limitations. First, the participants in the feasibility pilot-study were recruited through social media and collaborating partners, and it may therefore be assumed that the participants were highly motivated for participation. However, ensuring a balanced group of participants in the interviews (e.g., gender, work status and program progress) allowed insight into a range of participant perceptions and experiences. Second, the first author was involved in analyzing the transcribed data, including creating the coding framework and the organization of themes, which could introduce a risk of researcher bias in the qualitative evaluation. The study did however aim to address this potential bias and assure transparency of data by the inclusion of co-authors and the core research team in the analysis process. Also, the study sample was primarily Caucasian and the feasibility pilot-study participants primarily female, limiting the generalizability of these findings. All participants' input was however assessed together during the analysis, aiming for a varied, rich insight into people's perspectives when engaging with EPIO.

This study also has a number of strengths as aspects of trustworthiness [69] (e.g., credibility, transparency) were well covered. First, the interviews were conducted by research personnel who were not involved in the data analysis, reducing potential research bias. Second, the credibility was assured by describing all steps in the analysis process as thoroughly as possible to allow the reader to follow the logic of the findings. By embedding carefully chosen quotes in the final manuscript, the researchers aimed to give the participants a voice in the outcomes while contributing to the credibility and transparency of the research. Transparency was also assured by method triangulation [70]. Finally, the researchers used several methods of data collection (i.e., notes from follow-up calls and interview transcripts) to gain a comprehensive view of the phenomenon representing changes in the participants' experiences when engaging with the EPIO program.

Future implications

The current study sought to address gaps in the existing literature examining engagement with digital pain self-management interventions, exploring the experiences of people with chronic pain when engaging with EPIO, an app-based pain self-management intervention program. Identified factors of engagement included motivation to learn, design and content fostering joy and enthusiasm, as well as helpful reminders and options for personalization. That positive emotions such as joy and enthusiasm can motivate people to engage in self-management and care supports existing research [43], and future research should examine how positive affect can be strengthened and channeled to further foster engagement with digital solutions. Future explorations of these aspects may also help understand why certain design features (e.g., gamification) work for some but not for others [26, 71]. Given the significant adherence/attrition challenges with digital interventions [24, 26, 27, 72], exploring ways to further cultivate motivation and engagement and support people living with chronic pain overcome barriers for continued use of effective digital self-management programs is crucial.

Social relations and support may be particularly important for the complex nature of self-management processes [73]. The indications that the EPIO program and/or delivery model may have fostered communication and social support, subsequently also impacting engagement in the current study should therefore also be further explored, including as factors for use and for implementation. With the suggestions of improved sense of control and self-confidence following use, future studies should also explore the role of self-regulation and self-efficacy when engaging with such self-management interventions.

Even though EPIO in this study targets chronic pain in general (i.e., not pain condition specific), it should be stressed that “chronic pain” is rarely considered a homogeneous entity, and type, form and degree of pain may differ depending on condition (e.g., fibromyalgia, spinal cord injury, trigeminal neuralgia). EPIO is developed based on recognized CBT/ACT related approaches to general pain self-management, and a degree of beneficial impact could therefore potentially be expected regardless of pain condition type. Considering the heterogeneity of chronic pain, however, future research should strive to explore to potential impact depending on pain condition(s).

It is possible that the simple blended care delivery model employed may have impacted motivation for engagement in the current study. Future research should therefore aim to explore engagement comparing delivery models (e.g., app-based only, simple blended care, more complex blended care etc.) of digital pain self-management interventions. Finally, the current findings showing engagement with EPIO through motivation to learn, enthusiasm and use of personalization, as well as raised awareness and a sense and fostering of support, compliments previous findings examining the system use, perceived usefulness and ease of use of EPIO [38]. The next step, examining the actual efficacy of EPIO in a randomized controlled trial, is currently being conducted.

Conclusion

This qualitative study explored patients' experiences and engagement with EPIO, a digital self-management intervention program for people living with chronic pain. Findings identified valued aspects related to motivation for engagement, showed how people with chronic pain may incorporate such programs into everyday life, and also how such a program may encourage a sense of acceptance, social support and relatedness. These findings highlight vital components encouraging digital program engagement and use in support of self-management for people living with chronic pain.

Abbreviations

ACT: Acceptance and Commitment Therapy

App: Application

CBT: Cognitive Behavioral Therapy

eHealth: Electronic health

Declarations

Ethics approval and consent to participate

The EPIO feasibility pilot study was approved by the Regional Committee for Medical and Health Research Ethics (REK 2018/8911) and by the hospital department for data protection and information security (i.e., Institutional Review Board equivalent) at Oslo University Hospital (PVO 2017/6697) [38]. Written informed consent was obtained from all participants. All methods were carried out in accordance with relevant guidelines and regulations [74].

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and analyzed during the current study are not publicly available due to national and organizational privacy and security regulations, but can be made available from the corresponding author on specific request, if approved by the hospital Department for Data protection and information security at Oslo University Hospital.

Availability of data and materials

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Funding

This study was funded through the Norwegian Research Council (grant number: 256574; principal investigator: Lise Solberg Nes).

Authors` contributions

All co-authors were part of the planning and initiation of the current study, and the core research team (KB, CV, EB, HE, EFN and LSN) executed the study. CV and EFN performed the interviews, while KB and CV conducted qualitative coding and the initial thematic analysis. EB, HE, and LSN contributed to the finalization of themes by providing expertise in eHealth or domain knowledge related to digital pain self-management programs. KB and LSN drafted and revised the manuscript based on comments from the co-authors, first from CV, EB and HE, and then the entire co-author team. All authors reviewed and provided feedback for the manuscript and approved the final manuscript.

Acknowledgements

The authors would like to thank the patients who were willing to participate in these individual interviews. Without their time and input, there would be no such research. The authors would also like to thank the research project team members, including the content development group and the design and software team at the Department of Digital Health Research at Oslo University Hospital, for their continued dedication and commitment to the EPIO research project.

References

1. Breivik H, Eisenberg E, O'Brien T: **The individual and societal burden of chronic pain in Europe: the case for strategic prioritisation and action to improve knowledge and availability of appropriate care.** *BMC Public Health* 2013, **13**(1):1229.
2. Joypaul S, Kelly F, McMillan SS, King MA: **Multi-disciplinary interventions for chronic pain involving education: A systematic review.** *PLoS One* 2019, **14**(10):e0223306.
3. Allegrante JP, Wells MT, Peterson JC: **Interventions to Support Behavioral Self-Management of Chronic Diseases.** *Annu Rev Public Health* 2019, **40**:127–146.
4. Mills SEE, Nicolson KP, Smith BH: **Chronic pain: a review of its epidemiology and associated factors in population-based studies.** *Br J Anaesth* 2019, **123**(2):e273-e283.
5. Veehof MM, Trompetter HR, Bohlmeijer ET, Schreurs KM: **Acceptance- and mindfulness-based interventions for the treatment of chronic pain: a meta-analytic review.** *Cogn Behav Ther* 2016, **45**(1):5–31.
6. Knoerl R, Lavoie Smith EM, Weisberg J: **Chronic Pain and Cognitive Behavioral Therapy: An Integrative Review.** *West J Nurs Res* 2016, **38**(5):596–628.
7. Williams ACC, Fisher E, Hearn L, Eccleston C: **Psychological therapies for the management of chronic pain (excluding headache) in adults.** *Cochrane Database Syst Rev* 2020, **8**:CD007407.
8. Eccleston C, Crombez G: **Advancing psychological therapies for chronic pain.** *F1000Res* 2017, **6**:461.
9. Moman RN, Dvorkin J, Pollard EM, Wanderman R, Murad MH, Warner DO, Hooten WM: **A Systematic Review and Meta-analysis of Unguided Electronic and Mobile Health Technologies for Chronic Pain- Is It Time to Start Prescribing Electronic Health Applications?** *Pain Med* 2019, **20**(11):2238-2255.
10. Lee JA, Choi M, Lee SA, Jiang N: **Effective behavioral intervention strategies using mobile health applications for chronic disease management: a systematic review.** *BMC Med Inform Decis Mak* 2018, **18**(1):12.
11. Eccleston C, Fisher E, Brown R, Craig L, Duggan GB, Rosser BA, Keogh E: **Psychological therapies (Internet-delivered) for the management of chronic pain in adults.** *Cochrane Database of Systematic Reviews* 2014(2).
12. Buhrman M, Gordh T, Andersson G: **Internet interventions for chronic pain including headache: A systematic review.** *Internet Interv* 2016, **4**:17–34.
13. Knoerl R, Lavoie Smith EM, Weisberg J: **Chronic Pain and Cognitive Behavioral Therapy: An Integrative Review.** *Western Journal of Nursing Research* 2016, **38**(5):596–628.
14. Russell L, Ugalde A, Milne D, Austin D, Livingston PM: **Digital Characteristics and Dissemination Indicators to Optimize Delivery of Internet-Supported Mindfulness-Based Interventions for People With a Chronic Condition: Systematic Review.** *JMIR Ment Health* 2018, **5**(3):e53.
15. Thurnheer SE, Gravestock I, Pichierri G, Steurer J, Burgstaller JM: **Benefits of Mobile Apps in Pain Management: Systematic Review.** *JMIR Mhealth Uhealth* 2018, **6**(10):e11231.
16. Enam A, Torres-Bonilla J, Eriksson H: **Evidence-Based Evaluation of eHealth Interventions: Systematic Literature Review.** *J Med Internet Res* 2018, **20**(11):e10971.

17. Talboom-Kamp EPWA, Verdijk NA, Kasteleyn MJ, Numans ME, Chavannes NH: **From chronic disease management to person-centered eHealth; a review on the necessity for blended care.** *Clinical eHealth* 2018, **1**(1):3–7.
18. Ludden GD, van Rompay TJ, Kelders SM, van Gemert-Pijnen JE: **How to Increase Reach and Adherence of Web-Based Interventions: A Design Research Viewpoint.** *J Med Internet res* 2015, **17**(7):e172.
19. van Gemert-Pijnen JE, Nijland N, van Limburg M, Ossebaard HC, Kelders SM, Eysenbach G, Seydel ER: **A holistic framework to improve the uptake and impact of eHealth technologies.** *J Med Internet Res* 2011, **13**(4):e111.
20. Varsi C, Solberg Nes L, Kristjansdottir OB, Kelders SM, Stenberg U, Zangi HA, Borosund E, Weiss KE, Stubhaug A, Asbjornsen RA *et al*: **Implementation Strategies to Enhance the Implementation of eHealth Programs for Patients With Chronic Illnesses: Realist Systematic Review.** *J Med Internet Res* 2019, **21**(9):e14255.
21. Devan H, Godfrey HK, Perry MA, Hempel D, Saipé B, Hale L, Grainger R: **Current practices of health care providers in recommending online resources for chronic pain self-management.** *J Pain Res* 2019, **12**:2457–2472.
22. Yardley L, Morrison L, Bradbury K, Muller I: **The person-based approach to intervention development: application to digital health-related behavior change interventions.** *J Med Internet Res* 2015, **17**(1):e30.
23. Yardley L, Spring BJ, Riper H, Morrison LG, Crane DH, Curtis K, Merchant GC, Naughton F, Blandford A: **Understanding and Promoting Effective Engagement With Digital Behavior Change Interventions.** *Am J Prev Med* 2016, **51**(5):833–842.
24. Barelló S, Triberti S, Graffigna G, Libreri C, Serino S, Hibbard J, Riva G: **eHealth for Patient Engagement: A Systematic Review.** *Front Psychol* 2015, **6**:2013.
25. Perski O, Blandford A, West R, Michie S: **Conceptualising engagement with digital behaviour change interventions: a systematic review using principles from critical interpretive synthesis.** *Transl Behav Med* 2017, **7**(2):254–267.
26. Kelders SM, van Zyl LE, Ludden GDS: **The Concept and Components of Engagement in Different Domains Applied to eHealth: A Systematic Scoping Review.** *Front Psychol* 2020, **11**:926.
27. van Gemert-Pijnen L, Kelders SM, Kip H, Sanderman R: **eHealth Research, Theory and Development,** 1st ed. edn: Routledge; 2018.
28. Sieverink F, Kelders SM, van Gemert-Pijnen JE: **Clarifying the Concept of Adherence to eHealth Technology: Systematic Review on When Usage Becomes Adherence.** *J Med Internet Res* 2017, **19**(12):e402.
29. Kelders SM, Kok RN, Ossebaard HC, Van Gemert-Pijnen JE: **Persuasive system design does matter: a systematic review of adherence to web-based interventions.** *J Med Internet Res* 2012, **14**(6):e152.
30. Asbjornsen RA, Smedsrod ML, Solberg Nes L, Wentzel J, Varsi C, Hjelmessaeth J, van Gemert-Pijnen JE: **Persuasive System Design Principles and Behavior Change Techniques to Stimulate Motivation**

- and Adherence in Electronic Health Interventions to Support Weight Loss Maintenance: Scoping Review.** *J Med Internet Res* 2019, **21**(6):e14265.
31. Asbjornsen RA, Wentzel J, Smedsrod ML, Hjelmesaeth J, Clark MM, Solberg Nes L, Van Gemert-Pijnen J: **Identifying Persuasive Design Principles and Behavior Change Techniques Supporting End User Values and Needs in eHealth Interventions for Long-Term Weight Loss Maintenance: Qualitative Study.** *J Med Internet Res* 2020, **22**(11):e22598.
 32. Wei Y, Zheng P, Deng H, Wang X, Li X, Fu H: **Design Features for Improving Mobile Health Intervention User Engagement: Systematic Review and Thematic Analysis.** *J Med Internet Res* 2020, **22**(12):e21687.
 33. Short CE, DeSmet A, Woods C, Williams SL, Maher C, Middelweerd A, Muller AM, Wark PA, Vandelandotte C, Poppe L *et al*: **Measuring Engagement in eHealth and mHealth Behavior Change Interventions: Viewpoint of Methodologies.** *J Med Internet Res* 2018, **20**(11):e292.
 34. Lupton D: **The digitally engaged patient: Self-monitoring and self-care in the digital health era.** *Social Theory & Health* 2013, **11**(3):256–270.
 35. Ledel Solem IK, Varsi C, Eide H, Kristjansdottir OB, Mirkovic J, Borosund E, Haaland-Overby M, Heldal K, Schreurs KM, Waxenberg LB *et al*: **Patients' Needs and Requirements for eHealth Pain Management Interventions: Qualitative Study.** *J Med Internet Res* 2019, **21**(4):e13205.
 36. Ledel Solem IK, Varsi C, Eide H, Kristjansdottir OB, Borosund E, Schreurs KMG, Waxenberg LB, Weiss KE, Morrison EJ, Haaland-Overby M *et al*: **A User-Centered Approach to an Evidence-Based Electronic Health Pain Management Intervention for People With Chronic Pain: Design and Development of EPIO.** *J Med Internet Res* 2020, **22**(1):e15889.
 37. Varsi C, Ledel Solem IK, Eide H, Børøsund E, Kristjansdottir OB, Heldal K, Waxenberg LB, Weiss KE, Schreurs KMG, Morrison EJ *et al*: **Health care providers' experiences of pain management and attitudes towards digitally supported self-management interventions for chronic pain: a qualitative study.** *BMC Health Services Research* 2021, **21**(1).
 38. Bostrom K, Borosund E, Varsi C, Eide H, Flakk Nordang E, Schreurs KM, Waxenberg LB, Weiss KE, Morrison EJ, Cvancarova Smastuen M *et al*: **Digital Self-Management in Support of Patients Living With Chronic Pain: Feasibility Pilot Study.** *JMIR Form Res* 2020, **4**(10):e23893.
 39. Braun V, Clarke V: **Using thematic analysis in psychology.** *Qualitative Research in Psychology* 2006, **3**(2):77–101.
 40. Braun V, Clarke V: **Reflecting on reflexive thematic analysis.** *Qualitative Research in Sport, Exercise and Health* 2019, **11**(4):589–597.
 41. Eassey D, Reddel HK, Ryan K, Smith L: **'It is like learning how to live all over again' A systematic review of people's experiences of living with a chronic illness from a self-determination theory perspective.** *Health Psychology and Behavioral Medicine* 2020, **8**(1):270–291.
 42. Peters D, Calvo RA, Ryan RM: **Designing for Motivation, Engagement and Wellbeing in Digital Experience.** *Front Psychol* 2018, **9**:797.

43. Løvoll HS, Røysamb E, Vittersø J, Zourbanos N: **Experiences matter: Positive emotions facilitate intrinsic motivation.** *Cogent Psychology* 2017, **4**(1).
44. Whitehead L, Seaton P: **The Effectiveness of Self-Management Mobile Phone and Tablet Apps in Long-term Condition Management: A Systematic Review.** *J Med Internet Res* 2016, **18**(5):e97.
45. Kim YH, Kim DJ, Wachter K: **A study of mobile user engagement (MoEN): Engagement motivations, perceived value, satisfaction, and continued engagement intention.** *Decision Support Systems* 2013, **56**:361–370.
46. Donkin L, Glozier N: **Motivators and motivations to persist with online psychological interventions: a qualitative study of treatment completers.** *J Med Internet Res* 2012, **14**(3):e91.
47. Mann EG, Lefort S, Vandenkerkhof EG: **Self-management interventions for chronic pain.** *Pain Manag* 2013, **3**(3):211–222.
48. Devan H, Hale L, Hempel D, Saipé B, Perry MA: **What Works and Does Not Work in a Self-Management Intervention for People With Chronic Pain? Qualitative Systematic Review and Meta-Synthesis.** *Physical Therapy* 2018, **98**(5):381–397.
49. Nurul Ulfa Abdul Aziz¹ NHMR, Suzila Mat Salleh¹, Nurulnadwan Aziz³: **Persuasive Technology in Intervention Programs for Health Issues: A Comparative Review.** *J Appl Environ Biol Sci* 2017.
50. Gunasekare ULTP: **Self Determination Theory (SDT): a review on SDT as a Complementary Theory of Motivation.** *Kelaniya Journal of Human Resource Management* 2016, **11**(1).
51. Legault L: **Self-Determination Theory.** In: *Encyclopedia of Personality and Individual Differences.* edn.; 2017: 1-9.
52. Ankawi B, Kerns RD, Edmond SN: **Enhancing Motivation for Change in the Management of Chronic Painful Conditions: a Review of Recent Literature.** *Curr Pain Headache Rep* 2019, **23**(10):75.
53. Solberg Nes L, Roach AR, Segerstrom SC: **Executive functions, self-regulation, and chronic pain: a review.** *Ann Behav Med* 2009, **37**(2):173–183.
54. Nes LS, Carlson CR, Crofford LJ, De Leeuw R, Segerstrom SC: **Self-regulatory deficits in fibromyalgia and temporomandibular disorders.** *Pain* 2010, **151**(1):37–44.
55. Dwarswaard J, Bakker EJ, Staa A, Boeije HR: **Self-management support from the perspective of patients with a chronic condition: a thematic synthesis of qualitative studies.** *Health Expectations* 2015.
56. Jafari H, Courtois I, Van den Bergh O, Vlaeyen JWS, Van Diest I: **Pain and respiration: a systematic review.** *Pain* 2017, **158**(6):995–1006.
57. Hopper SI, Murray SL, Ferrara LR, Singleton JK: **Effectiveness of diaphragmatic breathing for reducing physiological and psychological stress in adults: a quantitative systematic review.** *JBI Database System Rev Implement Rep* 2019, **17**(9):1855–1876.
58. Zaccaro A, Piarulli A, Laurino M, Garbella E, Menicucci D, Neri B, Gemignani A: **How Breath-Control Can Change Your Life: A Systematic Review on Psycho-Physiological Correlates of Slow Breathing.** *Front Hum Neurosci* 2018, **12**:353.

59. Vo V, Auroy L, Sarradon-Eck A: **Patients' Perceptions of mHealth Apps: Meta-Ethnographic Review of Qualitative Studies.** *JMIR Mhealth Uhealth* 2019, **7**(7):e13817.
60. Doherty K, Doherty G: **Engagement in HCI.** *ACM Computing Surveys* 2019, **51**(5):1–39.
61. Duggan GB: **Applying psychology to understand relationships with technology: from ELIZA to interactive healthcare.** *Behaviour & Information Technology* 2016, **35**(7):536–547.
62. Jacob C, Sanchez-Vazquez A, Ivory C: **Social, Organizational, and Technological Factors Impacting Clinicians' Adoption of Mobile Health Tools: Systematic Literature Review.** *JMIR Mhealth Uhealth* 2020, **8**(2):e15935.
63. Hamilton NA, Karoly P, Kitzman H: **Self-Regulation and Chronic Pain: The Role of Emotion.** *Cognitive Therapy and Research* 2004, **28**(5):559–576.
64. Huygens MW, Vermeulen J, Swinkels IC, Friele RD, van Schayck OC, de Witte LP: **Expectations and needs of patients with a chronic disease toward self-management and eHealth for self-management purposes.** *BMC Health Serv Res* 2016, **16**:232.
65. Gogovor A, Visca R, Auger C, Bouvrette-Leblanc L, Symeonidis I, Poissant L, Ware MA, Shir Y, Viens N, Ahmed S: **Informing the development of an Internet-based chronic pain self-management program.** *Int J Med Inform* 2017, **97**:109–119.
66. Borosund E, Varsi C, Clark MM, Ehlers SL, Andrykowski MA, Sleveland HRS, Bergland A, Nes LS: **Pilot testing an app-based stress management intervention for cancer survivors.** *Transl Behav Med* 2020, **10**(3):770–780.
67. Borosund E, Ehlers SL, Varsi C, Clark MM, Andrykowski MA, Cvancarova M, Solberg Nes L: **Results from a randomized controlled trial testing StressProffen; an application-based stress-management intervention for cancer survivors.** *Cancer Med* 2020, **9**(11):3775–3785.
68. Andersen LN, Kohberg M, Juul-Kristensen B, Herborg LG, Sogaard K, Roessler KK: **Psychosocial aspects of everyday life with chronic musculoskeletal pain: A systematic review.** *Scand J Pain* 2014, **5**(2):131–148.
69. Raskind IG, Shelton RC, Comeau DL, Cooper HLF, Griffith DM, Kegler MC: **A Review of Qualitative Data Analysis Practices in Health Education and Health Behavior Research.** *Health Educ Behav* 2019, **46**(1):32–39.
70. Casey D, Murphy K: **Issues in using methodological triangulation in research.** *Nurse Res* 2009, **16**(4):40–55.
71. Peng W, Kanthawala S, Yuan S, Hussain SA: **A qualitative study of user perceptions of mobile health apps.** *BMC Public Health* 2016, **16**(1):1158.
72. Simblett S, Matcham F, Siddi S, Bulgari V, Barattieri di San Pietro C, Hortas Lopez J, Ferrao J, Polhemus A, Haro JM, de Girolamo G *et al*: **Barriers to and Facilitators of Engagement With mHealth Technology for Remote Measurement and Management of Depression: Qualitative Analysis.** *JMIR Mhealth Uhealth* 2019, **7**(1):e11325.
73. Szinay D, Perski O, Jones A, Chadborn T, Brown J, Naughton F: **Perceptions of factors influencing engagement with health and wellbeing apps: a qualitative study using the COM-B model and**

Figures

Figure 1

Figure 2

Identified main topics and sub-themes, related to participants' experiences when engaging with the EPIO intervention program

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [MultimediaAppendix1.docx](#)