Feasibility, Retention and User Experience in a Behavior Change Support System for Digital Addictions

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Abstract

As digital technologies become increasingly embedded in our everyday lives, digital addictions are frequently discussed as one of the prominent aspects of this relationship. Nevertheless, research targeting this issue has been examined only to a limited extent from the perspective of information systems. For this reason, we developed Recovio, a mobile Behavior Change Support System (mBCSS) grounded in the Persuasive Systems Design (PSD) framework, and piloted it with 18 university students to evaluate its feasibility, retention, and user experience. Among the participants who received the intervention, retention was 85.7% at week 1 and 64.3% at week 4. Participants who dropped out tended to have higher baseline digital addiction scores and lower baseline self-efficacy scores. Qualitative analysis revealed that participants found Recovio informative and supportive, while identifying daily check-ins and goal setting as areas needing improvement. These findings provide a practical foundation for Recovio and our study protocol, while informing the design of future behavior change support systems for digital addictions.

Keywords

Behavior Change Support Systems, Persuasive Systems Design, Digital Addictions, Thematic Analysis, mHealth

1. Introduction

The affordances that technology adds to our everyday lives are also making it increasingly indispensable. Yet, the relationship between technology and us is not always positive. In some cases, it can easily spiral out of control and take a more negative turn. One important example of this phenomenon is digital addictions. Digital addictions, as an umbrella term, refer to maladaptive relationships that individuals establish with digital technologies, including digital devices, applications, and online platforms. Every individual may experience difficulties in controlling their interaction with technology. However, continuing this relationship despite the negative psychological, social, and functional consequences may lay a groundwork for conceptualizing the situation as an addiction [1, 2].

A large number of people worldwide are affected by digital addictions and its subtypes. For example, a global prevalence of 6% to 27% was estimated for internet addiction, game addiction, smartphone addiction, social media addiction, and cybersex addiction [3]. Another study found a global average of 7.02% for generalized internet addiction, while they are reporting 2.47% prevalence for internet gaming disorder [4]. In addition to the general population, 18.7% of university students were estimated to have social media addiction globally [5]. This situation, on the other hand, is not formally defined as a comprehensive diagnostic category in the two widely used diagnostic classification systems, ICD-11 and DSM-5. Diagnoses directly related to digital addictions are limited to "internet gaming disorder" in DSM-5 Section III and gaming disorder in ICD-11 [6, 7]. In this regard, this study does not approach digital addictions as a disease diagnosis, but rather accepts it as a conceptual framework aimed at understanding the problematic relationship individuals establish with digital technologies.

Considering the place of technology in our lives, we also see it as an important opportunity to be used as an intervention tool in improving this pattern. Digital interventions may help in working with digital addictions, especially in terms of reducing screen time, addiction symptoms, and promoting

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healthier digital habits [8, 9, 10]. However, despite the promising findings, further research is suggested to understand how digital interventions can effectively support healthier digital habits and how users perceive and engage with these systems [11, 12, 10]. To address this gap, we designed and developed a mobile Behavior Change Support System (mBCSS) named "Recovio" by aiming to explore the information systems point of view of this situation [13].

In this pilot study, we aim to identify potential issues before they emerge in a larger-scale study by evaluating the acceptability and feasibility of our approach. We observe individuals' interaction with the application over time, as well as their preliminary findings that could be associated with digital addictions. One of the key focal points of this study is our information systems perspective. We explore how individuals understand and perceive the application they used, rather than directly testing the effectiveness of the intervention. The application, developed using the Persuasive Systems Design (PSD) framework, will also be evaluated in line with the framework itself, and the findings will both form a roadmap for the main study and offer a new perspective to the digital addiction intervention literature [14, 13].

2. Theoretical Background

2.1. Persuasive Systems Design

The PSD model is a structured framework for designing and analyzing systems with persuasive aims. It conceptualizes the persuasive systems in three steps: understanding the key issues behind, analyzing the persuasion context, and designing the system qualities. According to [14], while designing or evaluating a persuasive system, one needs to address how they see users in general, the persuasion strategies within the system, and actual system features. In this context, PSD specifically helps designers and researchers to understand the information processing event by exploring the persuader, change type, use, user, and technology contexts, message, and the route of the system developed. It also organizes these principles in four categories of persuasive features: Primary Task Support, Dialogue Support, System Credibility Support, and Social Support.

In this specific "digital addiction" context, using the PSD framework was particularly important because of the dilemma of using an online intervention for digital addictions [15, 16]. PSD accepts information technology as "never neutral", and emphasizes the importance of openness and usefulness in persuasive systems. In this regard, it was a suitable choice especially for creating a system without coercing the users or relying on manipulative design practices and providing an ethical approach to handling this dilemma [14, 13].

2.2. Digital Addictions

The literature does not have a consensus on how to define digital addictions [1, 2]. Instead, every study adopts its own perspective and uses different terms to describe the interaction with digital technologies. Some concepts emphasize the "online" context by using the terms such as internet addiction, internet use disorder, or problematic use of internet, while others take a more behavior specific approach by focusing on, for example, gaming or shopping [17, 18, 19, 20, 21, 22]. There is also a device-oriented approach using terms of smartphone addiction or computer addiction [23, 24]. However, from an information systems perspective, we adopt the digital addictions term since it is more inclusive. It does not restrict the phenomenon we describe to a single object like a smartphone, a platform like social media, or a behavior like gaming. It lets us explore both online and offline aspects of the engagement while also making it possible to explore the device oriented point of view.

3. Methods

3.1. Study Design and Setting

This research is a pilot study exploring "Recovio", an application designed for individuals struggling with their digital use [16]. It is a single-arm repeated measures design over 4 weeks with assessments at baseline, week 1, and week 4. Throughout the study, the ethical principles of Finnish National Board on Research Integrity TENK were followed. Also, the findings were reported by using the Consolidated Standards of Reporting Trials (CONSORT) extension for pilot and feasibility trials [25].

The participants of the study were university students at the University of Oulu in Finland. They were recruited through in-person classroom visits and university-wide poster advertisements using convenience sampling [26]. To increase the variation by year, classrooms from each year were visited to invite students to participate in the pilot study. The inclusion criteria were being willing to use the application for 4 weeks, having an Android mobile phone, and being able to use the application in English. The target sample size was 18, with 30% attribution rate added to the minimum required sample size of 12 [27].

In the classroom visits, a short presentation explaining the application and the pilot study was given. At the end of each presentation, students were directed to the online recruitment page through an enrollment link and a QR code, where they would fill in their information and provide consent. The presentations are also shared in the online learning environments of the courses. When a person provides their consent and fits the research's inclusion criteria, the baseline questionnaire link is sent by the researchers through email. After the baseline questionnaires were filled out, the participants received another email including login credentials and a brief explanation on downloading the application. Upon first logging in, the participants received onboarding on how to use the application as well. All the survey replies were collected using the online survey creation and collection tool, Webropol 3.0. Also, log data was collected from the application itself.

3.2. The Recovio Application

After onboarding was completed, participants started using the Recovio. The application was designed in a way that leads participants throughout their journey within its five main sections: "Home", "Check-in", "Community", "Education", and "Profile". In the "Home" section, users see which step they are in, their daily streak, a motivational quote related to the step, daily tasks, and simulation and rehearsal exercises. In the "Check-in" page, participants were asked to log their data related to their mood, emotional states, screentime, craving, and goals daily, so they can monitor their perceived change. In the "Community" section, participants are able to post digital use related content. In the "Education" section, there are 28 steps of psychoeducation modules where participants can read about digital habits. Finishing all 28 psychoeducation modules takes at least 28 days, as they are unlocked daily if the participant completes tasks and reads the day's psychoeducation. Motivational quotes and tasks evolve according to the step the user is in on that day. Lastly, in the "Profile" section, participants can see their "badges" that they earn from their success within the application such as completing onboarding, streaks, finishing the first week, and so on.

3.3. Assessments

To assess the feasibility and acceptability of the study, we examined recruitment rate, onboarding completion, retention, follow-up completion, app engagements, and adherence. We also collected preliminary outcomes of the future main study including digital addiction levels, well-being levels, self-efficacy levels, and how they perceive the application.

The participants were expected to fill in the questionnaires of the Internet Addiction Test (IAT), The World Health Organization-Five Well-Being Index (WHO-5), the General Self-Efficacy Scale (GSE), and Behavior Change Support System (BCSS) [22, 28, 29]. Also, sociodemographic and study-relevant background information were collected. In addition to baseline questionnaires, participants also filled

in the PSD questionnaire at the end of week 1 and week 4. This questionnaire was not included at the baseline, since participants cannot answer questions related to the application before using it. Lastly, at the end of the study, participants were also asked the open-ended question of "If a friend asked what this app does well (and not so well), what would you say?" to understand the application's usability and acceptability better and explore potential improvements focused on the application's components.

3.4. Data Analysis

Quantitative data were analyzed by using descriptive analyses. Continuous variables such as retention and attrition rates, data completeness, and questionnaire outcomes were reported by using median, interquartile ranges (IQR), ranges, and percentages due to the exploratory nature of the pilot study. For the qualitative data, six steps of thematic analysis from [30] were used. Firstly, two researchers familiarized themselves with the data. After noting initial ideas, they independently generated initial codes. These initial codes were then discussed between researchers to reach consensus codes. After that, they searched, reviewed, and named the themes. Finally, one researcher reported the findings with the contributions of the second researcher.

4. Results

4.1. Pilot Feasibility

4.1.1. Participant Flow

Approximately 380 students were reached through class presentations in addition to poster advertisements. In total, 26 students were assessed for their eligibility. One person did not meet the inclusion criteria of having an Android smartphone. Additionally, 7 individuals filled out the recruitment form but did not fill in the baseline questionnaires. In the allocation phase, there were 18 participants who were successfully recruited and completed the baseline questionnaires. Out of 18 participants, 4 participants filled out the baseline surveys but did not download or complete the onboarding in the application, so these participants did not receive the intervention. In total, 14 people successfully downloaded and completed the onboarding to the application. During the follow-up, 5 participants did not provide week 1 and week 4 data in total: 2 participants dropped out at week 1, and 3 participants dropped out at week 4. In the end, we analyzed 18 participants' baseline data, 12 participants' week 1 data, and 9 participants' week 4 data (See Figure 1).

4.1.2. Retention and Follow-Up

Among the participants who received the intervention (n=14), the retention was 85.7% at week 1 and 64.3% at week 4. Corresponding cumulative attrition was 14.3% by week 1 and 35.7% by week 4. There was an additional 25% loss between week 1 and week 4. When we used all allocated participants, including the ones who filled the baseline surveys but did not download the application or complete the onboarding, the week 1 retention rate was 66.66%, and the week 4 retention rate was 50%.

4.1.3. Data Completeness

At baseline, median response time for filling out the questionnaires was 12.45 minutes (N=18). For 12 participants at week 1, it was 13.50 minutes, and for 9 participants at week 4, it was 20.27 minutes. The increase at week 4 response time was possibly because of the new qualitative question introduced. On the other hand, data completeness was high across all scales and time points. Among the submitted responses, the completed survey rate changed between 75%–100%. Also, the item level completeness remained around 97.77%–100% across scales. Overall, missingness was minimal and did not indicate any data quality concerns.

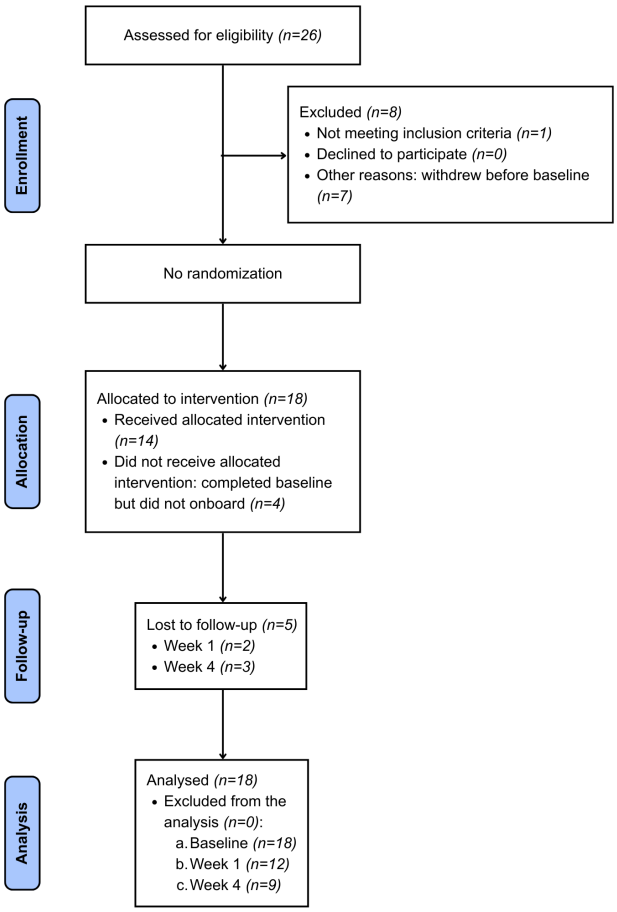


Figure 1: CONSORT Flow Diagram Adapted for Pilot Study

4.1.4. Technical Issues

Throughout the study, 6 participants reported technical issues related to the application. Four participants experienced a problem with their login credentials. They reported that they get an error saying their login credentials are incorrect and they are not able to start using the application. Also, a participant experienced an issue with giving permission to the app when they tried to install it. Lastly, another participant had a problem with installing the app in their phone due to the expired download link. Researchers handled the problems on the same day as reporting.

4.2. Comparison of Completers and Dropouts

4.2.1. Baseline Characteristics

We carried out a descriptive analysis for exploring demographic profile and baseline characteristic distribution of our sample group. Overall, 50% of the participants were female. Particularly among completers, 55% were female, 45% were male. Also, 71% of the participants were Bachelor's degree students, while 50% of them spoke Finnish as their native language. Lastly, 83% of the participants were living with their family, partner, friends, or in shared apartments, while 17% were living alone. Below, we also present the baseline characteristics of participants by their completion status in Table 1 using median values with Q1 and Q3.

Age was similar between completers (26.0) and dropouts (25.5). The largest visible difference was

Table 1
Baseline Characteristics by Completion Status, Median (Q1 to Q3)

	Total (N=18)	Completers (n=9)	Dropouts (n=9)
Age	26.0 (21.0 to 31.0)	26.0 (21.0 to 35.0)	25.5 (22.5 to 28.0)
IAT	39.0 (25.0 to 45.0)	36.0 (34.0 to 38.0)	46.0 (40.0 to 48.0)
WHO-5	16.0 (12.3 to 18.0)	14.0 (11.0 to 16.0)	16.0 (16.0 to 18.0)
GSE	32.0 (28.3 to 35.0)	32.0 (31.0 to 37.0)	29.0 (28.0 to 35.0)
Motivation	7.0 (5.0 to 7.75)	7.0 (5.0 to 7.0)	7.0 (5.0 to 8.0)
Confidence	5.5 (4.3 to 7.0)	5.0 (5.0 to 7.0)	6.0 (3.0 to 7.0)
Willingness	5.0 (5.0 to 5.0)	5.0 (5.0 to 5.0)	5.0 (4.0 to 5.0)
Screentime	10.5 (8.1 to 11.8)	11.0 (7.0 to 11.0)	10.0 (8.5 to 13.0)

observed in IAT scores. The dropout group had higher IAT scores (46.0) than the completer group (36.0). WHO-5 (16.0) and confidence (6.0) scores were also higher in the dropout group. On the other hand, GSE (32.0) and screentime (11.0) scores were higher in the completer group.

4.2.2. Application Use

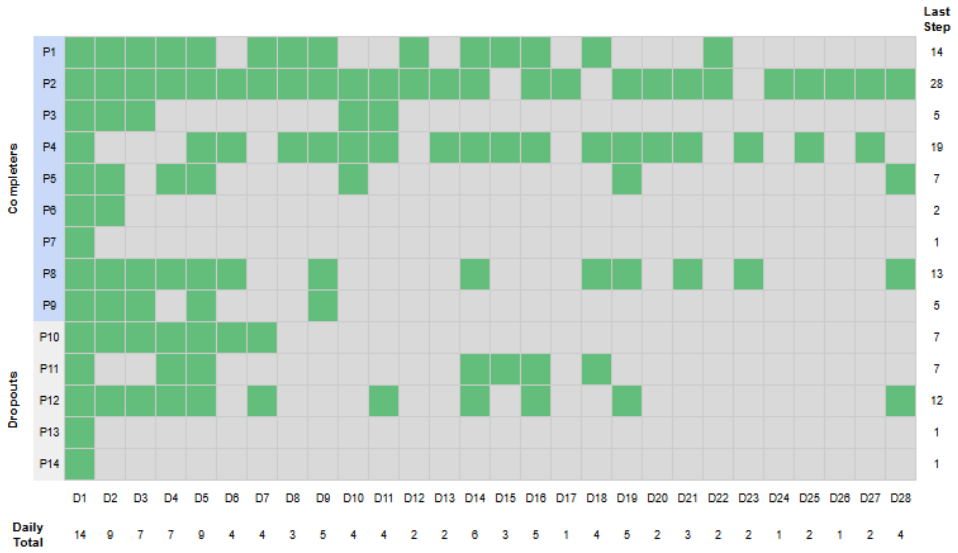


Figure 2: Daily App Activity Across 28 Day Period.

Overall, 14 participants generated 117 days of app activity across 28 days period. Median active days were 7 with a range of 1 to 25. In general, activity was highest at the start of the study, and started declining after Day 5. Fourteen participants were active 54 times in the first week. Week 2 (26) and Week 3 (23) total session numbers were close to each other, but in the last week (14), a dramatic decline was observed. Both completers and dropouts were relatively active in the first week of the study. Completers showed more sustained use over time, with 4 participants remaining active across later study days. On the other hand, 1 participant in the dropout group used the application throughout the study but did not fill out the Week 4 surveys. Also, 1 participant in the completer group only completed their first tasks and daily check-in, and stopped using the application even if they filled out the surveys throughout the study (See Figure 2).

When we look at the in-app engagements, all onboarded participants completed the first day check-in and tasks. Out of 14 onboarded participants, 9 used rehearsal and simulation exercises at least once. 78% of 9 completers (n=7) used exercises, while 40% of 5 dropouts (n=2) were using them. Particularly, 8 participants used simulation exercises, and 5 participants used rehearsal exercises. Only 4 participants

used both simulation and rehearsal exercises. Additionally, 56% of 9 completers (n=5) and 40% of 5 dropouts (n=2) interacted with the community section at least once. Specifically, 3 people posted, 6 people commented, and 5 people used reactions in the community section. In total, participants interacted 17 times with the community section. Lastly, 77% of completers (n=7) and 60% of dropouts (n=3) wrote their life stories, with overall of 10 participants.

4.3. Qualitative Analysis

At Week 4, participants were asked to provide feedback on what Recovio does well and not so well. All 9 completers provided feedback with 922 words in total. The median response length was 57 words ranging from 8 to 421. In the thematic analysis conducted 4 recurring themes were identified: "Overall Value", "Daily Check-in", "Goal Setting", and "General Improvement Suggestions".

The overall value theme was the most common theme, with 8 participants mentioning it. Participants described the application as "supportive" and "good" overall, and emphasized that its content, self-monitoring, and exercises were useful (P2, P4, P5, P8). For example, one participant specifically noted that "the system gives useful advice and keeps a track of my emotions pretty accurately" (P4). Also, they mentioned that "it gives a lot of good information" (P1), and "it has lots of interesting features and information" (P8).

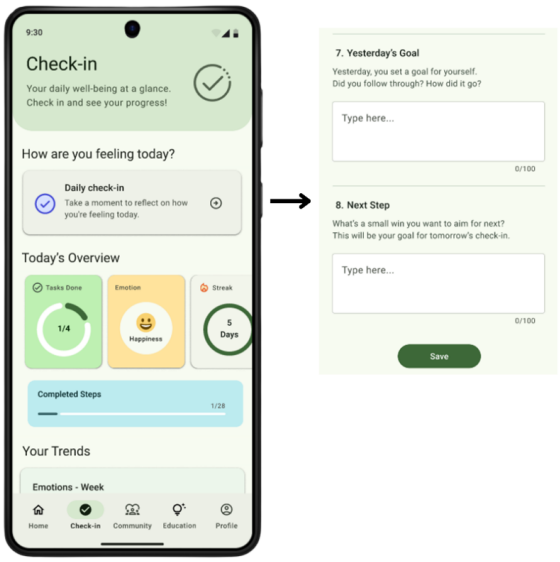


Figure 3: Check-in Section and Goal Setting Questions.

Goal setting theme followed the overall value theme with 5 participants reporting it. Participants generally viewed goal setting as useful but suggested better progress tracking. They had a hard time recalling the previous goals as one participant stated, "it would be nice if I could see the goal I wrote yesterday" (P6). Also, another participant suggested adding a monitoring option to goal settings to rate how well it went (P6). They also described generating new daily goals over time as "surprisingly difficult" (P9).

Daily check-in theme were mentioned by 4 participants in total. One participant described daily check-ins as "easy, quick, and really helpful for understanding emotional trends" (P1). On the other hand, others mostly emphasized burden and repetition, explaining that it needs too much investment and even if it is good at the beginning, it becomes "repetitive" over time (P1, P2, P5). Also, one participant mentioned "craving" question became "too much of a hassle" after a week (P6). Current implementation of the check-in and goal setting questionnaires can be seen in Figure 3.

The improvement suggestions theme was also reported by 4 participants. Participants specifically requested making education modules (Figure 4) "in a way that it is more interactive" (P1), improving

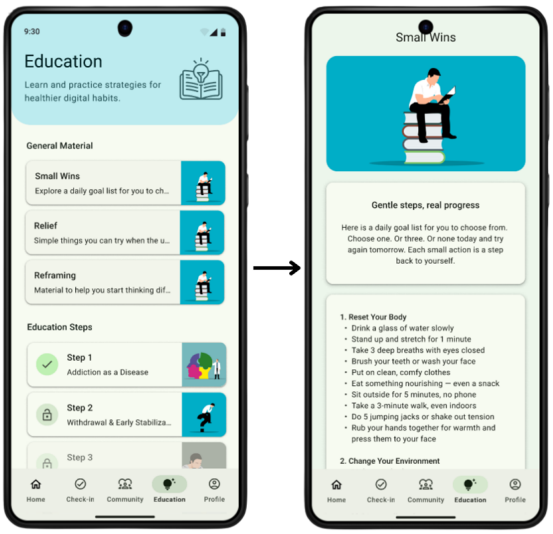


Figure 4: Education Section and Content View.

notifications by sending "more than one notification" (P1), adding automatic screen time tracking (P4), and giving them more space to "write down their progress and next goals" (P4).

5. Discussion

In this study, we tested how our research protocol works in practice, explored the potential problems that can emerge from our recruitment plan, evaluated the acceptability and potential burden of our measurements, and analyzed our data to identify patterns behind study completion differences. Additionally, we also explored our application's readiness for a larger scale research by examining participants' use patterns, technical issue reports, and qualitative feedback.

5.1. Feasibility and Acceptability

One key finding of the study was the friction between consent and baseline measurements. A total of seven students gave consent to participate in the study, but did not complete the baseline measurements. In addition, four participants filled out the baseline questionnaires but did not download the app or complete the onboarding process. This means that 28% of individuals who were eligible to participate and gave consent, and 22.5% of those who filled out the baseline questionnaires, dropped out before the intervention began. Although such losses may be considered natural in intervention studies, we prefer to consider that these rates may be related to problems encountered in recruiting or onboarding participants [31]. For example, losses between recruitment and the baseline survey may have been caused by various reasons such as the survey link being sent via email or the surveys being too long for participants. However, since we were unable to contact these individuals, we do not have direct and reliable data at this stage. On the other hand, it is possible that the situation of the participants who completed the baseline surveys but did not log into the application may be related to technical problems. In total, six participants reported technical problems, but all these participants ended up using the application. However, some participants may have experienced similar technical problems but did not report them, and consequently, they may not have been able to start using the application. In addition, although technical issues were addressed on the day they were reported, this situation may have negatively affected participants' motivation and willingness to continue the study [32, 33]. Therefore, the technical issues identified during the pilot study will be resolved promptly by increasing

the technical reliability of the system. Specifically, installation flow and the onboarding process are high priorities and will be made as easy and seamless as possible before scaling to the main study.

Another important finding is the retention and attrition results obtained from this pilot study. These findings will provide a guiding trajectory for the main study. Among participants who received the intervention (n=14), retention was strong in the first week (85.7%), but declined to 64.3% at the end of the study. The fact that most losses occurred after the first week suggests that maintaining participants' commitment to the study from the end of the first week onwards will be a critical period. Although it is often stated that dropout may not occur in the early stages, the definition of "early stage" may vary depending on the length, or volume of the intervention [34]. In our study, the period when participants were relatively more active and the dropout trend began was the first week, particularly the first five days. Even though the instruments were acceptable and understandable for this population (item completeness was between 97.77% to 100%), one factor that influences this trend may be the addition of the PSD questionnaire at week 1 and the open-ended question at week 4. While the PSD questionnaire slightly increased the median survey completion time by 8.43%, the addition of the open-ended question increased it by 50.15% at the end of the study. Similarly, according to the participant feedback, after a while, certain sections within the application began to feel more "repetitive" and "burdensome". Consequently, both the daily input burden within the application and the increased question load over time may have affected retention and attrition rates.

Additionally, when we look at the activity within the application, we see that application usage peaked in the first five days and then dramatically started declining. The median number of active days being seven indicates high heterogeneity among participants. While a small subgroup interacted with the application more intensively and sustainably, another group stopped using it after a short time. Thus, we compared baseline characteristics of individuals who completed the study and dropped out to identify potential subgroup patterns. It was found that the dropout group had higher internet addiction scores and lower well-being levels. This suggests that high addiction scores may make it difficult to continue the study to the end, or that individuals with high addiction scores who are not affected in terms of well-being may feel less need to continue using the application. Furthermore, the completer group were found to have higher screen time and self-efficacy levels. It may indicate that individuals who perceive their capacity to achieve a specific goal or manage their situation as higher may have higher treatment adherence. Of course, since these findings are exploratory, it would not be correct to draw definitive conclusions at this stage. However, these results hint that participants' baseline profiles may provide highly important information for understanding the outcomes in the future.

5.2. User Feedback

From the qualitative data, we gathered clear fine-tuning targets for further application design. Although feedback was mostly positive and participants found the application informative and good, they provided redesign and improvement ideas for multiple sections. From these sections, two components emphasized the most were the check-in section and goal-setting questions within it.

Participants found the daily check-in section helpful for following their trends, but repetitive and too formal for daily use (P1, P5). They also mentioned that "goal setting" was great, but they found it difficult to come up with new things and recall the goal they set the other day (P6, P8). We aim to address these two themes together by making changes in the check-in section. Since participants found the check-in section "repetitive" and "laborous", we plan to take goal-setting questions out of the check-in section and let users set their goals weekly. This way, we aim to reduce the effort needed for filling in the daily check-in and make improvements to goal-setting questions.

In the "improvement suggestions" theme, participants reported small problems and potential improvements for different parts of the application. For example, a participant reported that the education section needs changes that make it more interactive (P1). Since the suggestions in this theme were not repeated by multiple participants, we aim to evaluate all of them and make the updates that are deemed appropriate by the research team.

Finally, in the overall value theme, participants reported the things Recovio does well and if they find

it beneficial overall. Participants found the application especially valuable in terms of its content by mentioning that it gives good and interesting information, useful advice, and explains addictions (P2, P4, P5, P8). They also specifically mentioned that it encourages tracking progress (P4), keeps track of emotions accurately (P4), helps to reflect behavioral patterns (P5), reminds about your goal and has interesting features (P8). When we look at the general comments about the application, participants reported that the motive of the application was clear and timely (P9), it was promising (P8), they would recommend it (P7), and it can be supportive for people having problems (P3).

5.3. Limitations and Future Research

In this pilot study, we identified multiple limitations related to our study design, data collection, data analysis, and results [35]. The research is designed as a single-arm longitudinal study. Since it does not include a control group, the changes in outcome cannot be attributed directly to Recovio. In addition, it was conducted at one university in Finland, and with only Android users. This approach may be a limiting factor for the external validity of our study [35]. Also, individuals who were more motivated or interested in their digital habits may have been overrepresented due to our sampling method. Moreover, even though qualitative data were coded independently by two researchers, and themes were consensus-based, findings are limited to participants who completed the study, and thus may not adequately represent the experiences of the dropout group.

In a future, larger-scale study, we plan to reach all university students rather than limiting the sampling to chosen classes. We will minimize participant loss derived from the technical problems within the application by addressing all the technical issues identified. In addition, we will use retention data and effect sizes to calculate the sample size of the future study. We will also clarify the difference between the group that dropped out after filling out the baseline questionnaires and those who did not download or complete the onboarding by defining inclusion criteria accordingly. Finally, we will fine-tune the Recovio according to the qualitative feedback gathered.

6. Conclusion

This study provided significant outputs from two main perspectives: implementation and initial findings. It revealed areas for improvement such as participant recruitment, data collection, and study design. Moreover, it helped us understand the user experience for Recovio while assessing whether it is ready for a larger study. In terms of the initial findings, they suggested that users may be more likely to use the application during the first week. In addition, notable differences were observed between individuals who completed the study and those who dropped out early, which has raised important questions regarding the factors that influence retention. It also provided valuable insights into which features users are more likely to prioritize and which elements are more likely to capture their attention. As a result, we are now able to improve both the study protocol and the application design based on the identified issues and recommendations before proceeding with future investigations. To sum up, the findings of this pilot study established a foundation and provided a critical starting point for a larger study and the further development of Recovio.

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Declaration on Generative AI

During the preparation of this work, the authors used ChatGPT-4o, Grammarly, and DeepL in order to: Grammar and spelling check, Improve writing style, and Formatting assistance. After using these tools, the authors reviewed and edited the content as needed and take full responsibility for the publication's content.

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