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Full length article

Supporting adolescents' mHealth needs: Qualitative and quantitative insights from a user survey of a mental health promoting app

Esra Cemre Su de Groot [a,*], Lianne P. de Vries [b,c], Ujwal Gadiraju [a], Olya Kudina [d], Loes Keijsers [e], Manon H.J. Hillegers [b], Willem-Paul Brinkman [f]

[a] Web Information Systems, Delft University of Technology, Delft, Netherlands
[b] Department of Child and Adolescent Psychiatry/Psychology Erasmus MC Sophia Children's Hospital, Erasmus University Medical Center, Rotterdam, Netherlands
[c] Department of Biological Psychology, Vrije Universiteit Amsterdam, Amsterdam, Netherlands
[d] Values, Technology & Innovation, Delft University of Technology, Delft, Netherlands
[e] Department of Psychology, Education and Child Studies, Erasmus University Rotterdam, Rotterdam, Netherlands
[f] Interactive Intelligence, Delft University of Technology, Delft, Netherlands

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ABSTRACT

While mental health apps can help to promote adolescents' mental health, prevent mental health problems, and reduce symptoms, maintaining sufficient user engagement with these apps remains challenging. This is often caused by a mismatch between the needs and preferences of adolescents and what the apps offer. Therefore, we need a better understanding of (i) adolescents' needs and preferences and (ii) potential differences based on user characteristics. To this end, we qualitatively and quantitatively analyzed a dataset describing the user experience of 1312 Dutch adolescents (12–25 years) from the general population after they interacted for several weeks with a gamified mHealth app (the Grow It! app) that aims to promote momentary emotional awareness, reflection, and adaptive coping. A total of 4833 free-text survey responses spanning five user experience survey questions were analyzed using an inductive and iterative coding process, while accounting for intercoder reliability. We used (i) a thematic analysis to identify adolescents' needs and preferences related to the app, and (ii) an exploratory quantitative analysis of the subthemes to investigate potential differences in which needs and preferences were mentioned by adolescents based on demographics. Through our thematic analysis, we identified three overarching themes related to the app's design: *usability*, *psychological impact*, and *meaningful interactive features*. Furthermore, we identified two overarching themes that related to the adolescents' motivation to use the app: *intrinsic (de)motivators*, and *social–environmental factors impacting usage*. Each of these themes consisted of four subthemes. Our exploratory statistical analysis shed light on several differences in how frequently these subthemes were mentioned based on age, sex, and educational level. By synthesizing our insights, we identify five design implications that can help tailor future mHealth apps to adolescents' needs and preferences. These include concrete suggestions to personalize self-monitoring, include actionable insights, align content with personal needs, implement meaningful interactive features (e.g., competitions, gamification, and social communication), and make apps appealing to the entire target group.

1. Introduction

The number of adolescents who experience mental health problems has been increasing and is expected to increase further due to societal challenges, demands, and major crises (such as the COVID-19 pandemic and climate change) (Daly, 2022; Poletti et al., 2023; Racine et al., 2021; Wiederhold, 2022). Additionally, it can take up to several years to receive appropriate care for adolescents and children (Hansen et al., 2021; Raven et al., 2017), during which existing problems can further deteriorate (Punton et al., 2022). Mental health apps offer an accessible opportunity to relieve the burden on the mental health care system and promote adolescents' mental health and well-being. In this paper, we broadly define mental health apps as apps that aim to promote mental health and well-being, prevent mental health problems, or reduce mental health symptoms. Respectively, previous studies on such apps have shown promising results for promoting mental health (Eisenstadt et al., 2021; Fischer-Grote et al., 2024; Leech et al., 2021), preventing mental health problems (Deady et al., 2017; Fischer-Grote et al., 2024; Leech et al., 2021; Doorn et al., 2021), and reducing symptoms (Bae

* Corresponding author.
E-mail address: e.c.s.degroot@tudelft.nl (E.C.S. de Groot).

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et al., 2023; Firth et al., 2017; Fischer-Grote et al., 2024; Leech et al., 2021). In general, users who are more engaged in their interaction with a mental health app show greater benefits of the app (Bakker & Rickard, 2019; Graham et al., 2021). However, consistent user engagement and adherence with these apps remain challenging (Garrido et al., 2019; Koh et al., 2022; Lehtimaki et al., 2021; Lipschitz et al., 2023). For instance, a systematic review by Lehtimaki et al. (2021) reported a high dropout rate among adolescents for digital mental health interventions. While many people install mental health applications, only a small number of users engage with these applications over a longer period (Baumel et al., 2019). Users typically stop engaging with a mental health app if it does not align with their needs and preferences (Smith et al., 2021; Wong et al., 2021). Therefore, understanding adolescents' needs and preferences regarding such apps can help inform approaches to improve engagement (Torous et al., 2018).

User engagement with mental health apps is known to be influenced by several factors, such as demographic characteristics (Bakker & Rickard, 2019; Borghouts et al., 2021; Lipschitz et al., 2020, 2023; Smail-Crevier et al., 2019; Szinay et al., 2020) and mental health state (Borghouts et al., 2021; Lipschitz et al., 2020, 2023; Zhang et al., 2021). For instance, across adolescence (Antezana et al., 2022; Garrido et al., 2019; Prochaska et al., 2023) and adulthood (Bakker & Rickard, 2019; Borghouts et al., 2021; Szinay et al., 2020), women generally show greater engagement compared to men. Moreover, a higher educational level (Bakker & Rickard, 2019; Szinay et al., 2020) has been linked to greater engagement. Younger adults have also been reported to be more engaged compared to older adolescents and adults (Lipschitz et al., 2020; Prochaska et al., 2023; Smail-Crevier et al., 2019). Apart from these demographic differences, the severity of mental health symptoms can also affect users' engagement (Borghouts et al., 2021; Garrido et al., 2019; Lipschitz et al., 2020; Zhang et al., 2021, 2021). While experiencing mental health symptoms relates to a greater interest in mental health applications (Lipschitz et al., 2020), severe mental health symptoms can also prevent users from using such an app (Borghouts et al., 2021; Zhang et al., 2021).

Although prior research has found these individual differences in engagement of mental health and well-being apps, little is known about how these individual differences in engagement emerge (Koh et al., 2022; Lipschitz et al., 2023). Understanding the needs and preferences of users and potential individual differences can help overcome low engagement and thereby improve the effectiveness of the app. Some studies have reported the potential of personalization to improve user engagement with mental health apps (Cheung et al., 2018; Saleem et al., 2021). Building an understanding of the different user needs and preferences allows specifying the app to align with its users (Torous et al., 2018). Although personalization of mental health apps provides promising results regarding user engagement and outcomes, there is still a need for a better understanding of how to facilitate personalization based on user needs and preferences (Jahedi et al., 2022).

Prior work has investigated the needs and preferences of adolescents from the general population related to a mental health app predominantly using interviews (Ribanszki et al., 2021; Wong et al., 2021) and focus groups (Kenny et al., 2016). Situated qualitative methods, such as these (semi-)structured interviews and focus groups, are suitable and common ways of identifying user needs of mental health apps (Lemon et al., 2020). However, the relatively smaller sample sizes concomitant with these methods can fall short in contexts where high variability can be expected and when pursuing insights into individual differences within a population (Braun et al., 2021). To our knowledge, the potential individual differences in adolescents' needs and preferences regarding mental health apps are still unexplored. Open-ended qualitative surveys allow for collecting a representative sample size for generic populations (such as adolescents) and exploring differences within this population, while still providing a rich and focused qualitative analysis (Braun et al., 2021). Therefore, we analyzed qualitative user experience surveys to investigate adolescents' needs and preferences, and potential individual differences, regarding a mental health app.

For this purpose, we used the Grow It! app as a use case; a gamified mHealth app, developed by Dietvorst et al. (2022), aiming to promote adolescents' mental health and well-being. The app has been developed for adolescents (12–25 years) to self-monitor and promote insight in their daily thoughts, behaviors, and emotions, and playfully promote different adaptive coping strategies. After using the app for 3 or 6 weeks, 1312 adolescents completed a user experience questionnaire containing open-ended questions about how they experienced using the app. Questions related to what adolescents liked and disliked about the app, what factors could improve the app, and the motives for adolescents to (dis)continue using the app. Based on these questions, we explored the following two research questions:

1. What are adolescents' needs and preferences regarding a mental health app?
2. How do these needs and preferences differ based on demographic differences?

Based on our findings, we have drawn several design implications to tailor mental health applications more toward user needs and preferences. The methods that we used are visualized in Fig. 1. Due to the nature and target group of the mHealth app that we analyzed, the conclusions of our paper relate to a mental health app that positively promotes mental health and well-being in a general population of adolescents. Nevertheless, these insights might also be valuable when designing preventive mental health apps for those at risk or apps that aim to reduce existing symptoms. The main contributions of our work are threefold:

- Our work enriches the understanding of adolescents' needs and preferences regarding mental health apps by corroborating prior findings and revealing new insights based on large-scale qualitative data.
- Our work revealed that adolescents' needs and preferences related to a mental health app can differ based on adolescents' demographic differences, predominantly based on age and sex.
- Based on our findings, we suggested five design implications for the development of future mental health apps for adolescents.

2. Background, related work, and the Grow It! App

2.1. User needs and preferences in mental health apps

The inclusion of direct user insights into how users experience the interaction with a mental health app in the design process might improve the engagement with mental health apps (Smith et al., 2021; Torous et al., 2018), as the app will be more tailored to the users' needs and preferences. While expert opinions (e.g., clinicians or researchers) are often used to gain insights into the user experience of a mental health application (Anastasiadou et al., 2019; Guala et al., 2023; Stoyanov et al., 2015), solely relying on expert opinions for the development of these applications might not be enough. In line, Kaveladze et al. (2022) found that user experience ratings done by experts using the Mobile App Rating Scale (Stoyanov et al., 2015) were positively associated with app downloads, revenue, and monthly active users, but not with user retention. The preferences and needs of users do not necessarily overlap those of researchers and professionals (Smith et al., 2021). Moreover, Ribanszki et al. (2021) reported a mismatch between the intended usage of their mental health app and how adolescents used the app in practice. Therefore, an understanding of adolescents' needs and preferences contributes to building an effective mental health app.

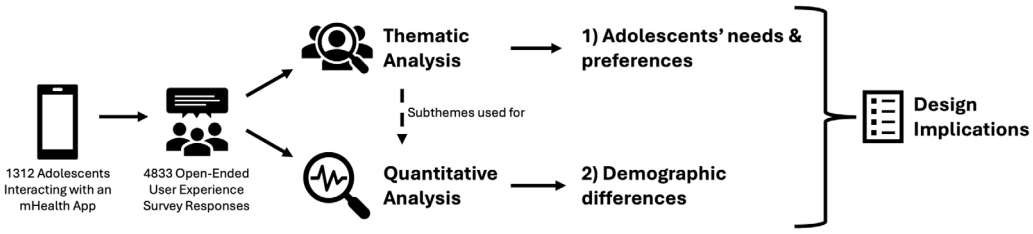


Fig. 1. We studied 1312 adolescents who interacted with a gamified mHealth app and filled in an open-ended user experience questionnaire, resulting in 4833 open-ended survey responses. These responses were analyzed using a thematic analysis to investigate adolescents' needs and preferences regarding the app. Based on the subthemes from the thematic analysis, an additional exploratory statistical analysis was done to investigate differences in needs and preferences based on age, sex, and educational level. These insights resulted in five design implications for the development of future mental health apps.

2.1.1. Insights from adolescents and young adults

Prior work exploring the user experience of mental health apps has shown that adolescents explicitly value privacy (Fausett et al., 2020; Garrido et al., 2019; Kenny et al., 2016; Lehtimaki et al., 2021) and discretion (Garrido et al., 2019; Lehtimaki et al., 2021; Ribanszki et al., 2021), and often feel ashamed for using a mental health app (Lehtimaki et al., 2021; Ribanszki et al., 2021). Functionalities that can ensure privacy and anonymity, such as data security, password protection, and control over privacy settings are important factors that could contribute to the willingness of adolescents to engage with the app (Lehtimaki et al., 2021). Ribanszki et al. (2021) point that such apps should not have a 'mental health-like' appearance, ensuring the discretion of the app.

Social elements within mental health applications are often valued by adolescents and young adults (Fausett et al., 2020; Garrido et al., 2019; Kenny et al., 2016; Smith et al., 2021; Wong et al., 2021). Adolescents have reported liking the option to offer and receive peer support by sharing about their mental health situation (Fausett et al., 2020; Kenny et al., 2016; Smith et al., 2021; Wong et al., 2021). Moreover, digital mental health apps that offer an in-person aspect (e.g., offering contact with a professional, peer, or parent) show greater adherence on average. During adolescence, feeling socially connected is important for mental well-being (Jose et al., 2012; Oberle et al., 2024). Prior work has reported that by reading anonymous stories about similar problems or getting matched with peers, adolescents can relate to others' experiences and feel connected with their peers (Kenny et al., 2016), and that they appreciate functionalities that directly request help from peers and family (Fausett et al., 2020). Social elements should be carefully implemented to balance the privacy, anonymity, and discretion needs of adolescents (Garrido et al., 2019).

Other factors. Adolescents have reported liking easy-to-use and straightforward apps that do not take a lot of time to use (Kornfield et al., 2022; Ribanszki et al., 2021). The app should be visually attractive (Garrido et al., 2019; Lehtimaki et al., 2021), not juvenile (Garrido et al., 2019), interactive and fun to engage with (Lehtimaki et al., 2021), possibly by using gamification features (Garrido et al., 2019; Ribanszki et al., 2021; Smith et al., 2021) and personalization (Garrido et al., 2019; Lehtimaki et al., 2021). Gamification can be defined as the use of game design elements in non-game contexts (Deterding et al., 2011). Specifically for the context of mHealth apps, Schmidt-Kraepelin et al. (2020) identified eight archetypes of gamification approaches that are being used, which include competition and collaboration, pursuing self-set goals without rewards, episodic compliance tracking, inherent gamification for external goals, internal rewards for self-set goals, continuous assistance through positive reinforcement, positive and negative reinforcement without rewards, and progressive gamification for health professionals. Furthermore, personalization can be operationalized by providing the user with the choice to pick what they want, let the provider decide, use rule-based methods, or use an algorithm to make data-driven automated decisions (Hornstein et al., 2023). Lastly, the content and context of the app should be relevant, relatable, and offer credible and trustworthy information — particularly when gamification and personalization techniques are used (Garrido et al., 2019; Lehtimaki et al., 2021; Wong et al., 2021).

2.1.2. Individual differences

Many studies have identified individual differences in engagement with mental health apps based on sex (Antezana et al., 2022; Bakker & Rickard, 2019; Borghouts et al., 2021; Garrido et al., 2019; Prochaska et al., 2023; Szinay et al., 2020), age (Dietvorst et al., 2022; Lipschitz et al., 2020; Prochaska et al., 2023; Smail-Crevier et al., 2019), and severity of mental health symptoms (Borghouts et al., 2021; Lipschitz et al., 2020, 2023; Zhang et al., 2021), but few have explored the specific needs and preferences underlying these differences. Antezana et al. (2022) conducted a randomized controlled trial to investigate mental health app usage together with post-surveys to better understand adolescents' (16–25 years) predisposition toward mental health apps across 45 participants (71% women). Women often mentioned the link between their app use and how it may affect their well-being, behavior, or lifestyle. Men more often responded that they tried an app out of curiosity, instead of having a particular goal related to their well-being. Their study suggests that the concept of well-being drives women's engagement with the apps, while men are more often driven by gamification. Smail-Crevier et al. (2019) investigated design preferences of adults based on age and sex for e-mental health programs. Participants who were at high risk of developing major depression (511 men; 500 women) needed to rate 17 design features of a web-based mental health program based on a 5-point Likert scale. Significantly more men, especially young men (18–29 years), preferred to receive information through gamification compared to women. Significantly more women preferred a self-help interactive program, practices, and exercises that help to reduce stress, directly ask questions to professionals, receive materials by email, and receive educational materials. Prochaska et al. (2023) investigated the acceptability and utility of a self-exploratory smartphone app to support adolescents' mental health and reported greater engagement among women and gender-neutral adolescents. In general, women have been reported to be more intrinsically interested in mental health applications, while men are reportedly driven by an extrinsic motivator such as gamification. Our study aims to contribute to this line of work by further investigating how adolescents' individual differences relate to differences in preferences and needs related to a mental health app.

2.2. The Grow It! App

Within the current study, we will use the Grow It! app as a use case to investigate adolescents' preferences and needs and their individual differences related to a mental health app. The app is a (non-commercial) gamified mHealth app designed to promote adolescents' (12–25 years) mental well-being. It has been developed by Dietvorst et al. (2022) using an iterative design process using co-creation, with multiple test panels of adolescents aged 12–25 years, child and adolescent psychiatrists, developmental and clinical psychologists, data analysts, and game designers (Dietvorst et al., 2022). Details about the development and functionalities of the app can be found in the development, feasibility, and acceptance study of Dietvorst et al. (2022). The app is particularly interesting for investigating adolescents' needs

and preferences because it was widely used for a consecutive period of 3 or 6 weeks and evaluated on user experience by 1312 adolescents, allowing investigation of potential individual differences. Furthermore, the app consisted of several elements designed to promote adolescents' mental well-being, related to momentary awareness, reflection, and adaptive coping. Additionally, several (gamified) design elements were included to promote engagement and motivation, such as rewards, competition, collaboration, personalization, and a chat function. This wide variety of implemented features allows for a rich analysis of identifying adolescents' needs and preferences.

2.2.1. Psychological working mechanisms

The app aims to enhance adolescents' momentary awareness of mood and behavior using an Experience Sampling Method (ESM). ESM is a structured self-reported diary method where adolescents answer a set of questions multiple times a day, which allows for in-moment measurements and monitoring over time (van Roekel et al., 2019). The insights that can be obtained by these ESM measurements may help early identification of mental health problems. Moreover, ESM can enhance adolescents' self-monitoring and potentially aid in increased self-insights and building resilience (van Os et al., 2017; Widdershoven et al., 2019). When playing the app, adolescents received five random notifications during the day to self-report their experiences. The ESM-questionnaires included questions about adolescents' location, with whom they were, their online contacts, mood, tiredness, loneliness, boredom, and worriedness (the exact questions can be found in the codebook[1] developed by Dietvorst et al. (2022)).

To further promote self-reflection, a personalized mood profile was added to the app for a subsample of adolescents. Within the mood profile, adolescents could see their mood over time visualized with colored circles representing emotions, and their size represented how strongly they felt it. Furthermore, adolescents could filter their mood profiles based on their sleep quality, location, with whom they were, and how active they were. More details on the mood profile can be found in the paper of Dietvorst et al. (2024).

Furthermore, the app aims to promote adolescents' emotional resilience by teaching adaptive coping strategies with daily challenges. These daily challenges were based on cognitive behavioral therapy (CBT) and co-created with adolescents and professionals. Besides its effectiveness among a clinical population (Hofmann et al., 2012), cognitive behavioral therapy can be used for preventive purposes to promote mental health and lower the risk of developing serious mental health problems (Havinga et al., 2021; Rasing & Creemers, 2017). The challenges within the app were developed to promote several coping strategies: distraction, problem-solving, social support, and acceptance (Dietvorst et al., 2022). When playing the app, adolescents could pick one out of three presented challenges each day. As part of a challenge, adolescents either had to make a photo (e.g., *"Make a picture of something you hold dear"*, aimed to promote distraction), do a quiz (e.g., *"What is sushi usually rolled in?"*, aimed to promote problem-solving), or do an assignment (e.g., *"Ask someone what they like about you and write it down"*, aimed to promote social support).

2.2.2. Design mechanisms for engagement and motivation

The app has several features implemented to promote engagement and motivation through rewards, competition, collaboration, personalization, and a chat function (Dietvorst et al., 2022). When starting to play the app, adolescents could choose a nickname using two turntables, the first one with an adjective and the second one with an animal name, resulting in a nickname (e.g., *Creative Rabbit*). Subsequently, each adolescent was anonymously put into a team with 4 to 6 other adolescents. Team members can communicate with each other by sending a selected set of positive stickers in a team chat. Communication with free text is not possible to prohibit bullying or negative peer pressure. Each team owns a virtual tree and competes against the other teams by growing the tree. Team members can earn points by completing ESM questionnaires and CBT-based challenges. When a team reaches a certain number of points, a new level is unlocked (called a *spurt*), which means that the tree grows, and each team member can choose one of three wrapped gifts that will be put in the tree. Adolescents are also able to see other teams' trees in an overview. Furthermore, as the game progressed, more points were needed to unlock a *spurt* to increase difficulty.

2.2.3. Grow It! App outcomes

Previous work on the overall evaluation and efficacy of the Grow It! app demonstrated within-person improvement in affective and cognitive well-being after using the app for several weeks (Dietvorst et al., 2023). Furthermore, adolescents who experienced more depressive symptoms, a lower atmosphere at home, and more impact from the COVID-19 pandemic showed greater improvements in well-being. Mens et al. (2022) have evaluated the effectiveness of the app on a daily and within-person level. Their study reports that the majority of the adolescents who used the app improved in daily well-being. The smaller subset of users who decreased in daily well-being already had lower well-being scores at the start of the study and might need clinical support. While unrelated to the CBT-based challenges, adaptive coping was positively related to positive affect. Dietvorst et al. (2024) have examined the effect of the mood profile. The mood profile did not seem to affect app engagement or user experience, implying that further improvements are needed. However, there was an effect in improved well-being found for adolescents who played the app with the mood profile compared to those who played the app without the mood profile. Furthermore, a randomized controlled trial[2] is ongoing to test the effect of the Grow It! app in a population of chronically ill youth against a control condition, while controlling for confounding variables. These indications of a positive effect of the app on adolescents' mental health may highlight the added value of investigating needs and wishes related to the app, to extract insights into what worked well and potential improvements.

The study of Dietvorst et al. (2022) also reported some findings related to age differences in the user experience of the Grow It! app across two samples. The closed-ended questions about the user experience of young adolescents (12–17 years) were compared to those of older adolescents (18–25 years). While older adolescents showed greater ESM compliance, significantly more older adolescents thought there were too many ESM questionnaires per day. Younger adolescents rated several aspects of the Grow It! app higher compared to older adolescents, namely the appearance (i.e., the feel and look; in both samples), the app in general (sample 1), and the chat function (sample 2). Furthermore, significantly more younger adolescents would recommend the app to their friends compared to older adolescents. We built upon these findings by (1) deriving needs and preferences from the unanalyzed open-ended user experience questions, (2) further investigating individual differences based on demographic variables, and (3) including the user experience data from an additional sample, including the mood profile (sample 3).

3. Methods

3.1. Data description

In three different cohorts during the COVID-19 pandemic (data collection between May 2020–May 2021), 2952 adolescents (aged 12–25)

[1] https://osf.io/2at58/files/q83hg?view_only=b691104ecc3d45ad8b48e1bd60ad7125

[2] https://www.isrctn.com/ISRCTN17883961

Table 1
Demographic variables and sample differences of Samples 1, 2, and 3.

		Sample 1	Sample 2	Sample 3	Total
Sample size	T0	865	1603	484	2952
	T1	413	728	171	1312
	T0 & T1	389	662	158	1209
Duration (weeks)		6	3	3	N/A
Mood profile		No	No	Yes	N/A
Age (years), mean (SD)		16.25 (2.96)	18.35 (3.24)	15.68 (2.84)	17.32 (3.30)
Sex, n (%)					
	Boys	104 (26.74%)	121 (18.28%)	45 (28.48%)	270 (22.33%)
	Girls	284 (73.01%)	537 (81.12%)	111 (70.25%)	932 (77.1%)
	Other	1 (0%)	4 (0.01%)	2 (1.27%)	7 (0.58%)
Educational level[a], n (%)					
	Low	43 (11.05%)	100 (15.11%)	11 (6.96%)	154 (12.74%)
	Medium	95 (24.42%)	198 (29.91%)	24 (15.19%)	317 (26.22%)
	High	227 (58,35%)	313 (47.28%)	120 (75.95%)	660 (54.59%)
	Primary/other	24 (6.12%)	51 (7.7%)	3 (1.90%)	78 (6.45%)
Cultural identity, n (%)					
	Dutch	335 (86.12%)	639 (96.53%)	130 (82.28%)	1104 (91.32%)
	Other	41 (10.54%)	6 (1%)	11 (6.96%)	28 (2.32%)
	Mixed	11 (2.83%)	17 (2.57%)	17 (10.76%)	75 (6.2%)

[a] Low educational level describes (preparatory school for) technical and vocational training, medium describes (preparatory school for) professional education, high describes (preparatory school for) university, and primary/other consists of primary school and other non-Dutch school systems. T0 describes the start of the study, and at T1 moment when the user experience questionnaire is filled in after interacting with the app.

Table 2
A description of the open-ended questions from the user experience questionnaire that were analyzed for our study. Responses (n) describe the number of responses on a question, while words (μ) describe the average number of words used for the response.

UE	Sample	Responses (n)	Words (μ)	Question
UE4	2,3	899	18	Explain why the Grow It! app may or may not have helped you
UE8	1,2,3	1312	12	Please explain the grade you gave the appearance of the app
UE19	1,2,3	1312	13	What would you change about the Grow It! app?
UE21	1,2,3	914	10	What made you play the app for 3 weeks? (sample 1: 6 weeks)
UE22	1,2,3	396	13	What made you stop playing the app earlier than 3 weeks? (sample 1: 6 weeks)

from the general population started to play the Grow It! app (Dietvorst et al., 2022, 2024). Data collection was conducted by Dietvorst et al. (2022). During the first cohort (Sample 1), adolescents played the app for 6 consecutive weeks. For the other two cohorts (Samples 2 and 3), adolescents played the app for 3 consecutive weeks. Furthermore, only Sample 3 included the mood profile described earlier. Adolescents were not paid for their participation. However, they could win a gift voucher or EarPods with a monthly lottery among adolescents. More details on the recruitment period, measurements, procedure, and governmental restrictions due to COVID-19 can be found in the online codebook[3] developed by Dietvorst et al. (2022). The study was approved by the Medical Ethics Committee of the Erasmus Medical Center (MEC-2020-0287).

Before adolescents started to play the Grow It! app, they filled in a baseline questionnaire (T0), and after they played the Grow It! app they filled in a final questionnaire (T1). All specific measures can be found in the online codebook developed by Dietvorst et al. (2022). In this study, we used the demographic characteristics questionnaire that measured variables such as age, sex, cultural identity, and educational level at T0. Furthermore, we used the open-ended questions from the user experience questionnaire at T1, which is a self-developed questionnaire by Dietvorst et al. (2022). A description of the different samples together with the demographic variables of the dataset can be found in Table 1.

Out of 2952 adolescents, a total of 1312 adolescents had filled in the user experience questionnaire, of which we analyzed five different questions: (i) *how the app has helped the adolescents*, (ii) *what they thought of the appearance of the app*, (iii) *what they would like to change about the app*, and (iv) *what made them continue* or (v) *stop playing the app*. Table 2 shows an overview of the questions, the number of responses for each question, the average number of words used, and in which samples the question was asked. Due to missing demographic data from 103 out of the 1312 adolescents who had filled in the user experience questionnaire, data corresponding to these 103 adolescents were not used for our statistical analysis. However, their corresponding qualitative data were useful to consider for the thematic analysis. We have preregistered our study.[4] Given that exploratory and qualitative studies often involve iterative refinement, the preregistration was updated after its initial version.

3.2. Qualitative data analysis

3.2.1. The coding process

Our coding process relates to an inductive process, creating codes from the data. The coding process was carried out by two coders (Supplementary, Section 1.1 for coders' positionality). To improve the reliability and promote discussions between the two coders, we used intercoder reliability measures (O'Connor & Joffe, 2020). Separate codebooks were created for each open-ended question. The entire coding workflow for one open-ended question is visualized in Fig. 2. As the first step of the qualitative coding process, both coders independently familiarized themselves with the responses and created an initial coding frame. The responses were analyzed as they are, without correcting typos or grammar mistakes. Codes were created on

[3] https://osf.io/2at58/files/q83hg?view_only=b691104ecc3d45ad8b48e1bd60ad7125

[4] https://osf.io/72cgu/overview?view_only=553184f3ae8d4989a9333a851cbca39f

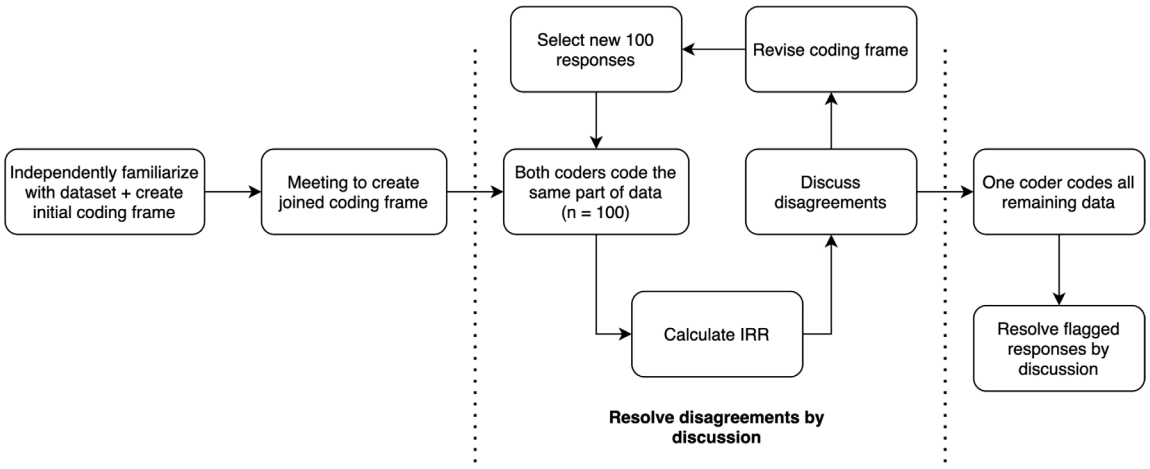


Fig. 2. Coding workflow for an open-ended question.

a semantic level, as we aimed to stay close to the explicitly expressed meaning of the adolescents' responses. In line, the codes were created in the original language to stay close to the meaning that was expressed by the participant, which can benefit the generation of themes (Abfalter et al., 2021). Furthermore, the coded open-ended responses ranged from single words to full paragraphs. Therefore, one response could have several codes, as participants could touch upon several views or topics in one response. Only 2% of all responses were not coded, for instance, because the response was empty (e.g., a response containing '-') or the response was not related to the question. Subsequently, both coders came together to discuss the two initial coding frames and merge them into one. Next, both coders coded a random subset of 100 responses using the jointly made coding frame, wherein a response could relate to multiple codes.

Interrater reliability (IRR) measures were then calculated per code using Cohen's Kappa. We aimed for a Cohen's Kappa value of at least 0.41 for each code, which is considered a *moderate* agreement (McHugh, 2012), and a Cohen's Kappa of at least 0.61 for the average of all codes within one question, which is considered a *substantial* agreement (McHugh, 2012). The IRR scores were used to discuss the disagreements and revise or clarify the coding frame. Additionally, we calculated the average IRR scores of all codes, together with a normalized IRR average (normalized by the number of times the code was used on average between the two coders). If the coding frame needed revision, a new subset of 100 responses was taken to reiterate this process.

When no revisions of the coding frame were needed, the coding frame was finalized and one coder continued coding the remaining responses. To ensure the quality of these codes, the coder flagged codes of responses about which the coder was not confident. Subsequently, the flagged responses were discussed with the other coder. The Cohen's Kappa values of the first and last iteration, the number of coding frame iterations, and the number of flagged responses for each question can be found in Table 3. For the last iteration, all questions had at least a normalized Cohen's Kappa agreement of 0.81, indicating almost perfect agreement (McHugh, 2012).

3.2.2. Thematic analysis

Our analysis is inspired by thematic analysis and provides an idiographic method to derive insights from the data (Schwandt, 2014), while not only prioritizing insights based on frequency counts (Braun & Clarke, 2012; Clarke & Braun, 2021; Vaismoradi et al., 2013). We use these insights to investigate adolescents' needs and preferences regarding a digital mental well-being app. Our method of generating themes relates to an experiential and realist approach, as we aim to capture and explore how adolescents experienced the Grow It! app (Braun & Clarke, 2012). Themes were generated to obtain insights into adolescents' views on specific aspects of the app and what made them use the app. The themes were generated using the codes from all user experience questions, as different questions could cover the same theme but from a slightly different perspective (e.g., UE4 addresses problem A in the app, while UE19 addresses a suggestion to resolve problem A — both responses would relate to the same theme). General overarching themes were developed, accompanied by subthemes that relate to these overarching themes. Furthermore, codes could be relevant to multiple subthemes. The themes were generated iteratively by coder 1 in English, using the codes. This iterative process of theme development has been described by Braun and Clarke (2012). During this process, coder 1 discussed the themes with coder 2 to critically reflect on the suitability of the created themes. Furthermore, we used triangulation based on findings from prior literature when presenting the results of our thematic analysis to investigate how our findings relate to prior work. Although a focus on frequency counts is generally not encouraged within thematic analysis (Clarke & Braun, 2021), we report on frequency counts to provide an idea of the consistency of the mentioned (sub)themes (Sandelowski, 2001).

3.3. Exploratory quantitative analysis of user demographics

In contrast to the idiographic approach to our method inspired by thematic analysis, we also analyzed our generated themes in a more nomothetic approach using a method inspired by qualitative content analysis (Vaismoradi et al., 2013). Whereas thematic analysis allows us to identify interesting and important insights from the data regardless of how often a theme was mentioned, qualitative content analysis provides opportunities to investigate differences based on user demographics by quantifying the data (Vaismoradi et al., 2013). Therefore, we used this method to investigate differences related to user demographics in adolescents' needs and preferences. While our method does not create new themes based on the frequency of occurrences in the data, which is often done in qualitative content analysis (Vaismoradi et al., 2013), we used the frequency counts of the subthemes generated in our thematic analysis to derive statistical insights (Sandelowski, 2001).

3.3.1. Statistical analysis

We used a logistic regression model to test whether specific user demographics (age, sex, and educational level) relate to the participant mentioning a specific subtheme. Prior literature indicates that user demographics may relate to responsiveness to open-ended survey questions (Miller & Lambert, 2014; Zhou et al., 2017) and the length of the response (Denscombe, 2008). Therefore, we controlled for the number

Table 3
Inter-rater reliability scores. The number of iterations describes how many double-coding iterations have been done before finalizing the codebook. K stands for Cohen's Kappa, and nK stands for normalized Cohen's Kappa (where Kappa values for separate codes are weighted depending on how often that code has been used on average). The first K describes the Kappa value for the first double coding iteration, and the last K describes the value for the last iteration when finalizing the codebook. The number of responses that are flagged in the final coding describes the number of responses that the final coder was unsure about and discussed with the second coder.

UE	#Responses	#Iterations	First K	Last K	First nK	Last nK	Flagged final coding, n (%)
UE4	899	3	0.57	0.76	0.61	0.81	75 (12.5%)
UE8	1312	3	0.5	0.77	0.68	0.85	110 (10.9%)
UE19	1312	2	0.58	0.74	0.73	0.86	125 (11.2%)
UE21	914	2	0.7	0.79	0.86	0.88	84 (11.8%)
UE22	396	2	0.63	0.68	0.82	0.81	35 (17.9%)

of subthemes mentioned by each participant. We also controlled for the three different samples, to account for differences in Covid-related measurements, time of the year, and whether the mood profile was present. We tested the main effect of each predictor after considering all other terms (predictors and confounding variables) using a single logistic regression model for each subtheme. As a result, we measure the effect of a predictor that is not shared with the other predictors. This approach might lead to more conservative results compared to separate models for each predictor. For sex, we analyzed the effects of *boys* and *girls*. The *other* category was excluded from the analysis as it only contained 7 adolescents. For educational level we focused on the educational levels *low*, *medium*, and *high*. As the *primary/other* category consisted of adolescents who did not all follow the same educational level we excluded this category from our analysis ($n = 78$). Therefore, the final sample size used for the quantitative analysis of the subthemes consisted of 1125 adolescents. We consider a predictor variable to be significant when the p-value is lower than our significance level ($\alpha = 0.05$). Importantly, we use statistical models to gain additional insights into our data and not to draw confirmatory conclusions. Therefore, we do not correct our significance level for multiple testing, as this is not deemed necessary for exploratory analyses (Bender & Lange, 2001). The code of our statistical analysis can be found in a repository.[5]

4. Results

We developed five different overarching themes based on our thematic analysis. The developed overarching themes are (1) *Usability of the app*, (2) *Psychological impact of the app*, (3) *Meaningful interactive features*, (4) *Internal (de)motivators*, and (5) *Social–environmental factors impacting usage*. These five overarching themes will be described based on their subthemes and relevant quotes in the following sections. As codes may relate to several subthemes, there is some overlap between the subthemes. For instance, the code that relates to a too juvenile design relates to both T1.1 (attitudes on the visual design) as to T1.4 (suitability for all users). Where applicable, we triangulate our findings with literature. An overview of all themes and corresponding subthemes can be found in Table 4. The final subsection will describe our exploratory analysis of differences based on user demographics (Section 4.6).

4.1. T1 usability of the app

This theme captures how adolescents perceived that several practical and functional aspects of the app contributed to or hindered the usage of the app. We discuss aspects related to the visual design, technical issues, the ESM questionnaires, and the suitability of the app for different users.

T1.1 Attitudes on the visual design

Overall, adolescents expressed a positive attitude toward the visual design of the app. Adolescents often mentioned that the design of the app was nice ($n = 304$, 23% of 1312), clear ($n = 290$, 22% of 1312), pretty ($n = 282$, 21% of 1312), and generally good ($n = 183$, 14% of 1312). For instance, this adolescent mentioned the app is nice and clearly designed:

It was nicely designed and everything was clearly visible. (UE8, boy)

However, some adolescents also mentioned that the design of the app was unclear ($n = 95$, 7% of 1312). Furthermore, some mentioned that the app was boring ($n = 80$, 6% of 1312), or too juvenile ($n = 61$, 5% of 1312) (opposed to 1% ($n = 11$) of adolescents who mentioned that the app matches its target audience). Furthermore, adolescents mentioned technical issues as part of the design of the app (e.g., bad image quality of the visual design; $n = 37$, 3% of 1312).

In general, adolescents seemed to value a good and pretty visual design that adds to the clarity of the app. In line, prior work also identified that adolescents like a visually attractive app (Garrido et al., 2019; Lehtimaki et al., 2021) and reported on the importance of an easy-to-use app (Kornfield et al., 2022).

T1.2 Technical issues

Besides the earlier mentioned technical problems in the visual design of the app, adolescents ($n = 33$, 3% of 1312) also mentioned other technical problems as a point of improvement for the app. One of these points was that the app should be working properly for all operating systems, including less common operating systems. Another technical issue was that the notifications of the app did not work when the app was not running in the background, which is essential when it comes to the engagement of the app and the functionality of the ESM. When adolescents do not receive notifications of a new ESM questionnaire, many questionnaires are missed since they only have a specific timeframe to complete the questionnaire. 7% ($n = 28$) of the adolescents who discontinued their engagement ($n = 396$) with the app before the end of the study mentioned the app not functioning properly due to the notifications not coming through, the app not being user-friendly, or other technical issues, as their reason. For instance, this adolescent:

Push notifications didn't work for me. (UE22, girl)

These findings resonate with the findings of Borghouts et al. (2021), who identified technical issues as one of the common barriers to interacting with a mental health app.

[5] https://doi.org/10.4121/641d2cd7-e0ee-4bb8-a2f6-dfa612e70904

Table 4
Overarching themes and subthemes resulting from the thematic analysis.

Overarching themes	Subthemes
T1 Usability of the app	T1.1 Attitudes on the visual design
	T1.2 Technical issues
	T1.3 Perception of ESM
	T1.4 Suitability for all users
T2 Psychological impact of the app	T2.1 Positive psychological impact
	T2.2 Negative psychological impact
	T2.3 No or little effect of the app
	T2.4 Lack of psychological tools and/or insights
T3 Meaningful interactive features	T3.1 Attitudes on social interaction in the app
	T3.2 Attitudes on playing in a team
	T3.3 Attitudes on gamification of the app
	T3.4 Attitudes on the CBT-based challenges
T4 Intrinsic (de)motivators	T4.1 Curiosity and interest
	T4.2 Dedication and building a habit
	T4.3 Mental state and need for the app
	T4.4 Forgetfulness and general disinterest
T5 Social–environmental factors impacting usage	T5.1 Other priorities in life
	T5.2 Contributing to research
	T5.3 Influenced by another social actor
	T5.4 Reward as a motivator

T1.3 Perception of ESM

A subtheme that was often mentioned by adolescents was the perception of the ESM. With respect to the question of whether the app helped or did not help, adolescents mentioned that the frequency of the ESM questions and notifications was too high (n = 48, 5% of 899) and monotonous (n = 82, 9% of 899). Furthermore, some adolescents experienced usability issues with the ESM questionnaires (n = 66, 7% of 899), which were mainly related to the timing of the ESM questionnaires, being unable to change previous answers when filled in incorrectly, or the illogical flow of questions. An example of an adolescent who experienced issues with the timing and usability of the ESM:

> *I work during the day and don't look at my phone, so I was often too late for questions. Additionally, I found the questions and answer options not very clear. For example, you had to indicate what you felt worried or relaxed about, but sometimes there wasn't really a reason, or I was actually more irritated than worried, for instance, and then I didn't know how to answer that question.* (UE22, girl)

When adolescents were asked what they would like to change about the app, many adolescents suggested more flexibility in the timing of the questionnaire (n = 187, 14% of 1312), one example:

> *[...] Additionally, it would be nice to be able to complete a questionnaire late in the evening during the weekend, because I experienced many negative things in the evenings of the weekend.* (UE19, girl)

Furthermore, adolescents suggested more variation in the ESM questions (n = 151, 12% of 1312), fewer ESM questionnaires and/or notifications (n = 147, 11% of 1312), better usability of the ESM (n = 46, 4% of 1312), and shorter ESM questionnaires (n = 19, 1% of 1312). In line with our findings, prior work on mental health apps indicated that the repetitiveness of questions has been disliked by adults (Guala et al., 2023). Furthermore, Ribanszki et al. (2021) pointed out that the intended usage pattern should match adolescents' time schedules.

Among the adolescents who continued playing the app, some adolescents mentioned that the notifications were a factor that helped them continue playing the app until the end of the study (n = 25, 3% of 914). However, among the adolescents who stopped playing the app before the end of the study, receiving too many notifications was also mentioned as a reason (n = 17, 4% of 396). Other reasons mentioned for discontinued use were too many ESM questionnaires (n = 59, 15% of 396), the (inflexibility of the) timing of the ESM questionnaires (n = 46, 12% of 396), and the ESM being too monotonous (n = 44, 11% of 396). After receiving a notification to fill in the ESM questionnaire, adolescents had a limited timeframe of 45 min to fill in the ESM questionnaire, with reminders after 10 and 40 min. Additionally, the ESM questionnaire had to be accessed via the notification. This inflexibility might have caused some confusion for adolescents, as expressed by this adolescent:

> *Additionally, you couldn't complete a questionnaire at a time that suited you; if you didn't open the questionnaire via the notification, you couldn't find it.* (UE4, girl)

T1.4 Suitability for all users

Another subtheme related to the usability of the app is its suitability for all users. As previously mentioned (Section 4.1), some adolescents mentioned that the design of the app was too juvenile (n = 61, 3% of 1312). A too-juvenile design of the app was also mentioned as one of the reasons why adolescents discontinued using the app (n = 2, 1% of 396). Prior research also indicated that the design of a mental health application should not be too juvenile (Garrido et al., 2019). Moreover, some adolescents suggested aligning the app better with older adolescents (n = 12, 1% of 1312), one example:

> *I think I might create a version that better suits older teenagers, approximately 16 to 21 years old.* (UE19, girl)

Some others mentioned further personalizing the app (n = 13, 1% of 1312), for instance, by adding more possibilities to customize the app with the user names and/or profile pictures. Additionally, adolescents who feel different from the "average adolescent" may not have felt like the app aligns with their preferences and needs, such as this adolescent:

> *I don't completely agree with the research and therefore also the app, because it very much assumes the average young person, and I didn't feel that the app was meant for me.* (UE19, girl)

Another adolescent mentioned personalizing more toward specific user needs by tailoring the questionnaires:

> *[...], more specific questionnaires tailored to the person's situation, [...]* (UE19, boy)

4.2. T2 Psychological impact of the app

This theme captures how adolescents perceived the psychological impact of the app, as well as their views on how the app's psychological impact can be enhanced.

T2.1 Positive psychological impact

Many adolescents mentioned that the app has helped them to be aware of their feelings at the moment (n = 337, 37% of 899) and improved their self-insight (n = 167, 19% of 899). These adolescents experienced the ESM questions as helpful, as they made them take a moment to think about how they were feeling. As a result, some adolescents mentioned that this impacted their way of thinking positively. For instance, this adolescent learned to put things more in perspective:

> *Self-reflection and thereby insight that some things are not as bad as we make them out to be in our heads.* (UE4, girl)

Moreover, this participant mentioned that it helped to get to know oneself:

> *[...] I really liked taking a moment several times a day to feel how I am doing. This way, I get to know myself better and notice more quickly when I am not feeling well.* (UE19, girl)

Besides improved awareness and insights into emotions and feelings, some adolescents also mentioned a general positive influence on their mental state (n = 26, 3% of 899), such as improved confidence and motivation. Another positive effect mentioned by the adolescents was improved daily structure in their sleep or daily routines in general (n = 7, 1% of 899), perhaps due to the frequent check-in moments of the app and reflection on their sleeping patterns. Others mentioned the ability to focus more on positive aspects (n = 38, 3% of 899), or using the app as an outlet for their feelings (n = 42, 5% of 899). These results coincide with prior work that has found that self-monitoring of mood can help to improve mental well-being in the general (Bakker & Rickard, 2018; Gatto et al., 2022) and clinical (van Os et al., 2017) populations.

Although many of the mentioned positive psychological impacts were more directly related to the ESM questions, some of the mentioned impacts were related more to the challenges. Some adolescents mentioned that the app helps them distract from boredom or negative feelings (n = 31, 3% of 899) and improves their social contact with others (n = 18, 2% of 899). Related to the physical appearance of the app, some adolescents mentioned it radiates a positive feeling (n = 142, 11% of 899), such as happiness. Others found the appearance of the app to have a calming effect (n = 17, 1% of 899).

These positive psychological effects were also mentioned as motivators to continue using the app. From all adolescents who continued using the app, reasons related to the psychological impact were that they liked taking a moment to be aware of their feelings (n = 63, 7% of 914), gaining improved self-insights (n = 69, 8% of 914), starting to feel better mentally (n = 49, 5% of 914), using the app as an outlet (n = 9, 1% of 914), and as a distraction (n = 38, 4% of 914). Interestingly, of all the adolescents who did not continue using the app until the end of the study, two adolescents (0.5%) mentioned that the reason was that the app helped them and now they do not need it anymore.

T2.2 Negative psychological impact

While many adolescents experienced positive psychological effects of the app, some adolescents mentioned a negative effect of the ESM and the app use in general (n = 52, 6% of 899). Examples of this negative effect are feeling stressed, obligated, frustrated, and/or annoyed by the (frequency of) the ESM questions and other aspects of the app. An example of a participant who felt like this:

> *Sometimes I didn't feel like filling anything in, and I feel obliged to do so. I know I signed up for this, but I don't know. It doesn't feel good when you look back and see everywhere: 0 out of 5.*[6] *[...]* (UE4, boy)

The feeling of being irritated and annoyed by the ESM questionnaires and/or the app was also a reason why adolescents stopped engaging with the app before the end of the study (n = 32, 8% of 396). These findings align with the review of Feng et al. (2021), which indicated potentially negative effects of self-tracking using technology, such as stress related to the workload of self-tracking or health-related obsessive-compulsive thoughts and behaviors.

Furthermore, some adolescents (n = 23, 3% of 899) felt that the ESM questions put more emphasis on negative emotions and events, which could cause them to become more focused on their negative feelings or feel confronted. It was also suggested by some adolescents (n = 12, 1% of 1312) to put less emphasis on negative questions in the ESM. Of all the adolescents who stopped playing the app before the end of the study (n = 396), 3% (n = 12) mentioned a negative impact on their mental state as a reason. In prior work, healthcare professionals also indicated that repeatedly being confronted with your negative emotions can have potentially negative effects on well-being (Dietvorst et al., 2024). Important to note is that not all adolescents experienced questioning negative events as necessarily having a negative impact on their mental state, such as this adolescent:

> *It made me think about unpleasant events, but also about nice ones.* (UE4, boy)

Another negative impact that was mentioned is stimulating phone use (n = 8, 1% of 899). Phone dependency was also mentioned as a reason to stop playing the app (n = 4, 1% of 396). Some adolescents did not want to check their phones all the time or were actively trying to spend less time on their phones, such as this adolescent:

> *I experienced a certain stress from the fact that I had to fill in a questionnaire constantly. I prefer not to be on my phone all day (especially not when I'm with others), but still felt obliged to fill in as many questionnaires as possible, which made me have to keep an eye on my phone. [...]* (UE4, unknown[7])

T2.3 No or little effect of the app

There were also adolescents who mentioned the app did not have any effect on them (n = 88, 10% of 899). Furthermore, of all the adolescents who stopped using the app before the end of the study (n = 396), 1.5% (n = 6) mentioned that the app was not helpful as their reason. It is important to note that while some adolescents explicitly mentioned they did not notice any effect, they sometimes mentioned they started thinking more about their emotions and feelings, such as this adolescent:

> *The app didn't really help me. Although I did find it nice to sort of go through the day in the evening.* (UE4, girl)

T2.4 Lack of psychological tools and/or insights

Some adolescents also mentioned that they missed tips or advice to help them feel better (n = 18, 2% of 899), or they missed a certain level of depth in the app (n = 17, 2% of 899), either related to the ESM questionnaires or the app in general. Of all the adolescents who stopped using the app, a few adolescents also directly mentioned a lack of tips/advice and depth as a reason (n = 4, 1% of 396):

[6] Adolescents could see how many of the daily questionnaires they have filled in.

[7] The sex of this adolescent is unknown, as there is no demographic data of this person, as described in Section 3.1. This also counts for every next quote that states "unknown".

Got too little out of it and had to spend too much time on it. (UE22, boy)

As a result, some adolescents suggested adding more depth to the ESM (n = 22, 2% of 899), which included suggestions to personalize the ESM questions, adding more specific questions, more open questions to explain certain mood or sleep ratings, and the ability to rate your day. Adolescents also expressed that they want more insights into their progress (n = 21, 2% of 899). Few adolescents wanted to gain more insights into their own or others' progress on the challenges. Mostly, adolescents from samples 1 and 2 mentioned they would like to have more insight into their answers to the ESM questions over time, which was implemented in sample 3 with the mood profile. Within sample 3, some adolescents still mentioned that they would like more insights into their answers compared to the current mood profile. For instance, being able to look back at the daily questions about negative and positive events, seeing averages of their ratings over time, and graphs of how the emotions fluctuate, such as this adolescent:

Looking back at my own entries/summary of weeks/graphs of emotions. (UE19, unknown)

Adolescents also suggested adding more tools to the app to promote well-being (n = 13, 1% of 1312). Some examples were giving more personalized advice related to the ESM answers (e.g., what you should do when feeling sad), setting daily goals, adding games about your feelings, and getting personalized feedback on the ESM answers. Especially receiving advice based on the ESM answers was suggested by adolescents, such as these examples:

I think it's good to reflect on how you feel more often, but I can imagine that some would also want guidance on what to do with that emotion. Like once you've determined that you are angry/sad, what you can then do about it. [...] (UE19, girl)

[...] Clicking or dragging emotions and then seeing emotions change, which is more visual than checking circles, positive texts/quotes. After filling out questionnaires, also tips and advice based on a certain score for the day/moment. Activities you can do; meditating, running, or something. Also, filling in how you slept, how was your night's rest? This influences emotions during the day. (UE19, unknown)

4.3. T3 Meaningful interactive features

This theme relates to adolescents' experiences with the app's interactive and social components, such as social interaction, collaboration, gamification, and the CBT-based challenges. Related to the general theme, several adolescents suggested making the app more interactive (n = 43, 3% of 1312) or adding games (other than the challenges and the gamification aspect of the app) to make the app more engaging (n = 18, 1% of 1312).

T3.1 Attitudes on social interaction in the app

On the question of whether the app helped or did not help, several adolescents responded that there was little social interaction within the app (n = 11, 1% of 899). Related to the appearance of the chat function, some adolescents mentioned that the stickers were nice (n = 18, 1% of 1312). However, adolescents also mentioned that there were too few stickers (n = 6, 0.5% of 1312) or they were not nice (n = 7, 0.5% of 1312). When adolescents made suggestions to improve the app, the most mentioned thing was being able to use free text when chatting with team members (n = 229, 17% of 1312), for example:

That you can actually chat and not just send stickers. This way you also get to know other teenagers. (UE19, boy)

Other suggested changes were generally adding more social interaction (n = 116, 9% of 1312) or a greater variation of stickers to communicate (n = 25, 2% of 1312). Interestingly, some adolescents mentioned that if the chat function does not allow more options to communicate, it is better to fully disregard the chat function (n = 11, 1% of 1312). Altogether, our results indicate that adolescents value the social elements in a mental health app, aligning with findings from prior literature (Fausett et al., 2020; Garrido et al., 2019; Kenny et al., 2016; Smith et al., 2021; Wong et al., 2021).

4.3.1. T3.2 Attitudes on playing in a team

Some adolescents mentioned that playing the app in a team helped motivate them to continue playing the app (n = 19, 2% of 914). Inter-team competitive game designs (cooperative-competitive), compared to solely collaboration or individual competition, can indeed increase user engagement (Grech et al., 2024; Morschheuser et al., 2019). However, other adolescents mentioned their team was inactive (n = 54, 4% of 1312), and playing in a team demotivated them (n = 8, 2% of 396). As a solution, adolescents suggested adding more options to motivate teammates (n = 19, 1% of 1312), changing teams (n = 50, 4% of 1312; e.g., by removing inactive teammates), playing individually (n = 20, 2% of 1312), and being able to create your own team (n = 9, 1% of 1312; e.g., with friends). The need to use free text in the chat function (described in Section 4.3) may also relate to the need to motivate fellow teammates, as described:

That people who do nothing can be reported and removed, and maybe you can chat with words instead of just stickers, even though I understand why the choice was made for stickers. It might make people more interested if you can actually talk with your teammates. And I found the app less enjoyable because 4 people in my team did nothing. Then you see another team two sprints ahead, and you're doing your best, but it's clear that you don't stand a chance to be at the top, which was very demotivating. (UE19, girl)

Others suggested adding challenges that you can play together with your team (n = 14, 1% of 1312) and gaining more insights into other teams (n = 6, 0.5% of 1312; e.g., seeing the progress of other teams or who is part of the team).

T3.3 Attitudes on gamification of the app

Of all adolescents who continued using the app, some adolescents (n = 30, 3% of 914) mentioned this was because the gamification of the app motivated them. This included the ability to earn points and make the tree grow, and/or the competition element of playing the game. Based on comments on the appearance of the app, many adolescents mentioned they liked the tree (n = 118, 9% of 1312), the gifts that can be put in the tree (n = 50, 4% of 1312), and the playful design of the app (n = 19, 1% of 1312). For instance:

[...] the growing tree and everything is fun, you can see your progress. (UE8, girl)

Some adolescents also mentioned that they did not like the tree (n = 8, 1% of 1312), the gifts (n = 13, 1% of 1312), or that there was too little variation in gifts (n = 12, 1% of 1312). Of all the adolescents who did not continue playing the app, some adolescents (n = 10, 3% of 396) mentioned the app not being motivating enough as their reason.

Some adolescents mentioned that they would like to change the gamification (n = 24, 2% of 1312), or the way that points can be earned (n = 13, 1% of 1312). When it comes to changing the way of earning points, adolescents suggested increasing the options to earn points, being able to earn more points, having a maximum number of points you can earn, or keeping the points they earned (instead of a weekly resetting of points). For changing the gamification aspect of the app, adolescents suggested playing individually, changing (the meaning of) the tree or the rewards, or changing the entire form of gamification. Two examples:

[…] I also didn't find the reward a good incentive after a while, because that tree could grow infinitely, so I thought, what's the point? Maybe it would be nice to unlock other things instead. (UE19, girl)

I would design it more for the entire age group. Instead of a tree with gifts, I would think of something else. I would rather think of, for example, a wishing well. When you receive a new gift, you can let people choose from different wishes which they can then put in their wishing well or hang in their wishing tree. You could add an extra feature where in sprint 5, for example, you can type a wish in your wishing tree or wishing well. This way, people also think about what they want in terms of wishes, and I think it's more interesting for the entire target group rather than a tree with gifts, which seems a bit childish to me. (UE19, girl)

T3.4 Attitudes on the CBT-based challenges

When adolescents mentioned why the app helped them, some adolescents mentioned that they liked the challenges (n = 55, 6% of 899). They mentioned that they started doing more fun things, became more physically active, or simply liked the challenge. A few other adolescents mentioned they did not like the challenges (n = 7, 1% of 899), for instance, because they thought they were boring, not fun, or not challenging enough. Of all the adolescents who continued using the app, some mentioned that they liked doing the challenges (n = 18, 2% of 914). Of all the adolescents who did not continue using the app, only a few mentioned not liking the challenges as their reason (n = 2, 0.5% of 396). As suggestions to improve the app, adolescents mentioned increasing the number of challenges per day (n = 28, 2% of 1312), adding a greater variation in challenges (n = 32, 2% of 1312), and the option to do challenges together with your team (n = 14, 1% of 1312). For example, this adolescent:

[…] You might have more interaction if there were challenges you had to complete as a team […] (UE19, boy)

4.4. T4 Intrinsic (de)motivators

This theme addresses adolescents' internal drivers and barriers that affect their willingness to engage with the app, which relates to their personal interest, dedication, and mental state.

T4.1 Curiosity and interest

One of the motivators of the adolescents who continued using the app was their curiosity (n = 38, 4% of 914) and interest (n = 79, 9% of 914) in using the app. We make a distinction between curiosity and interest. In this distinction, curiosity is more generally related to being curious about the workings of (specific aspects of) the app, while interest is more related to the effect that the app may have on one's mental health. For instance, adolescents were interested in whether the app would benefit their mental health, could teach them something, or were generally interested in the concept of mental health. For example:

I thought it was fun and appealing to learn more about myself. (UE21, girl)

Furthermore, of all adolescents who continued playing the app, some also mentioned they just generally liked the app as their motivation (n = 110, 12% of 914).

T4.2 Dedication and building a habit

From all adolescents who continued using the app, adolescents mentioned several reasons that relate to a sense of dedication and internalizing using the app. Some adolescents mentioned using the app became a habit (n = 8, 1% of 914) or it did not take them any effort (n = 22, 2% of 914). Others mentioned that if they start something, they also want to finish it (n = 77, 8% of 914), such as the following adolescent:

If I start something, I believe I must also finish it. (UE21, girl)

T4.3 Mental state and need for the app

Adolescents' mental state also impacted whether they used the app and/or found it helpful to use the app. Some adolescents mentioned that they did not need the app (n = 54, 6% of 1312), for instance, because they were already aware of their feelings and emotions throughout the day, or felt good mentally. Out of all the adolescents who stopped using the app, a few mentioned this was because they felt they did not need the app (n = 2, 0.5% of 396). In contrast, a need for help was also mentioned as a reason to continue using the app (n = 21, 2% of 914). These adolescents wanted to use the app to improve their mental health, which aligns with prior work on engagement with mental health apps (Lipschitz et al., 2020). At the same time, a few adolescents mentioned they stopped using the app because they were already receiving professional mental health care (n = 2, 0.5% of 396). For some adolescents, being in a bad mental state withheld them from using the app (n = 17, 4% of 396), which aligns with prior work in adults by Borghouts et al. (2021) and Zhang et al. (2021). For example:

[…] I was really feeling down during the last week, and then I just couldn't bring myself to engage with it. (UE22, boy)

T4.3 Forgetfulness and general disinterest

Of all adolescents who stopped using the app, several adolescents mentioned that the app was generally boring (n = 51, 13% of 396), or not fun (n = 12, 3% of 396). Furthermore, some adolescents mentioned that they forgot about using the app (n = 51, 12% of 396). Others mentioned that they did not feel like using the app (n = 12, 3% of 396). For example:

I forgot it and didn't feel like it. (UE22, boy)

4.5. T5 Social–environmental factors impacting usage

This theme addresses adolescents' external drivers and barriers that affect their willingness to engage with the app, which relates to other life-demands, contributing to science, social influences, or rewards as an incentive.

T5.1 Other priorities in life

Of all the adolescents who stopped playing the app, most of them mentioned they stopped playing the app because they were too busy with other things (n = 88, 22% of 396), for example:

I got a lot of schoolwork and didn't have time anymore. (UE22, boy)

These adolescents were too busy doing other activities or simply had other priorities, which is why they did not engage with the app. More specifically, a few adolescents mentioned they did not have time as they needed to go back to school physically after being at home due to the COVID-19 pandemic (n = 5, 1% of 396).

T5.2 Contribution to research

A driver to keep interacting with the app that was often mentioned by adolescents was contributing to science with their participation (n = 274, 30% of 914). Adolescents valued that they contributed to science with their participation. More specifically, some adolescents mentioned they wanted to contribute to the COVID-19 situation with their participation (n = 10, 1% of 914), as it would allow researchers to investigate how adolescents' mental health is affected by the pandemic.

It is an important study […] (UE21, boy)

Table 5
The subthemes used for the quantitative analysis (QA) of differences between user demographics. The description describes the subtheme after the edits were made for the purpose of the quantitative analysis, the examples show a subset of examples that could have been mentioned by the adolescents, and n describes the number of adolescents that mentioned this subtheme at least once (out of 1125 adolescents).

Subtheme	Description (QA)	Examples	n
T1.2 Technical issues	Issues related to the technical aspects of the app	Bad image quality, technical problems with notifications	74
T1.3 Perception of ESM	Issues related to the usability of the ESM questionnaires	Monotomy of ESM, timing of questionnaires, frequency of ESM	533
T1.4 Suitability for all users	The app does not align with all of its users	Too juvenile, should be better personalized	66
T2.1 Positive psychological impact	A positive psychological impact on the mental well-being	Increased awareness of emotions, more self-insights, more positive feelings	600
T2.2 Negative psychological impact	A negative psychological impact on the mental well-being	More focus on negative emotions, more phone use, annoyed or stressed by the ESM/app	110
T2.3 No or little effect of the app	No or very little impact of the app on mental well-being	App did not help, no effect of app	83
T2.4 Lack of psychological tools and/or insights	The app has too little tools to feel better	More depth in self-insights, more advice/tips on feelings	61
T3.1 Attitudes on social interaction in the app	Issues related to the social interaction in the app	Too little social interaction, stickers in chatfunction are not nice, adolescents want free-text chat, remove the chat	341
T3.2 Attitudes on playing in a team	Issues related to playing in a team	Team is not active, adolescents want a possibility to change the team, play individually	126
T3.3_pos Attitudes on gamification of the app	Positive attitude on (aspects of) the gamification of the app	The tree is nice, the gifts are nice, gamification motivates	164
T3.3_crit Attitudes on gamification of the app	Issues related to the gamification	The tree is not nice, gifts are not nice/too little variation, gamification format should be changed, add more games, play individually	92
T3.4_pos Attitudes on CBT-based challenges	Positive attitude on (aspects of) the challenges	The challenges are nice, more physically active, doing fun activities	62
T3.4_crit Attitudes on CBT-based challenges	Issues related to the challenges	Challenges are boring/not fun, there should be more (variation of) challenges, challenges in team format	67
T4.1 Curiosity and interest	Motivated by an intrinsic curiosity or interest	Curious in the app, interested in psychological impact of the app, playing because the app is fun	182
T4.2 Dedication and building a habit	Motivated by an intrinsic feeling of finishing what you start	It became a habit, it takes no effort, wanting to finish what you start	91
T4.4 Forgetfulness and general disinterest	Demotivated by an intrinsic feeling of disinterest	Not feeling like playing the app, forgetting to play the app, boring to play the app, the app is not fun	107
T5.1 Other priorities in life	Not playing the app because of being busy with other external things	Busy with other things in life, other priorities, no time due to school	74
T5.2 Contributing to research	Being motivated by contributing to science	Helping science, helping with the covid19 situation	244
T5.3 Influenced by another social actor	Another person/institution told them to (not) participate	Recommended by someone or school, obligated to participate by school, not obligated to participate all weeks by school/someone	111
T5.4 Reward as motivator	Participating to be able to gain a reward	Getting a voucher, airpods	75
No subtheme mentioned	N/A	N/A	13

T5.3 Influenced by another social actor

Furthermore, of all adolescents who continued playing the app, some mentioned that this was because someone recommended them to do so ($n = 44$, 5% of 914), for instance, based on a recommendation of one of their parents or school. Some adolescents mentioned it was made obligatory to participate by their school[8] ($n = 56$, 6% of 914), for example:

It was mandatory from school. (UE21, girl)

Of all the adolescents who did not continue using the app, some mentioned this was the case because it was not obligatory for them to participate ($n = 19$, 5% of 396).

T5.4 Reward as a motivator

Some of the adolescents who continued using the app mentioned they did so because of the reward (a lottery with all other adolescents) for their participation ($n = 84$, 9% of 914), for example:

[...] and the motivation from the chance to win AirPods. (UE21, boy)

[8] One school told their students to participate in the study.

4.6. Exploratory quantitative analysis on user demographics

4.6.1. Selection and edits of subthemes

An overview of our analyzed subthemes for our quantitative analysis, together with a description and sample size, can be found in Table 5. For our quantitative analysis, we disregarded *(T1.1) Attitudes on the visual design* as this subtheme is very broad and some interesting items are also captured by other themes (e.g., the visual appearance of the gamification in T3). Furthermore, we disregarded *T4.3* Mental state and need for the app, as this subtheme consists of different perspectives, and splitting this subtheme would result in a very low sample size (not more than 21 adolescents out of 1125). In some subthemes, we removed one (*T1.3, T3.1*) or two (*T1.4, T3.2*) of the codes that represent the subtheme to represent a more coherent view. Similarly, two subthemes (*T3.3, T3.4*) were split to represent positive and critical attitudes related to the subtheme. An overview of all subthemes can be found in Table 5. Details about the adjustments that have been made can be found in the Supplementary, Section 1.2 .

4.6.2. Data analysis

Our logistic regression models identified significant effects of age, sex, and educational level for several subthemes. These results can be found in Table 6 and are visualized in Fig. 3. Tables including results for predictor and confounding variables of all tested subthemes can

Table 6
The significant ($p < 0.05$) predictors of the logistic regression models for each subtheme. The predictor variables *Educational level medium* and *high* are compared against a *low educational level*. For the predictor variable *sex*, being a *boy* was compared to being a *girl*. In total, regression models were created for 20 subthemes. For clarity, only the results of significant coefficients are shown.

Predictor	Subtheme	β	SE	z	p
Age	T1.2 Technical issues	0.322	0.13	2.484	0.013
	T1.3 Perception of ESM	0.339	0.072	4.739	0
	T2.2 Negative psychological impact	0.323	0.11	2.951	0.003
	T2.3 No or little effect of the app	−0.414	0.14	−2.944	0.003
	T2.4 Lack of psychological tools and/or insights	0.485	0.143	3.381	0.001
	T3.1 Attitudes on social interaction in the app	−0.295	0.08	−3.665	0
	T4.1 Curiosity and interest	−0.279	0.096	−2.906	0.004
	T4.2 Dedication and building a habit	0.361	0.119	3.031	0.002
	T5.3 Influenced by another social actor	−0.795	0.156	−5.081	0
	T5.4 Reward as motivator	−0.849	0.175	−4.845	0
Educational level - medium	T3.1 Attitudes on social interaction in the app	−0.458	0.229	−2	0.045
Educational level - high	T2.1 Positive psychological impact	−0.429	0.212	−2.022	0.043
	T3.1 Attitudes on social interaction in the app	−0.441	0.209	−2.107	0.035
Sex - boy	T1.2 Technical issues	0.931	0.269	3.465	0.001
	T2.1 Positive psychological impact	−0.431	0.166	−2.59	0.01
	T4.2 Dedication and building a habit	−1.072	0.408	−2.629	0.009
	T5.3 Influenced by another social actor	0.625	0.233	2.684	0.007
	T5.4 Reward as motivator	1.002	0.262	3.822	0

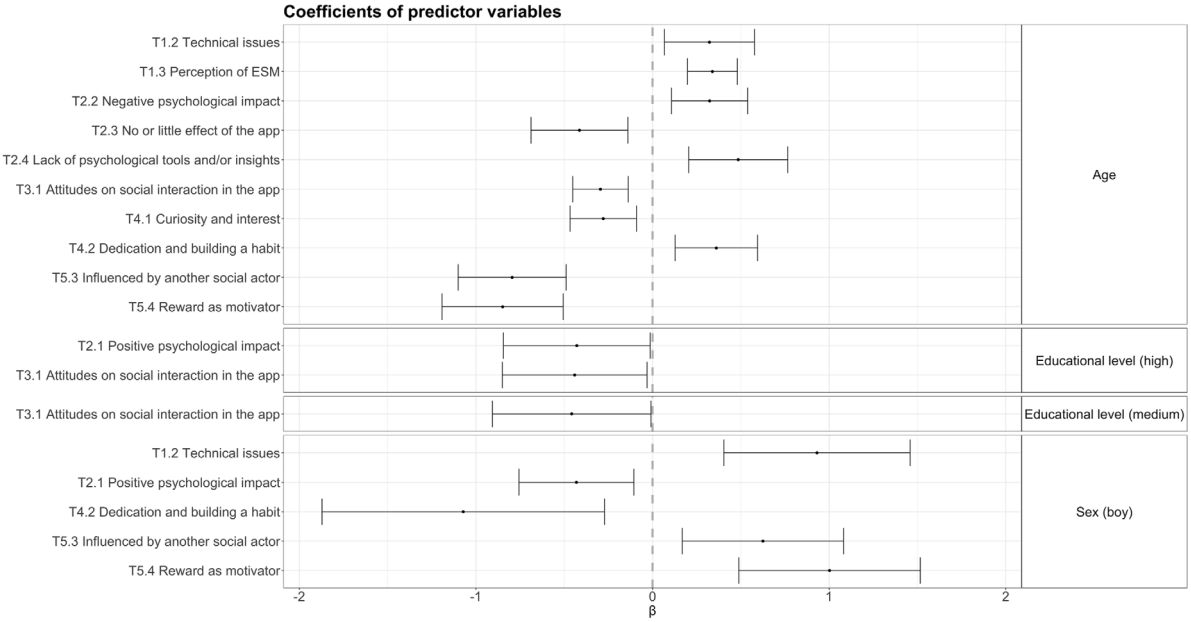


Fig. 3. The coefficients (95% confidence interval) of the predictor variables (*Age*, *Educational level (high)*, *Educational level (low)*, and *Sex (boy)*) related to the subthemes. The predictor variables *Educational level medium* and *high* are compared against a *low educational level*. For the predictor variable *sex*, being a *boy* was compared to being a *girl*. For clarity, only significant coefficients are visualized.

be found in the Supplementary, Section 2. The strongest effects were found for age and sex. Older adolescents more often mentioned aspects related to technical issues (T1.2), issues with the usability of the ESM (T1.3), the negative psychological impact of the app (T2.2), a lack of psychological tools and/or insights (T2.4), and having motivation due to dedication and building a habit (T4.2) compared to younger adolescents. Younger adolescents more often mentioned no or little effect of the app (T2.3), issues related to social interaction (T3.1), curiosity and interest as a motivator to use the app (T4.1), recommendations by others to use the app (T5.3), and being motivated by the reward for participation (T5.4) compared to older adolescents.

For the educational level, we found that adolescents from a high educational level mentioned less positive psychological impact of the app (T2.1) and fewer issues related to social interaction (T3.1) compared to adolescents with a low educational level. Adolescents with a medium educational level also showed fewer issues related to social interaction (T3.1) compared to those with a low educational level.

For sex differences, we found that boys more often mentioned technical issues (T1.2), participating due to the recommendation of others (T5.3), and being motivated by the reward (T5.4) compared to girls. Girls more often mentioned the positive psychological impact of the app (T2.1), which aligns with work indicating that girls generally have greater self-awareness and reflection compared to boys (Antezana et al., 2022; Burwell & Shirk, 2007), and using the app due to dedication and building a habit (T4.2) compared to boys.

5. Discussion

Our study aimed to contribute to the understanding of adolescents' needs and preferences regarding an mHealth app (RQ1) and explore

Table 7
Overview of the design implications together with concrete suggestions and to which subthemes from the thematic analysis they are informed by.

Design Implication	Concrete suggestion(s)	Related subthemes
Personalize self-monitoring	• Allow user to customize the content of the questions • Align the timing of the questionnaires with user's usage pattern	T1.3 Perception of ESM T1.4 Suitability for all users T2.1 Positive psychological impact T2.2 Negative psychological impact T2.4 Lack of psychological tools and/or insights T5.1 Other priorities in life
Include actionable insights	• Provide personalized algorithmic advice on how user's behaviors relate to well-being	T2.3 No or little effect of the app T2.4 Lack of psychological tools and/or insights
Align content with personal needs	• Algorithmic personalization of the offered content (e.g., exercises, information) based on the user's momentary and future needs • Increase user's awareness of the potential benefits of the offered content	T2.3 No or little effect of the app T2.4 Lack of psychological tools and/or insights T3.4 Attitudes on the CBT-based challenges
Implement meaningful interactive features	• Combine team-based competitions with individual competitions • Make sure the reward is meaningful when using gamification • Use privacy-sensitive social communication that allows to convey a message	T3.1 Attitudes on social interaction in the app T3.2 Attitudes on playing in a team T3.3 Attitudes on gamification of the app
Make the app appealing to the entire target group	• Allow users to customize the visual design of the app • Increase boys' awareness of the positive psychological effects	T1.1 Attitudes on the visual design T1.4 Suitability for all users T2.1 Positive psychological impact T4.2 Dedication and building a habit T5.3 Influenced by another social actor T5.4 Reward as a motivator

possible differences based on user demographics (RQ2). Based on the thematic analysis of the open-ended user experience questions, we analyzed the needs and preferences of adolescents related to an mHealth app. We found that adolescents value aspects of the app that relate to usability, psychological impact, and implemented interactive features. Besides the themes that are directly related to features within the app, we have also identified themes that are more directly related to the user and indirectly to the app. These themes are about the intrinsic (de)motivators and social–environmental factors that impact adolescents' usage of the app. Furthermore, our exploratory quantitative analysis identified several differences in adolescents' needs and preferences based on age, sex, and educational differences. Personalization of certain aspects of the app might help to align the app toward all these different user needs and preferences (Torous et al., 2018). In our discussion, we will reflect on these findings by drawing design implications and directions for future research.

5.1. Design implications and future directions

Based on the identified needs and preferences, we have derived some main design implications for the future development of real-world mental health apps for the general population. Below, we describe the main design implications and suggestions for future directions. An overview of the design implications can be found in Table 7. The design implications are set up to develop an app to promote users' mental health. Therefore, design implications might not always be relevant for the development of apps with a different objective, such as data collection or a more clinical setting.

5.1.1. Personalize self-monitoring

Allowing adolescents to expand or customize the content and timing of the ESM questions to their personal needs (where meaningful) might positively affect how adolescents value the self-monitoring aspect of a mental health app. By personalizing the self-monitoring questions, adolescents can track information that they believe is meaningful to monitor, which might increase the perceived usefulness. As a result, adolescents' motivation to adhere to self-monitoring might increase, as perceived usefulness is considered to be a key factor in promoting engagement of technological systems (Lee et al., 2005). As an example, for adolescents who tend to focus too much on negative feelings when self-monitoring, it might be beneficial to shift focus to positive aspects and feelings throughout the day by reflective ESM questions, rather than the negative feelings (Hollis et al., 2017). Additionally, providing adolescents with more control over the timing and content of the ESM questionnaires might positively impact their sense of autonomy. A feeling of autonomy can positively impact intrinsic motivation according to the Self-Determination Theory (Ryan & Deci, 2000). In line, Horsch et al. (2017) have found that giving users control over the timing of reminders can facilitate a feeling of self-empowerment and mediate adherence to self-monitoring. Future studies could further investigate how self-monitoring questions can best be aligned with personal needs, both regarding content and timing.

5.1.2. Include actionable insights

While self-monitoring by itself already had a positive psychological effect on many adolescents, including actionable insights from the collected data might further enhance the value of self-monitoring for adolescents (Rapp & Cena, 2016). Some adolescents in our study explicitly expressed the need for more tools to promote their mental well-being, such as personalized advice based on the ESM questions. A subset of adolescents from this study was already able to gain real-time personalized insights in their ESM data using the mood profile (Dietvorst et al., 2024). These adolescents could see their average mood ratings based on different contexts (e.g., based on their location, sleep quality, with who they were, how much exercise they did, etc.). While the mood profile allows adolescents to gain insights into their mood based on one specific context at a time, it requires complex analytical effort to translate these insights into actionable insights (Choe et al., 2014; Hollis et al., 2017), as multiple behavioral and environmental factors can work together and impact well-being dynamically. Machine learning models can aid in detecting complex patterns of how specific behavior and context relate to well-being and derive actionable insights (Bentley et al., 2013; G. Mitchell et al., 2021; Hollis et al., 2017; Nosakhare & Picard, 2020). Such tools can thus be used to provide

adolescents with personalized real-time insights on which measured daily behaviors can benefit their mental well-being, suggesting rich grounds for future work.

5.1.3. Align content with personal needs

Personalizing content (e.g., exercises or offered information) within the app related to the psychological mechanisms, such as the CBT-based challenges in the Grow It! app, and increasing adolescents' awareness of their potential benefits could perhaps improve the alignment of the content with personal needs. From a clinical perspective, the meta-analysis of Swift et al. (2018) has shown that aligning psychotherapy with clients' preferences can improve therapy outcomes and decrease drop-out. Also, for eHealth that promotes the mental health of the general population, the review of Saleem et al. (2021) identified that personalization can promote engagement. Within the Grow-It! app, the CBT-based challenges promote different types of adaptive coping strategies. The effectiveness of different coping strategies can depend on the specific person and situation (Kobylińska & Kusev, 2019). Personalizing the challenge type based on adolescents' needs might help to equip adolescents with a diverse set of coping skills, increasing adolescents' resilience in various situations. Machine learning models may offer interesting opportunities for personalizing such exercises based on users' (mental) state and context (Oyebode et al., 2023), similar to Just-In-Time Adaptive Interventions (JITAIs) (Nahum-Shani et al., 2018). Future studies can investigate ways to use algorithmic support to tailor exercises within mental health apps toward the needs of an individual and explore the potential benefits.

Our results indicate that not all adolescents seemed to be aware of the psychological mechanism (adaptive coping) related to the challenges, as this was not directly communicated to the adolescents. Psychoeducational information (i.e., explaining why something is offered and what psychological mechanisms are behind it) may improve willingness to engage with eHealth (Apolinário-Hagen et al., 2018). Therefore, explaining the potential benefits of the challenges, on top of personalizing the suggested challenges, might make adolescents more willing to engage with the challenge and become aware of the benefits. Future studies could investigate various ways of increasing adolescents' awareness of the potential benefits of a mental health app and how this relates to adherence.

5.1.4. Implement meaningful interactive features

Adolescents expressed the need for interactive features, such as playing in a team, incorporating gamification, and a chat function, to be meaningful for it to have (a greater) added value. For instance, developers should be careful when implementing team-based features into mental health apps, as their impact on users' motivation can work out both negative or positive, depending on the activity of team members. One way to mitigate this effect while still allowing for a cooperative-competitive game design is to include an individual competition next to the team-based competition (Featherstone & Habgood, 2019). This way, adolescents are still able to win independently of the activities of their team members. Other suggestions would be to provide adolescents with the choice to compete individually or in a team, change inactive teams, or only allow team-based competition for adolescents who have obtained a minimum activity level (e.g., using the app at least several times a week).

Furthermore, to improve the relevance of gamification for all adolescents, the content of the gamification could be tied to the purpose of the app (Ribanszki et al., 2021; Sardi et al., 2017). As suggested by one of the adolescents, the meaning and purpose of the reward could be improved. One way to add meaning to the reward would be to unlock badges that represent specific accomplishments (Sardi et al., 2017). This way, other types of behaviors, rather than obtaining the most points, can be stimulated, such as stimulating active participation of all team members on the same day to promote cooperation within the team, or stimulating positive behavior change, such as practicing a new coping strategy. Another way to increase the meaning of the reward would be to unlock an interactive reward. For instance, a reward could come with new exercises or tools to further promote their well-being (Ribanszki et al., 2021). Furthermore, unlocking features to further personalize an avatar could increase user retention (de Groot & Gadiraju, 2024). This avatar could then be used to communicate with other adolescents in a privacy-sensitive way to promote social relatedness (Torkamaan & Ziegler, 2021), which can improve adolescents' intrinsic motivation (Ryan & Deci, 2000).

In line with promoting social relatedness, improving the social interaction between adolescents in the app was often mentioned by adolescents. Although the possibility of interacting with free text is something that adolescents often mentioned, it imposes risks regarding adolescents' privacy, bullying, or negative peer pressure. One option to increase social communication between team members would be to use pre-made sentences instead of stickers. Another solution would be to remove the chat function and facilitate another way to increase social relatedness, which is also done by playing in a team. To still be able to stimulate team members to participate actively, a "poke" button could be incorporated that adolescents can press to stimulate their teammates to engage with the app.

5.1.5. Make the app appealing to the entire target group

Adolescents' comments on the visual design of the app varied from person to person, implicating different needs and preferences for how the app should look. Furthermore, for some adolescents, the app felt too juvenile. Interestingly, our exploratory analysis did not find support for a relationship between the juvenility of the app and age. We suggest customizability as a solution to align the app more with its users. Allowing users to tweak aspects of the visual design of the app might allow the app to align with a greater variety of needs and also provide adolescents with autonomy (Torkamaan & Ziegler, 2021). However, developers should be aware of not overburdening users with customizable options (Ribanszki et al., 2021; Zhang et al., 2021), for example, by making it optional. Furthermore, we suggest future developers of mental health apps look for more ways to make these apps more appealing to boys, as boys seem more often driven by external factors than girls. Perhaps by making them more aware of the positive psychological impact that the app could have, as this was less often mentioned by boys compared to girls.

5.2. Designing with conflicting needs

Our design implications prioritize users' needs and preferences, with the goal of building a real-world app, which might not fully apply to mental health apps where other needs are critical. For instance, when the goal is to collect data for research. In this case, the design choices for ESM measurements (e.g., sampling strategy, number of assessments, type of items, etc.) are dependent on the research questions (van Roekel et al., 2019). A study may require adolescents to complete five random assessments daily for sufficient statistical power and measurements across different contexts. As a result, adjusting the assessment schedule to suit adolescents' needs and preferences may not be feasible. In that case, the app's primary goal is data collection, not necessarily creating a sustainable real-world app. In this regard, van Roekel et al. (2019) describes best practices to increase ESM compliance. Nevertheless, aligning the design of the app as much as possible with user needs might contribute to collecting good-quality data and increasing compliance.

Even within our design implications for real-world mental health apps, conflicting user needs may arise. For instance, when personalizing the content of the app (such as CBT-based challenges) using a machine learning model, the model requires sufficient data or data collected at certain time points to reach a good performance. If the user prefers to use the app less frequently, this might decrease model performance. In this situation, the user might value both needs: their schedule and

receiving accurately personalized content. Future work could explore ways to address these conflicting user needs. For instance, one way could be by enhancing users' perceived usefulness of specific design choices by clearly explaining the importance of design choices (Giboney et al., 2015; van Roekel et al., 2019). Explaining the consequences of certain behaviors (e.g., using the app less frequently) on functionalities of the app (e.g., quality of personalization) may allow users to make informed decisions on what they value most and adjust their usage behavior accordingly.

5.3. Strengths, caveats, and limitations

Our study analyzed a total of 4833 open-ended survey responses from 1312 Dutch adolescents from the general population, which can be considered a large sample size for qualitative data (Chandrasekar et al., 2024). This large dataset supports a rich thematic analysis, a robust thematic saturation, and strengthens the reliability of the user experience insights. Because adolescents answered the user experience questionnaire after a period of 3 or 6 weeks of using the app, they had a thorough understanding of the app's functionalities and their own lived experience related to using the app. Therefore, the user experience insights reflect more authentic and ecologically valid experiences compared to, for instance, providing feedback after testing the app for only a short period of time (e.g., during a single session). Moreover, the use of multiple open-ended questions allowed adolescents to express their lived experience using their own words, which allowed us to capture richer and more nuanced descriptions of their experiences compared to closed-ended questions.

Besides the strengths of our study, there are also some limitations. First, adolescents used the Grow It! app during the COVID-19 pandemic. This included some governmental restrictions that varied within our data (such as a curfew and online classes). We have controlled for the differences in restrictions in our quantitative analysis. However, it is unclear if the pandemic might have influenced adolescents' user experience with the app.

Furthermore, our sample mainly consisted of adolescent girls (77.1%), highly educated (54.59%), and having a specific Dutch cultural identity (91.32%), which also imposes limitations on the generalizability of the insights we synthesized. As adolescents did not receive monetary compensation for their participation, it could be that this group is naturally more interested in mental health apps or contributing to science. In line, our findings showed that these were the two biggest motivators for adolescents who kept using the app. Moreover, our results do not include the views of adolescents who dropped out early (56%) or were not interested in starting to play the Grow It! app in the first place, which could describe reasons for uptake. Therefore, our findings might not directly translate to adolescents who are not already interested in using a mental health app or value their contribution to science. Future studies could include a more diverse group of participants and viewpoints of non-users, as these insights could be valuable when expanding the group of adolescents interested in using a mental health app.

While theme frequencies imply theme consistency, lower frequencies do not necessarily imply irrelevance (Clarke & Braun, 2021). Through qualitative analysis of open-ended survey responses, we identified the needs and preferences of adolescents. When an adolescent mentions a need or a preference, it is assumed that they value it, but we cannot draw inferences about less frequently mentioned needs. These may either be uncommon or original, but still significant. Therefore, future research should further explore the importance of these needs with the target group, possibly using large-scale closed-ended questionnaires to rate the importance and relevance of the identified needs.

6. Conclusions

To improve the engagement and effectiveness of mental health apps for adolescents, we need to obtain a better understanding of their needs and align the apps to those needs. Our work enriches the understanding of adolescents' needs regarding such apps based on qualitative user insights of 1312 adolescents. Our findings complement existing explorations into understanding adolescents' needs, and our insights uncover new grounds that can inform the design of future mental health apps. Our exploratory analysis showed that adolescents' needs can differ based on demographic differences, predominantly based on age and sex. These findings suggest that there does not exist a one-size-fits-all set of needs that a mental health app needs to comply with. Therefore, personalization toward individual needs might prove to be effective.

We translated our findings into five design implications that capture the personalization of several elements of the app. By establishing a better understanding of adolescents' needs and setting up design implications, we hope future developers are better equipped to align mental health apps toward adolescents' needs and ultimately promote adolescents' mental health.

Ethics statement

This study is approved by the Medical Ethics Committee of the Erasmus Medical Center (MEC-2020-0287). The study was conducted in accordance with the local legislation and institutional requirements.

CRediT authorship contribution statement

Esra Cemre Su de Groot: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Formal analysis, Conceptualization. **Lianne P. de Vries:** Writing – review & editing, Validation, Methodology, Formal analysis, Data curation. **Ujwal Gadiraju:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization. **Olya Kudina:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization. **Loes Keijsers:** Writing – review & editing, Funding acquisition, Conceptualization. **Manon H.J. Hillegers:** Writing – review & editing, Funding acquisition, Conceptualization. **Willem-Paul Brinkman:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.chbr.2026.101109.

Data availability

In our paper, we refer to the codebook of the data that we used from the original Grow It! study. Here, a data request form can be found to request access to the data. The paper also presents a link to the code of our analysis. In this link, also our codebook that was used for our qualitative analysis can be found.

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