Original Article

mHealth app features that facilitate adolescent use for lifestyle management, and are endorsed by caregivers and health care providers

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Contributions: (I) Conception and design: P Ghosh, A Braddock; (II) Administrative support: None; (III) Provision of study materials or patients: P Ghosh, AK Tosh, A Braddock; (IV) Collection and assembly of data: All authors; (V) Data analysis and interpretation: P Ghosh, KT Bosworth, L Flowers; (VI) Manuscript writing: All authors; (VII) Final approval of manuscript: All authors.

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Background: Mobile health (mHealth) apps are becoming a promising tool to motivate sustainable lifestyle and behavior changes, including modifications to diet and exercise. However, most current mHealth apps do not have meaningful, and sustained user acceptance, particularly, among adolescents. They perceive mHealth apps designed for adults to be tedious and visually unexciting, which discourage adolescent usage. Researchers and adolescent mHealth app developers would benefit from a foundational understanding of which functions and features adolescents feel would most motivate app use. Capturing caregivers' and health care providers' inputs are also important as both groups play an integral role in adolescent health care decision-making. The purpose of the study is to explore and analyze mHealth app features identified by adolescents, caregivers, and health care providers that have the potential to inspire continued use, thereby resulting in sustained health behavior changes in adolescents.

Methods: We used inductive thematic analysis of qualitative data obtained from semi-structured focus groups conducted via Zoom©. Important features of mHealth apps that encourage adoption and continued use were explored with 25 participants, including adolescents, their caregivers, and health care providers.

Results: Common features facilitating continual usage of mHealth apps that were identified as significant by participating adolescents, their caregivers and health care providers were: look and feel of the app, customization, educational information/recommendations, and integration with electronic health record. Features such as gamification and social interaction that are usually lacking in current adolescent mHealth apps were well recognized as meaningful for motivational purposes.

Conclusions: The findings suggest that adolescents and caregivers identify an app as valuable when it is user-friendly and intuitive and appreciate features that are motivating and can engage users in positive behaviors. Health care providers prefer mHealth apps that are user-friendly and can be effectively integrated into the cycle of care, thereby enabling delivery of efficient and value-based health care. Thus, mHealth app designs that are informed by health care providers' clinical experience and needs, in combination with app features that are desired and supported by both adolescents and their caregivers, have the potential to motivate widespread adoption and long-term use, which could result in improved health behaviors and outcomes among adolescents.

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Keywords: Mobile health app (mHealth app); health behaviors; caregivers; adolescents; health care providers

Received: 17 January 2024; Accepted: 27 April 2024; Published online: 05 July 2024.
doi: 10.21037/mhealth-24-3
View this article at: https://dx.doi.org/10.21037/mhealth-24-3

Introduction

Background

Efficient management of chronic health conditions in adolescents is important as it plays a key role in their growth and development and reduces future health risks. For example, adolescent obesity is considered a strong predictor of obesity and higher mortality in adulthood (1). Adolescents with overweight, were almost 18 times more likely than their non-overweight peers to be affected by obesity in early adulthood and 8.5 times more likely to develop hypertension as young adults than the non-overweight group (1-3). Evidence also suggests that chronic health conditions may aggravate due to sedentary lifestyles like lack of exercise (4) and unhealthy behaviors. Improving patients' ability to manage their own health and make informed decisions plays a crucial role in boosting health behaviors/lifestyle and management of chronic health conditions (2). While lifestyle management in everyday life can be challenging, mobile health (mHealth) applications (apps) have been shown to be powerful support tools in improving routine health behaviors, e.g., Chen *et al.* 2014, have shown that mHealth apps can improve short-term body mass index (BMI) among adolescents (5). mHealth apps have also been found to play a supporting role in managing multiple chronic diseases such as diabetes, heart disease, cancer, asthma, and hyperactivity among adolescents and adults (6-8). Serving as a cost-effective tool to support self-management (9), mHealth apps facilitate monitoring of health issues and symptoms remotely (9,10). Patients using mHealth apps can capture their health data without having to remember them or jot them down manually (11) which in turn helps them to share their data with health care providers resulting in increased awareness and more efficient self-management of chronic diseases (12).

The widespread accessibility of smartphones presents unique value-adds for new health-promoting technologies. Smartphones paired with robust mHealth apps, have the potential to engage and empower patients in a personalized, accessible, and sustainable manner. An mHealth app is defined as "the application of mobile technologies, including phones, tablets, telemonitoring, and tracking devices, to support and enhance the performance of health care and public health practice" (13). Presently, 95% of Americans own a mobile phone, 77% (14) have a smartphone with app capabilities, and 70% of adults use some sort of health tracker for themselves or for their family members (15). In 2018, studies showed that a majority of adolescents (95%) had access to a smartphone (16,17). Data from the Pew Research Center show that digital technology use among rural Americans have increased over the past decades, narrowing some digital gaps (18). A study based on Washington State school districts reported that a lower mean percentage of rural youth had access to internet-enabled devices than their urban counterparts (80.0% *vs.*

Highlight box

Key findings
- To ensure long-term use, adolescents', caregivers', and health care providers' identification of and enthusiasm for app features are crucial in the development of mHealth apps.
- Gamification and social interaction are significant in motivating widespread adoption and long-term use of mHealth apps among adolescents.

What is known and what is new?
- A majority of adolescent mHealth apps designed for management of chronic diseases is usually adapted from apps developed for adults and lacks engagement and feedback from users and relevant stakeholders.
- This study focuses on capturing the voices of adolescents, caregivers, and health care providers in identifying mHealth app features that can encourage sustained app use and improve adolescents' health behaviors.

What is the implication, and what should change now?
- To motivate adolescents and empower them to manage self-health care through use of mHealth apps, patients' and relevant stakeholders' engagement is valuable in identifying the most useful app features.
- Further research is needed to explore the psychology of gamification and its use in promoting positive health behaviors.

90.1%) (19). This tracks with the Pew Research Center data showing that 80% rural U.S. adults owned smartphones *vs.* 89% of urban U.S. adults in 2021 (18). Similarly, according to Graves *et al.* 2021, rural school districts in Washington State reported a lower mean percentage of students with access to broadband compared to urban districts (67.5% *vs.* 84.2%) (19)—comparable to the 2021 Pew Research Center study that showed 72% rural U.S. adults had access to home broadband *vs.* 77% urban U.S. adults (18). This growing accessibility has not only facilitated availability of mHealth apps for extensive patient populations (consumers/users), but also for traditionally underserved groups, such as rural and low-income populations. The international mHealth app industry is large and growing. It was estimated that the global mHealth industry generated revenues of $57 billion in the fiscal year 2022 (20) alone and is projected to grow to $236 billion by 2026 (21).

Rationale and knowledge gap

Tools like mHealth apps have the potential to help reduce the burden of chronic diseases (6) that affects 50% of the U.S. population and results in 86% (7) of annual health care spending ($3.7 trillion/year) (8). Apps that can help prevent, slow, and manage chronic diseases such as obesity, diabetes, etc. can improve care and patient quality of life. A study (22) conducted by Cleghorn *et al.* in 2019 demonstrated that national mass media advertising of certain weight loss promoting mHealth apps led to wider adoption and resulted in an increase in quality-adjusted life-years and decrease in cost to the health system in New Zealand. Although mHealth apps have shown potential to improve health behaviors, e.g., enhancing physical activities and dietary habits, and improving short-term (less than 12 months) BMI in adolescents (5), unfortunately, most existing apps lack scientific evidence (23,24), and are not developed by health care experts utilizing relevant stakeholder (e.g., user/adolescent, caregiver, and provider) inputs (23).

Most mHealth apps are created for and used by adults. Currently only 21% of adolescents have downloaded an mHealth app, and only 8% use them regularly (25). One of the limitations adolescents have identified as a deterrent toward wider adoption of mHealth apps is that a majority of available apps are designed for adults or adapted from them, i.e., they are not developed with adolescent inputs (25). In our prior work, we also found that an mHealth app developed and designed based on adolescent feedback improved the potential for widespread adoption and long-term use (26).

Adolescents often make health decisions and app purchases based on inputs from their caregivers and health care providers (25,27-30). Thus, it is crucial to also understand what features these two groups value and find useful in providing care, along with their perceptions regarding the adolescent's use of mHealth apps. And while adolescents value the engagement of caregivers in their health care, they also desire confidentiality with their health care providers (31), and the latter are expected to provide the balance between caregivers' involvement and adolescents' privacy. Thus, actively involving health care providers and taking their recommendations into account in implementing at-home health behavior interventions, has been demonstrated to result in better and more sustained health outcomes, e.g., weight loss (32,33). One study has also shown that a combination of an mHealth technology and in-person provider counseling is the best means of achieving and maintaining a healthy weight (34).

Both caregivers and health care providers play an essential role in supporting and increasing awareness about sustainable health behaviors among adolescents. Adolescents who lack a comprehensive support system, are often vulnerable to engaging in health behaviors that are detrimental and risky, leading to poor health. Literature has shown that caregiver involvement and motivation play an integral role in increasing adolescent participation in health care decision-making (28). Clinicians who play a role in decision-making not only have an understanding of adolescents' preferences, but also like to see at-home use information via electronic health records (EHRs) that can help with regular monitoring and can be comprehended quickly during routine clinic visits (35). Evidence has shown that EHR tools can assist with chronic medical management (35-37) and prevention of chronic diseases (38-42).

The current model for clinic-based provider/patient engagement for adolescents is limited in its ability to provide meaningful and sustained weight management strategies and improving health behaviors. This results from the absence of needed continued engagement and limited communication, and lack of use of adolescents' preferred method of engagement using apps (26,43). Where mHealth apps are available, many fail because users are not incentivized to continue to use them after initial download (44). Previous studies have highlighted feedback on mHealth apps on certain features that drive engagement (45-47) some of which are also captured in this study. However, current literature has revealed gaps in capturing adolescent's preferred features

which are endorsed by caregivers and health care providers to facilitate continual usage of mHealth apps by adolescents (25,27-29). Through understanding and analysis of user preferences, augmented by the support and engagement of caregivers and health care providers in helping adolescents navigate the health care system and take control of their own health through effective use of mHealth apps, we are addressing an important gap in existing literature.

To the author's knowledge, this is the first study that captures feedback and inputs from all groups associated with promoting healthy behaviors among adolescents through use of mHealth apps, namely, the adolescent users themselves, their caregivers, as well as health care providers.

Objectives

The purpose of the study is to explore mHealth app features identified by adolescents, caregivers, and health care providers that would motivate continuous app use by adolescents, thereby resulting in sustainable health behavior changes. Studies show that effective use of technology could improve communication and engagement between adolescents and their health care providers (30) and that adolescents could start using mHealth apps if their doctor recommended it (25). Caregiver motivation, direct communication and information sharing have been identified as fruitful strategies for increasing adolescent involvement and engagement in health care decision-making (28). Findings also encourage health care providers to engage caregivers in shared decision-making about their adolescents' care (27). Overall, both caregivers and health care providers play an essential role in supporting and increasing awareness about sustainable health behaviors among adolescents (25,27-30). Recognizing the important role that caregivers and health care providers play in encouraging adolescents to make health behavior changes through use of mHealth apps, we conducted separate focus groups with caregivers, and health care providers to understand which features all three groups value the most. Preferences captured from all three groups can better inform design and implementation of engaging mHealth apps.

Methods

Approach

To accomplish our objective, we utilized a user-centered approach with multiple cycles of iteration and improvement—analyzing if the needs were addressed effectively and efficiently by the design, and then iterating the design process with more clarity in understanding of needs (48-51). We started by developing paper wireframes that were translated into static prototypes using Adobe Photoshop. As described in *Figure 1*, a static prototype 1 based on our first digital iteration was presented to our focus groups. Feedback from our participants, identifying features/themes that would improve usability as summarized in this study, were incorporated in our design iterations. Prototype 2, shown in *Figure 1*, is an overview of the final design iteration post-focus groups. Themes/features recurring in participant feedback were identified and implemented in prototype 2—successful incorporation of individual features was used as a measure of design iteration improvement.

CommitFit is an mHealth app designed by expert clinicians at University of Missouri (MU) Healthcare to help adolescents improve their health behaviors and manage their weight which is accomplished through empowering the users to set and achieve healthy lifestyle goals. We created the app in collaboration with adolescents, caregivers, and health care providers. Hence, our study echoes the voices of users and key stakeholders representative of the population that has a comprehensive understanding of factors driving adoption and long-term use of mHealth apps for lifestyle changes and improved health behaviors among adolescents.

Recruitment and participants

After obtaining a Health Insurance Portability and Accountability Act (HIPAA) waiver and Institutional Review Board (IRB) (#2054598) approval from the University of Missouri, we referred to a list (based on EHR) of adolescent patients [age: 13 to 15 years old] and caregivers from MU Health Care clinics. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). Participating caregivers had children between the ages of 13 and 15 years. All caregivers had adolescents participating in the focus groups except one caregiver who participated by themselves. We attempted to recruit adolescents and caregivers from diverse backgrounds, e.g., African American ethnicity, low-income, overweight, or obese, and rural community. The following inclusion criteria were used to select adolescents for the study: they had to be between age 13 and 15 years, had to speak English fluently, read at the 6th grade level or higher, and be proficient with smartphone app use. Adolescents who had a pre-existing severe mental health diagnosis (other than mild or controlled anxiety and/or depression), intellectual disabilities, or eating disorders were

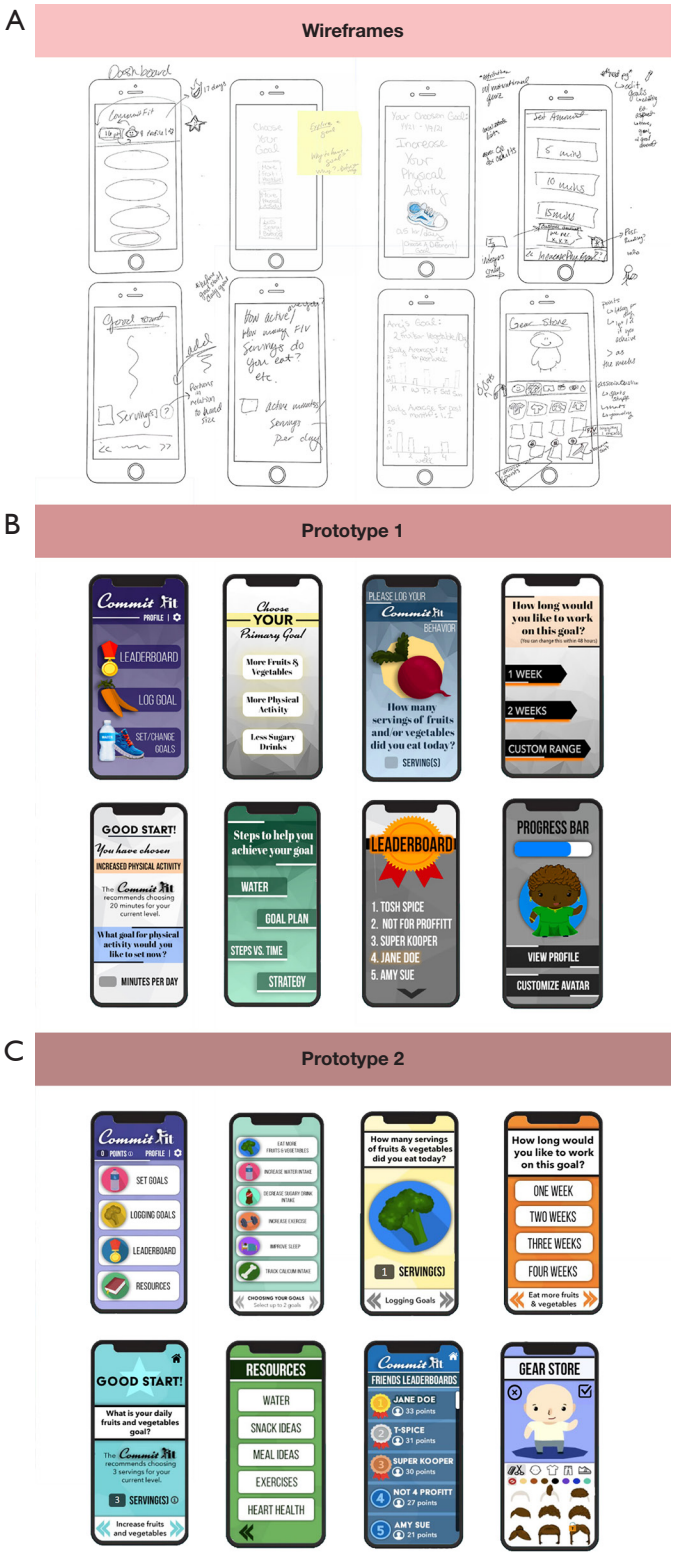

Figure 1 Overview of the iterative design process as user feedback was incorporated. (A) Wireframes developed by health experts; (B) prototype 1: overview of first digital design iteration (presented during focus groups); (C) prototype 2: overview of final design iteration post-focus groups.

Table 1 Examples of semi-structured focus group questions

Participant category	Example questions
Adolescents	Tell me about an experience trying to improve your health using an app
	What features would make you more likely to continue or avoid using the app?
	What basic health behavior elements would you want mHealth to have?
	How often would you likely review your health behaviors and goals?
	Would you want to share your progress with your health care provider or parents?
	What did you like the most and least about CommitFit?
Caregivers	Do you have any concerns that apps like CommitFit will increase their phone use?
	Would you use this information to facilitate conversations around health behaviors?
	How likely would this app influence your teen's health behaviors?
	How would you motivate your adolescents to use the "CommitFit" app?
	What features would make adolescents more likely to continue or avoid using the app?
	What did you like the most and least about CommitFit?
Health care providers	Do you use any technology tools/apps for addressing weight or lifestyle in your clinic?
	How do you use the growth curves if you do bring them up in clinic?
	How do you approach weight and lifestyle related conversations with adolescents in the clinic visit currently?
	How do you think health care providers are using that information right now?
	How to increase engagement using mHealth apps without putting additional burden on health care providers

excluded from the study.

Caregivers of eligible adolescents were contacted via phone or email to inform them about the study. MU Family Medicine and Pediatric health care providers were contacted for the health care provider focus groups via email, and their average years of practice was more than 10 years. Consent forms were emailed to caregivers of adolescents who were interested in the study. They were required to provide informed consent via email for their adolescents and themselves. Email consent was also obtained from all providers who agreed to participate in the study. Participants were given the opportunity to clarify any questions about the study to confirm understanding, and withdraw from the study, if preferred. We compensated all participants with $50 e-gift cards from selected vendors such as Walmart, Target, and Amazon for their participation.

Focus groups

Focus group facilitators A.S.B., R.P., and R.J.K. led six individual focus groups, and at least one other researcher observed and recorded each focus group session. Each focus group lasted for approximately 60 minutes. A total of 25 participants participated in the focus groups. All six focus groups were conducted virtually using the Zoom© platform, and the groups included: female adolescents, male adolescents, caregivers, and health care providers. There were two focus groups for adolescents—one for male (2 males) and another for female adolescents (4 females). Two focus groups included caregivers—3 caregivers (1 male, 2 female) in one focus group and 4 (1 male, 3 female) in the other. The last two focus groups were conducted with health care providers—the first had 5 providers (3 females and 2 males) and the second had 7 (5 females and 2 males). Participants were presented with a static prototype of CommitFit. The static prototype incorporated all relevant app features. Participants were challenged to comprehend and construct meaning from the visual static prototype design of our mHealth app with little to no guidance from the facilitators and express their opinions about specific app features. Focus group questions and prompts were informed by semi-structured questions (*Table 1*) that were prepared by practicing clinicians and were designed to encourage broad feedback regarding preferences and usability of our mHealth app.

Table 2 Distribution of demographics of adolescents who participated in the study

Characteristics	Category	Participants
Gender	Male	2
	Female	4
Race	White/Caucasian	5
	African American	1
Age (years)	13	3
	15	3
Insurance	Managed Medicaid	1
	Commercial	4
	Private	1
Body mass index (percentile)	Less than 85th	5
	85th or more	1
Location	Rural	1
	Urban	5

Analysis

A traditional and comprehensive thematic analysis of qualitative data was conducted. Themes and quotes included in this paper focus mainly on common preferences of adolescents, caregivers, and health care providers for features and functionalities that encourage users to not only start but continue using mHealth apps.

Qualitative data analysis from the focus groups was conducted in three phases: an immediate team debrief, rapid qualitative analysis post-focus group, and thematic analysis of complied qualitative data. Team debriefing helped us to reflect upon and discuss what went well in the focus groups, and reach an agreement on specific variations, constructively redirecting our thoughts toward effective analysis of the data collected. Rapid qualitative analysis is a process of reviewing the focus group transcripts by researchers to identify key concepts of data collected pertaining to relevant iterative design processes. We used this method after each focus group to understand patterns of the participants' responses to specific mHealth app features in our visual static prototype that would motivate them to continue using such apps. This process helped develop a foundational understanding of adolescents' needs and preferences, and caregivers' and health care providers' perspectives regarding adolescents' adoption and sustained use of mHealth apps.

For our final phase of analysis, we de-identified and analyzed our focus group transcripts using inductive thematic qualitative analysis (52). This approach allows flexibility to dig deep into the data without any prior bias or conceptions (53). In the absence of a pre-existing frame, coding is accomplished by data driven analysis (52,53). The inductive approach helps identify and interpret themes that are strongly linked with the study data (54) which in turn provides insights into and understanding of the data set (55-58). Each focus group audio recording was transcribed using Microsoft 365 software followed by manual review by research team member (P.G.) to identify and remove errors. Next, researchers (P.G.) and (K.T.B.) worked individually, using Dedoose© software, to complete independent blind coding of the transcripts, and then worked together to develop a codebook following discussions and consensus on the validation of the findings. With the entire research team, themes were refined and reviewed to ensure reliability and accuracy. Throughout the process, frequent meetings were held to identify coherent patterns, and establish accurate representation of the data. Weekly team debriefings were also conducted to maintain transparency and ensure trustworthiness of our qualitative analysis. This process was repeated until the researchers were satisfied that they had reached the saturation point of identifying consensus coding. Final themes were coded by researcher (P.G.). Findings were organized into main themes and sub-themes. This was also facilitated by the organized structure we followed during the analytical process: maintaining and sharing of a code manual with team members for inspection and review, followed by finalizing the code. This structured process ensured that the codes and themes were supported by accuracy of data, establishing credibility. The adolescents' feedback, the caregivers' perspectives, and the health care providers' inputs facilitated convergence of the data.

Results

We recruited 6 adolescents (2 males, 4 females) (*Table 2*), 12 health care providers (7 females and 5 males) (*Table 3*) and 7 adult caregivers (1 male, 6 females) (*Table 4*) for a total of 25 focus group participants. Taking the focused nature of the topic into account, and given our target user population, our sample size is adequate to unfold the richness of data after reaching a saturation point when no new ideas are generated from focus groups (59,60).

Focus groups helped capture the preferred features

Table 3 Distribution of demographics of health care providers who participated in the study

Characteristics	Category	Participants
Gender	Male	5
	Female	7
Race	White/Caucasian	11
	American Indian or Alaska Native	1
Years in practice	More than 10 years	9
	5 to 10 years	3
Specialty	Family medicine	4
	Pediatrics	7
	Other	1
Education	Doctor of medicine (MD)	9
	Doctor of osteopathic medicine (DO)	2
	Psychologist	1

Table 4 Distribution of demographics of caregivers who participated in the study

Characteristics	Category	Participants
Gender	Male	1
	Female	6
Race	White/Caucasian	5
	African American	2
Insurance	Managed Medicaid	1
	Commercial	4
	Private	2
Location	Rural	1
	Urban	6

identified by adolescents and supported by their caregivers and health care providers. The following themes facilitating acceptability and long-term use of mHealth apps by adolescents for lifestyle management were uncovered.

Look and feel

Most of the caregivers and adolescents felt that aesthetic is important for mHealth app use because look and feel are important factors that encourage user adoption. They recommended mHealth apps that are easy and convenient to use, with simple fonts, bold graphics, and bright colors that are appealing to the eyes.

- ID 1: female adolescent, white, 13 years: "*Maybe the background could be a little more color, but the grays are ok because the color in front will pop it out more, so you pay more attention to the front. But if the background was just a plain color, then the pretty background takes away from the words and stuff you're trying to put across. But I do like the plain colors like the blue and the green and the purple down at the bottom.*" [adolescent].

Some recommended a user-friendly and mature interface.

- ID 2: female caregiver, white: "*I like the look of the app. I think it's clear, easy to read and it's not too juvenile, but still has fun colors and I kinda like it.*" [caregiver].

Health care providers also showed preference for lively colors and features that would keep the adolescents encouraged to use the app—one of the health care providers commented on "positive look" as "motivating".

- ID 2: female provider, white: "*Things that look positive with lots of colors, I think that could be really motivating.*" [provider].

Customization

Adolescents and caregivers identified feature-specific customization like personalized goal settings, data tracking and monitoring, and logging behaviors as important in engaging adolescents in continued mHealth app use. Many adolescents stated that goal setting would give them a sense of autonomy and personalization.

- ID 1: female adolescent, white, 13 years: "*Two to three hours or like one to two hours of a day [setting goals]. You'd be like I wanna do more than that, then you can set your goal a little more than that, and if it's too much, you can take it back down. Or if that's too less, you can set it somewhere in between, there is a wide variety of time in the day. Yeah, so that's a good.*" [adolescent].

As health care providers play an important role in preventing and managing chronic disease conditions in adolescents, they discussed the significance of setting individualized goals that would motivate healthy lifestyle changes.

- ID 4: female provider, white: "*Or we're going to add in a lot of the kids as we know don't want to eat vegetables, so, we're going to try to incorporate one or two more vegetables into our, on the week or however we decide on that and then exercise.*" [provider].

Adolescents showed interest in tracking/monitoring features such as learning about their water and sugary drink intake as well as their goals and amount of sleep.

- ID 4: female adolescent, white, 15 years: "*If it like tracks what you do, I think that really helps so you can see that you're improving*." [adolescent].

These features were also deemed important for adoption and continued use of mHealth apps and were endorsed by caregivers and health care providers.

- ID 5: female caregiver, white: "*I love that type of stuff, so even if there's something like once you're, on goal for so long, it's like tracking 'it for you'*" [caregiver].
- ID 4: female provider, white: "*A goal related to healthy eating and then a goal related to exercise and then I need you to work on it and then we'll talk about it. You know what your progress is at the next visit, so I think that's a great idea*." [provider].
- ID 1: male provider, white: "*It would be nice if it keeps track of that in some way that I would get a report like, if you're my patient, [name] that says you know [name]'s logged into the device three times in the last week*." [provider].

Although customization could help motivate continued use, participants also preferred some form of control over customization and notifications, as too many choices could create decision overload. It was preferred that frequency and types of notifications received be individualized. Some adolescents preferred frequent notifications acting as a motivator, whereas others preferred fewer notifications to reduce distractions or anxiety.

- ID 4: female adolescent, white, 15 years: "*It kind of motivated me to start getting to bed earlier just so that I could wake up and see it was really interesting to find out what my sleeping habits were*." [adolescent].

Educational information/recommendation

Adolescents and caregivers requested recommendations like healthy snacks and health care providers stated the importance of recommending physical exercises that would encourage sustainable healthy behaviors. Availability of easily accessible and free educational resources in mHealth apps also appealed to caregivers.

- ID 3: female adolescent, white, 15 years: "*I'm really bad at eating healthy so I think you would definitely need to put in like healthy recipes. So definitely adding healthy recipes would help*." [adolescent].
- ID 6: female caregiver, African American: "*So maybe ask the user as well as giving them options to snack ideas and exercising, tips and healthy choices. Ask them themselves, what you are going to eat today? They can think about what they're going to eat and make a healthy choice, so it can become easier*." [caregiver].
- ID 7: female caregiver, African American: "*I like it [mHealth app] give some ideas for healthy snacks. I think that would be really helpful they usually probably don't know, what to get exactly*." [caregiver].
- ID 4: female provider, white: "*Some kind of physical activity or something that I know. Sometimes it helps if the kids help remind their parents and it's something they want, then they'll buy into it and want to do it*." [provider].

Integration with EHR

Features that allow mHealth app users to export health data directly to health care providers for their review via EHR were supported by caregivers and adolescents.

- ID 5: male adolescent, African American, 13 years: "*I feel it'd be helpful to talk about it [sharing health data with health care provider]*." [adolescent].
- ID 7: female caregiver, African American: "*I think the ability to have communication is always a good thing. And then if I would like if they saw something they were concerned about or wanted to go in further to discuss than they [health care provider] could contact me*." [caregiver].
- ID 3: male caregiver, white: "*I think that would be helpful. Also, the child would know, here's my physician who has an invested interest in my health and that way, if there's anything else that comes up, there are lines of communication like and so those problems can be addressed*." [caregiver].

Users acknowledged the value of sharing information and appreciated the time saved. This feature could also facilitate direct, accurate, and honest conversation between adolescents and their health care providers.

Health care providers were particularly enthusiastic about mHealth app integration with the EHR as it could potentially improve quality of care through active feedback based on touch points, making it patient-centered and evidence-based. Importantly, EHR synced apps can also save health care providers time and improve patient outcomes by reducing the burden of collecting, analyzing, and documenting data (61-63).

- ID 4: female provider, white: "*Yeah, so that helped them keep track. Oftentimes they don't want to write it*

down, *but if it helps*, *I like that*." [provider].

- ID 5: male provider, white: "*In my experience*, *patients like to have some touch point*, *and sooner than three months*, *like in a month and I don't have any*. *So*, *I have started doing more of these touch-based sorts of visits on the portal*. *And so*, *whatever solution you come up*, *I think that would be helpful*" [provider].
- ID 6: female provider, white: "*Thinking about the feedback loop to the clinician*, *that's huge and I just wanted to make this comment*, *because when you look at other people using apps in very sophisticated ways or data systems*, *always being able to predict that you need to intervene is really helpful*." [provider].

Gamification

Gamification, as defined here, includes at least one of the techniques (rewards, games, badges, leaderboards, avatars, streaks) that can increase an adolescent's intrinsic motivation, promoting continued use of an mHealth app. Gamification is particularly effective in motivating adolescents and encouraging them to maintain sustainable health behaviors in a playful and goal driven manner (64). Adolescents and caregivers in our focus groups also endorsed the importance of using gamification in mHealth apps to boost continued use.

- ID 2: female adolescent, white, 15 years: "*I like the leaderboard because that would be fun*." [adolescent].
- ID 2: female adolescent, white, 15 years: "*I think that's a good idea [leaderboard] if you know them*." [adolescent].

Specifically, caregivers' responses regarding avatars also indicated a way to motivate adolescents to achieve intended goals of continued use and improved health behaviors. Both adolescents and caregivers advocated incorporation of fun games in mHealth apps, as games could motivate regular use, thereby ensuring improved outcomes.

- ID 6: female caregiver, African American: "*I like that you could do the avatar as well in any [look] change that*, *so that seems*, *you can make your avatar however you want it to be*." [caregiver].
- ID 6: male adolescent, white, 13 years: "*[Personalization of avatars] and like the skin color*, *those kinds of things*, *like my clothes*, *my shoes*." [adolescent].
- ID 4: female adolescent, white, 15 years: "*Yeah*, *like you can like upgrade it [gear for avatar]*. *I think that is a good idea*." [adolescent].
- ID: 4 female adolescent, white, 15 years: "*I mean there could be like a little game in between if you like hit your goal*." [adolescent].

Adolescents and caregivers opined that gamification could increase intrinsic motivations as well. Adolescents commented that they would use apps that motivate them by giving rewards and incentives.

- ID 4: female adolescent, white, 15 years: "*I would find it difficult to continue using the app every day if there isn't some sort of motivation*." [adolescent].
- ID 1: female adolescent, white, 13 years: "*It does really encourage you to log in and stay within your point system*." [adolescent].

Caregivers echoed similar thoughts and showed enthusiasm in incentivizing adolescents to facilitate continued use of mHealth apps. For adolescents lacking intrinsic motivations that are characterized by engaging in behaviors for one's own sake, tangible rewards in the form of gift cards or money were also suggested by caregivers to motivate them externally. Overall, rewards and incentives were recognized as powerful gamification techniques to engage users that could be utilized to motivate and involve adolescents in setting and achieving their own health goals. As voiced by an adolescent, there was also indication that rewards in the form of gear stores, points, and badges could help achieve healthy behavior goals.

- ID: 5 female caregiver, white: "*Be appealing with some type of reward*." [caregiver].
- ID 4: female adolescent, white, 15 years: "*Gamification features and making streaks really accessible and easy to document progress [goal towards healthy behaviors] straightforward*." [adolescent].

Finally, health care providers echoed the same perceived advantages and commented on 'positive reinforcement' and 'rewards' to motivate adolescents to start and continue using mHealth apps.

- ID 4: female provider, white "*A positive reinforcement for the children so that they remind their parents like*, *hey*, *if you do these many logins*, *maybe you get a pass to Bonkers*." [provider].

Social interaction/competition

Adolescents and caregivers felt motivated and engaged through social interactions and friendly competitions. The sense of belonging in a group played a significant role in the adolescents' desire to continue use of mHealth apps.

Competition was well supported by both the caregivers and the adolescents. Healthy competition could encourage

adolescents to improve their eating habits and maintain good strategies for sustainable positive behavior like physical exercising.

- ID 3: male caregiver, white: "*My daughter is motivated by competition so I know if all of a sudden, she was competing with friends and it said you have one hour like all randomly throughout the day or whatever you have one hour to get 100 jumping jacks and she would stop what she's doing to get them all done. [Friends] would be racing against each other and this, you know, happens randomly throughout the day and they have to log it done at 1:00, right? that type of stuff.*" [caregiver].
- ID 2: female adolescent, white, 15 years: "*I would like working out with people who want the same like goals as you and like they push you, but not too far.*" [adolescent].

Health care providers too felt that interactions with family members would be helpful and encouraging for adolescents to use the app.

- ID 1: male provider, white: "*So just having it, at least in a way that appear, a child could interact with the tool.*" [provider].
- ID 1: male provider, white: "*For doctors what would be helpful if we're going to encourage families to use this tool.*" [provider].

However, some of the adolescents and caregivers were concerned that competition could become unhealthy if adolescents felt pressured to be compared to their peers, and that it could cause dissonance or emotionally detrimental effects if they lost.

- ID 3: female adolescent, white, 15 years: "*I like that idea, but I would make it optional because I know there are some people that are really really competitive and love that kind of stuff. But there's also some people that would maybe get demotivated if they saw somebody else just doing really good and think, oh I don't think I could get there.*" [adolescent].
- ID 5: female caregiver, white: "*For some people that might help them who are like a little bit more competitive, but not for others.*" [caregiver].

Discussion

Key findings

Analysis of qualitative data collected via focus groups conducted in this study with adolescents, caregivers, and health care providers who were presented with a static prototype of our mHealth app, led to the identification of six key themes that motivate and influence adolescents to start and continue using mHealth apps. We learned that engaging app features, such as user-friendly interfaces with appealing look and feel, were important facilitators of mHealth app adoption among adolescents, while customization with personalized settings, tracking, etc. reinforce desired behaviors. Social interaction was another major facilitator of app use and adoption among adolescents. Participants reported that adolescents would be more likely to try a particular mHealth app if it incorporated gamification or game elements and tangible rewards. All stakeholder groups advocated for integration of mHealth apps into the EHR. Another important theme that was embraced by adolescents, caregivers, and health care providers for sustained usage of mHealth apps was the inclusion of educational information and recommendations related to lifestyle management.

Although adolescents have identified some of these themes as significant in previous studies (25), the app features associated with these studies were designed primarily for adults (25) and failed to address the adolescents' specific preferences. One of the principal reasons for poor uptake of mHealth app interventions may rest at the core of the design process. As reported by Chan *et al.* in 2017, only 22.5% of mHealth app development efforts captured feedback from adolescents prior to designing the app (25). Understanding features that elicit adolescents' motivations to use mHealth apps is crucial as it determines how best to tailor the app to facilitate continued use (65). While a handful of studies have focused on adolescents' attitudes towards mHealth apps, in this study, we have also systematically collected qualitative data on features that are supported by caregivers and health care providers, two key stakeholders involved in the cycle of care. Insights gained from this study may inform future app developers and health care researchers about mHealth app preferences for sustained use that can potentially improve health behaviors among adolescents.

Overall, findings from this study emphasize the importance of mHealth apps focusing on individual health behavior goals for effecting sustained positive changes among adolescent users.

Strengths and limitations

There are several limitations to our study. This qualitative study is limited to a relatively small sample size. Due to coronavirus disease 2019 (COVID-19), the focus groups were conducted using the virtual platform Zoom©,

leaving a possible gap in capturing the nuances and subtle expressions of participants which would otherwise be feasible in a face-to-face conversation. Some of the participants were common across focus groups. While we were inclusive in recruiting participants, female adolescents dominated in the adolescent focus groups compared to male participants. Similarly, while we attempted to recruit participants from diverse ethnic backgrounds, there was an overrepresentation of white/Caucasian individuals in our focus groups. To address these shortcomings, we will try to recruit and capture insights from male adolescents, and overall, participants of diverse ethnic backgrounds in our future trials. mHealth apps are not a one-size fits all solution. Therefore, different adolescent users tend to value and identify features in their own ways. Additionally, due to social desirability, participants say what they think researchers want to hear, and thus, there is a limitation in terms of identifying features that work best for all in any targeted population. Although there are several limitations in this study, a major strength of this study is its qualitative research approach. Conducting multiple focus groups with adolescents as well as caregivers, and health care providers allowed us to capture elaborate thoughts and suggestions from all participants. As a result, the study was able to apprehend insights and nuances from all three groups making this study robust in its own way.

Comparison with similar research

Participation of adolescents, caregivers, and health care providers in multiple focus groups allowed the capture of elaborate thoughts and suggestions from all stakeholders—this apprehension of insights and nuances makes this study robust in its own way. All previous studies addressing mHealth apps for adolescents were limited in reporting only features identified by the direct users (25,64). Despite their evolving independence, caregivers play a role in adolescents' lives and particularly in decisions regarding purchasing, downloading, and use of mHealth apps. Thus, they are in a strong position to influence their adolescents' desire for adoption and continued use of health management features and tools that improve health behaviors. The active engagement of clinicians in design of mHealth apps for supervision of their adolescents' health choices provides a layer of confidence for adolescents and caregivers. Caregivers also agree that the ability to engage meaningfully with health care provider inputs using mHealth apps in the home setting provides an added layer of clinical accountability for their adolescents and facilitates continued integration of medical advice in their care.

We determined that the look and feel of mHealth apps can pique adolescents' interest, e.g., bright colors and a mature interface with visuals appeal to the adolescent population (66). The use of contrast and bright colors has also been found to assist colorblind users (67). It is crucial that color is used in an effective and impactful manner (68) to capture users' attention, while not making it overwhelming. Adolescents in the Chan *et al.* 2017 and Bosworth *et al.* 2023 studies expressed colorful design to be desirable, which aligns with our findings that contrast and bright colors are preferred for their visual appeal (25,26). Although a recent study has shown potential harm of social media to adolescents, further evidence suggests that exchange of information among adolescent peers who share similar health conditions empowers them to manage self-health care (69). The significance of social interactions is also illustrated by other studies (70,71) that state that social interactions foster a sense of community among users. Access to another complementary feature, namely, the ability to follow individualized recommendations such as custom exercise and diet regimens inspires healthier habits among adolescents in contrast to excessive exercising and teasing that can lead to depressive symptoms (72,73), eating disorders and potential serious risks (74). Oversight of adolescent app use by caregivers and health care providers can mitigate some of these risks.

In this study, we found that gamification is an important element in encouraging mHealth adoption and long-term use. Interestingly, although a previous study (75) concluded that the gamification feature does not influence user ratings of app review, other studies like Primack *et al*. 2012, Miller *et al*. 2016, and Chan *et al*. 2017 established that apps with gamification integrate new challenges (25,76,77), inspiring self-motivation among adolescents to continue using them (78) and engaging in sustainable health behavior patterns. While another study (25) showed that overly complex apps with competing priorities may act as a barrier to the adoption of mHealth apps, our study indicates that appropriately aligned priorities that encourage social interaction through healthy competition can overcome such perceived barriers.

Explanations of findings

The mHealth features identified by adolescents and supported by caregivers and health care providers in this study are expected to play an important role in motivating

adolescents to not only start using such effective mHealth apps but also continue using them for long-term sustained health management. This is especially significant as most lifestyle management mHealth apps lack the motivational features required to influence adoption and continued use after initial download. The findings from this study are also well positioned to inform future development of similar mHealth interventions targeting adolescents.

CommitFit encompasses the basic elements of a lifestyle management mHealth app including features such as setting personal health goals, monitoring health behaviors like physical activity and healthy diet, etc. While this study focuses on the use of CommitFit as a tool for management of healthy weight, our user-centered design approach, informed by the most common features and functionalities of lifestyle management mHealth apps, reinforces the universal applicability of our themes to mHealth apps in general, including apps commonly used for management of chronic diseases like diabetes. Thus, insights from this study can broadly help diverse stakeholders like caregivers, providers, and other professionals involved in the care of adolescents. Developers can incorporate the app features/themes identified in this study to design apps that are goal-oriented (e.g., health behaviors), practical and for targeted patient populations. Common mHealth app features such as look and feel, customization, education, and recommendations on health topics, EHR integration as well as implementation of gamification methods to specifically improve the efficacy of goal setting and health behavior monitoring can boost continued use of mHealth apps. App designers can design their apps with bright and contrast colors so they are appealing to adolescents, while the ability to customize can play an important role in tailoring apps to the needs of the younger tech advanced generation. Education and resources could inform and inspire the target audience to improve their health behaviors, while integration with EHR for shared decision-making could better connect providers and other health care professionals with adolescents and caregivers thereby adding to the continuum of care through self-management. Lastly, gamification is a key feature that can motivate users to continue using mHealth apps for betterment and maintenance of a healthy lifestyle.

The features that were found to be pivotal for long-term adolescent use were look and feel, customization, gamification, educational information/recommendation, integration with EHR, and social interaction/competition. In this study, participating caregivers and health care providers also acknowledged the crucial role they envision these features playing in encouraging adolescent engagement. Among the above-mentioned themes, two were identified to be especially significant—gamification and social interaction features. Gamification was recognized as an extrinsic motivator for adolescents, while social interaction was perceived as valuable by caregivers and health care providers.

Implications and actions needed

The study provides preliminary evidence on common mHealth app features desirable to adolescents and their caregivers and supported by health care health care providers in managing chronic health conditions. Considering our findings, the authors recommend more qualitative studies on the preferences of adolescents and caregivers for mHealth app development, specifically in using emerging technologies like artificial intelligence. Further evaluation is needed to understand if adolescents' preferred features actually result in increased app usage and retention. Additionally, our findings should stimulate further research to explore the psychology of gamification and its use in promoting positive health behaviors. A deeper dive is necessary to explore the roles gamification and social interaction can play along with caregivers' and health care providers' engagement in adolescent lifestyle management through use of mHealth apps. The insights gathered from this study will equip future app developers design more robust solutions for younger generations. Lastly, it would be significant to explore issues related to data privacy, protection and sharing to ensure no harm is caused to adolescent users.

Conclusions

Despite a significant increase in number of adolescent mHealth apps in the last several years, most of them are scaled down versions of adult mHealth apps and have limited features that adolescents prefer. Alleviating this aberration could lead to widespread adoption and continued use of mHealth apps among adolescents, thereby facilitating access to important tools that could positively impact management of chronic health conditions through lifestyle changes. Since caregivers play a key role in adolescents' health decisions, we also captured their preferences to ensure inclusion of mHealth app design elements that they envision as motivating and improving long-term app

use. Finally, the involvement of health care providers in designing mHealth apps and supporting adolescents' use could lead to the development of apps with broader appeal and more effective integration into the clinical cycle of care. This could also potentially result in sustained use, thus meeting the overall goal of empowering adolescents to take control of their own health and feel more informed and engaged in improving their health behaviors. The insights and results from this study will help developers and researchers of mHealth apps better understand the importance of incorporating desirable and targeted features and sharing patient health care data with health care providers in a meaningful and efficient manner.

Additional research is needed to not only explore the impact of mHealth apps on larger and diverse populations of adolescents, but to also better understand additional features and functionalities that prompt and sustain positive health behavior changes.

Acknowledgments

Funding: This work was supported by the University of Missouri (MU) TRIUMPH (Translational Research Informing Useful and Meaningful Precision Health) grant and the University of Missouri Coulter Biomedical Accelerator. The content is solely the responsibility of the authors and does not necessarily represent the official views of TRIUMPH, the University of Missouri Coulter Biomedical Accelerator or the University of Missouri-Columbia.

Footnote

Data Sharing Statement: Available at https://mhealth.amegroups.com/article/view/10.21037/mhealth-24-3/dss

Peer Review File: Available at https://mhealth.amegroups.com/article/view/10.21037/mhealth-24-3/prf

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://mhealth.amegroups.com/article/view/10.21037/mhealth-24-3/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the University of Missouri's Institutional Review Board (#2054598) and informed consent was obtained from all individual participants.

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doi: 10.21037/mhealth-24-3
Cite this article as: Ghosh P, Proffitt R, Bosworth KT, Koopman RJ, Flowers L, Wilson G, Tosh AK, Braddock AS. mHealth app features that facilitate adolescent use for lifestyle management, and are endorsed by caregivers and health care providers. mHealth 2024;10:21.